THE MEKONG RIVER COMMISSION SECRETARIAT

Flood Damages, Benefits and Flood Risk in Focal Areas

The Flood Management and Mitigation Programme, Component 2: Structural Measures & Flood Proofing in the Lower Mekong Basin

December 2009

Draft Final Report, Volume 2C

Deltares Enabling Delta Life Delft Hydraulics

ROYAL HASKONING

HASKONING NEDERLAND B.V.

UNESCO IHE

CONTENTS

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1 INTRODUCTION

1.1 Guide to the reporting structure of the Flood Management and Mitigation Programme - Component 2, Structural Measures and Flood Proofing

Component 2 on Structural Measures and Flood Proofing of the Mekong River Commission's Flood Management and Mitigation Programme was implemented from September 2007 till January 2010 under a consultancy services contract between MRCS and Royal Haskoning in association with Deltares and Unesco-IHE. The Implementation was in three stages, an Inception Phase, and two Implementation Stages. During each stage a series of outputs was delivered and discussed with the MRC, the National Mekong Committees and line agencies of the four MRC member countries. A part of Component 2 - on 'Roads and Floods' - was implemented by the Delft Cluster under a separate contract with MRC. Component 2 prepared five Demonstration Projects which have been reported separate from the main products.

The consultancy services contract for Component 2 specifies in general terms that, in addition to a Final Report, four main products are to be delivered. Hence, the reports produced at the end of Component 2 are structured as follows:

Volume 1 **Final Report**

Volume 2 **Characteristics of Flooding in the Lower Mekong Basin**
Volume 2A *Hydrological and Flood Hazards in the Lower Mekong Basin;*
Volume 2B *Hydrological and Flood Hazards in Focal Areas;*
Volume 2C *Flood Damages, Benefits and Flood Risk in Focal Areas;*
Volume 2D *Strategic Directions for Integrated Flood Risk Management in Focal Areas.*

Volume 3 **Best Practice Guidelines for Integrated Flood Risk Management**
Volume 3A *Best Practice Guidelines for Flood Risk Assessment;*
Volume 3B *Best Practice Guidelines for Integrated Flood Risk Management Planning and Impact Evaluation;*
Volume 3C *Best Practice Guidelines for Structural Measures and Flood Proofing;*
Volume 3D *Best Practice Guidelines for Integrated Flood Risk Management in Basin Development Planning;*
Volume 3E *Best Practice Guidelines for the Integrated Planning and Design of Economically Sound and Environmentally Friendly Roads in the Mekong Floodplains of Cambodia and Vietnam*[1]*.*

Volume 4 **Project development and Implementation Plan**

Volume 5 **Capacity Building and Training Plan**

Demonstration Projects
Volume 6A *Flood Risk Assessment in the Nam Mae Kok Basin, Thailand;*
Volume 6B *Integrated Flood Risk Management Plan for the Lower Xe Bangfai Basin, Lao PDR;*
Volume 6C *Integrated Flood Risk Management Plan for the West Bassac Area, Cambodia;*
Volume 6D *Flood Protection Criteria for the Mekong Delta, Vietnam;*
Volume 6E *Flood Risk Management in the Border Zone between Cambodia and Vietnam.*

The underlying report is **Volume 2C** of the above series.

[1] Developed by the Delft Cluster

1.2 Flood damages, benefits and risk in the Focal Areas

In this Volume, results of the Socio-Economic Surveys that have been carried out as part of the FMMP-C2 assignment are reported, along with the analysis of the results in terms of flood damages and risks. Surveys have been carried out in three districts in the Vietnamese Mekong Delta, in four districts in Cambodia, in two districts in Laos and two districts in Thailand.

In all the surveyed districts in Vietnam, Laos and Cambodia and Thailand, the district officials have been visited and baseline and flood damage information has been collected from them. In addition, 746 Household and 122 Business surveys have been carried out with individual households and businesses to document their direct and indirect damages during the 2006-flood.

Focus Group Discussions have been held in 26 communes or districts to document social aspects, vulnerability and benefits of flooding.

The resulting direct and indirect flood damages have been related to maximum water levels on a provincial (Vietnam only) and district level for three categories of damage: (i) Infrastructure & Relief, (ii) Housing and (iii) Agriculture.

In combination with the flood hazards as established by the long term ISIS maximum water levels for the respective districts, flood risks curves could be established. From these curves the potential damage reduction by flood control measures has been established. In Thailand, the damages had to be related to direct observations at twoo measuring stations.

On the basis of the Household and Business survey results, also damage curves for houses in relation to inundation depth could be established. Similar curves for Agriculture have been estimated on the basis of the information obtained during the Focus Group Discussions.

Environmental risks in general and for the Focal Areas are presented, followed by the Social aspects of flooding.

The Survey of the Nam Kok focal area in Thailand was delayed and the data processing and social analysis was completed in 2009 during Stage 2 of FMMP-C2 and has been integrated in this report.

1.3 Methodology and approach for flood damage assessments

There are basically two approaches for flood risk assessment: a top-down and a bottom-up one. In the top-down approach historical damage data for an (administrative) area are used to assess the flood damage risk in that area. In the bottom-up approach inundation-damage relationships are developed on a per unit (ha, house) basis, and the flood damage risk is assessed by applying the per unit risk to the number of units in the concerned area. In this study both approaches have been followed for damages to Housing and Agriculture; for Infrastructure & Relief only the top-down approach could be applied.

Flood risk management can only be done properly when there is a clear picture of the actual flood risks in the LMB. For the assessment of these risks, knowledge is required of the flood characteristics and also of the impacts of floods in terms of damages and benefits. Flood damage curves are prepared on the basis of this information to show the relation between the depth of flooding and the damaged caused, and are then used to analyse the risks. Only when these risks are well understood can proper measures be designed for the reduction of these risks without losing the flood benefits.

The grand total of damages caused by a flood in a certain area is the total of direct damages plus the total of indirect damages and minus the total flood benefits. Direct damages are primarily from:

- Loss of life and injuries: Number of people killed, missing and injured by the flood; treatment costs for the injured persons;
- Damages to properties in the targeted areas such as houses, schools, offices, commercial & industrial buildings and installations, hydraulic works, energy, transportation and other infrastructures and supplies/assets of individuals and businesses. These damages depend on the magnitude and duration of the flood. The damages to properties are the costs of replacement or restoration of an affected structure and inventories;
- Crop damages depend on the depth, timing and duration of a flood. The bigger the flood, the more submerged cultivated area sustains bigger losses. However, if flood occurs after harvesting, there would be no crop damage at all;
- Livestock and agricultural equipment depends on the magnitude and duration of the flood. The damages to livestock are the costs of livestock lost or the loss of income due to a distress sale. The damages to agricultural equipment/tools are the cost of replacement or restoration of these assets.

Indirect damages, among others, are from:

- Costs of illness of humans and livestock related to poor environmental conditions and increased water-born diseases. These costs including additional cost of health care that families and individuals spend more compared to condition of 'no flood'; and additional expenditures from local government for disease prevention and treatment and for sanitation control during the flood;
- Income losses due to disruption of economic activities and/or services by the flood for (i) individuals, landless labourers, families and enterprises; (ii) large commercial and industry enterprises that have been partly or fully closed down for some period of time during high flood water level;
- Higher costs of living due to temporary relocation, purchase food that otherwise would be available from the family farm, lack of basic supply as save water and electricity, additional cost for transportation and daily activities;
- Costs of temporary relocation and rescue are the cost that local government agencies and NGOs incur before, during and after the flood to support affected people living during the flood and recovering at after the flood;
- Cost of prevention measures are incurred by individuals, households, enterprises and institutions before and during the flood;
- Costs of cleaning and sanitation after the flood are mainly labour mobilization by individuals, households, enterprises and institutions to clean their houses and buildings.
- Other costs include the negative impacts of flooding on tourism revenue, loss of income or revenue for people or enterprises outside the target areas, loss in social stability, problems in income distribution and confidence of people in the Government and other forward and backward economic linkages are omitted from the study as no data are available or could be collected on these issues.

Benefits of flooding are primarily from:

- Fishery flood water provides habitat for fish (breeding grounds and nursing and growing environment). Natural fish is an important resource for people living in the LMB. The quantity of natural fish would be reduced in case of a low flood level; it depends on the magnitude, timing and duration of flood, but the best indicator is the flooded area;

- Agricultural production Flood water (i) brings sedimentation for the flood plain; (ii) flushes toxic substances from the cultivated soil; (iii) flushes acids from acid sulphate soil areas; (iv) kills the rats and pests; (iv) speeds up the process of plant residue disintegration; (v) improves soil structure; and (vi) provides soil fertility. This impact could be measured by net benefit from agricultural production after a year with a high flood as compared with a year with a normal flood;
- Bio-diversity conservation Flooding plays an important role in maintaining bio-diversity values for Mekong River Basin, especially in the wetlands in the LMB. There are a few studies on these positive impacts, but their values in monetary-terms are not available.

1.4 Focal areas

From the review made during the inception phase of FMMP-C2 it appeared that damage data that are readily available in the four MRC-member countries refer to a limited set of direct damages aggregated at provincial or even national level. These data alone were considered inadequate for a flood vulnerability assessment, let alone for the establishment of flood damage curves. It was therefore decided to launch campaigns of primary and secondary data collection in the four countries.

As the present project does not allow for basin wide data collection and survey work at the required level of detail, it was decided during the inception phase to carry out detailed data collection and socio-economic surveys in the selected focal areas, as these focal areas are the areas where the implementation of the demonstration projects is anticipated. These focal areas were identified and agreed by MRC, NMC's, and Consultants during the Inception Phase. They are described below and are indicated in Figure 1.1.

Thailand:

- Lower Nam Kok (flash and combined mainstream and tributary floods). In this area the focus will be on flood risk assessment, in coordination with the IKMP, and the preparation of an IFRM strategic direction and plan for the Lower Nam Kok. From this plan projects may be identified of which one could be selected as a demonstration project.

Lao PDR:

- Bank protection in Bokeo province. In this area the focus will be on the assessment of damages due to bank erosion and on the formulation of a strategic direction for bank protection and of feasible measures to reduce erosion damages. Such measures could be included in the ProDIP and eventually be selected as demonstration project.
- Lower Xe Bangfai basin (combined mainstream and tributary flooding). In this area the focus will be on the flood risk assessment in the Lower Xe Bangfai and the preparation of an IFRM strategic direction and plan for this area. In this area IFRM should not only refer to the present situation but also take into account the potentials for development of the flood prone area. From this plan projects may be identified of which one could be selected as a demonstration project. However, only one demonstration project has been envisaged for Lao PDR.

Cambodia:

- Bank protection in Kratie province. In this area the focus will be on the assessment of damages due to bank erosion and on the formulation of a strategic direction for bank protection and of feasible measures to reduce erosion damages. Such measures could be included in the ProDIP and eventually be selected as demonstration project.
- Right Bank Bassac River south of Phnom Penh Municipality (Takeo, Delta flood). In this area the focus will be on flood risk assessment under present conditions, but also taking into account different development scenarios for this area. An IFRM strategic direction and plan

will be developed that not only aims at the reduction of the actual and future flood damage risks in this area, but that will also consider options for flood risk reduction in the cross border area in the Vietnamese Long Xuyen Quadrangle. (see also under Vietnam). It is envisaged that from the IFRM plan a number of projects will result for ProDIP and also a demonstration project.

- Left Bank Mekong River south of the National Road No 1 (Delta flood).: In this area the focus will be on flood risk assessment under the actual conditions and also taking into account the development potentials of this area. Possibilities for flood risk reduction in this area in relation with IFRM in the cross border Plain of Reeds (see also under Vietnam) will be investigated.

Vietnam:

- Plain of Reeds (Delta flood). In this area the focus will be on flood risk assessment and the preparation of an IFRM strategic direction and plan. In this plan also options for reduction of flood risk in the Cambodian cross border area of southern Prey Veng province will be considered. It is envisaged that from this IFRM plan a number of projects will result for ProDIP and also a demonstration project.
- Long Xuyen Quadrangle (Delta flood): In this area the focus will be on flood risk assessment under the actual conditions and also taking into account the development potentials of this area. Possibilities for flood risk reduction in this area in relation with IFRM in the cross border Takeo area (see also under Cambodia) will be investigated.

1.5 Data collection

Primary and secondary data have been collected from local (Provincial and District) officials, households and businesses, to establish an inventory of flood vulnerability characteristics and direct and indirect flood damages.

Focus group discussions with people living and working in the project areas have been held to provide insight into a range of relevant issues such as the benefits of flooding, traditional coping mechanisms and community resilience.

The surveys have been held to collect and/or validate existing information on direct damages for an agreed reference flood; and, to the extent possible, and to document and quantify indirect damages associated with the reference flood event. For this purpose the 2006 flood was selected as this flood can be considered an 'average flood' and as this year was considered recent enough for respondents to remember with an acceptable level of accuracy. During the Household and Business interviews respondents have been asked to also estimate damages in case the flood water would have reached higher level than in 2006. During the meeting with Provincial and District authorities flood damages have been collected for as many years as were available in their records.

The sources of data on direct and indirect damages included interviews with the following groups:

Provincial and District officials: Review and validation of existing data on casualties and direct damages caused by historic flood/erosion events. This is an extensive listing in kind and in monetary terms of damages occurred in the recent past. The categories to be considered are: human, housing, education, health care, structures, agriculture & forestry, irrigation & flood protection infrastructure, fisheries, transport, communication, power, industry, construction, water & sanitation. In addition there are the cost incurred by the district/provincial/national government for emergency flood prevention, temporary relocation, rescue and emergency supplies. Care was taken to include in the district data also the share of damaged provincial and national infrastructure.

Interviews with relevant officials were used to collect information on indirect costs caused by flooding/erosion for a single recent reference year in which significant flooding/ erosion occurred (2006), using the survey tool developed by the project for this purpose. Damage categories included educational facilities, healthcare facilities and assets, road and transport facilities, irrigation facilities, water supply & sanitation infrastructure, power facilities, and communication infrastructure.

Households: collection of data of individual households in the envisaged project areas for a particular reference year in which significant flooding/erosion occurred (2006). Data collection included household characteristics, characteristics of the recent flood(s), losses to residential structures, hypothetical damages to the residential structures in the case the inundation depth would have been higher, agricultural assets/incomes, crop losses, livestock losses, fish/shrimp losses, other HH income sources (e.g., home-based businesses, hired labour) and health impacts.

Local businesses (non home-based): collection of data of individual businesses in the envisaged project areas for a particular reference year in which significant flooding/erosion occurred (2006). Data collection included business data, characteristics of the recent flood(s), direct and indirect damages to business structures, equipment and inventory, impact on revenues and employment, and expenditures for flood protection.

In addition, the field work in each study area included:

Baseline flood vulnerability data collection: In consultation with local district and/or commune officials and existing databases, data are to be assembled to document key aspects of flood and erosion vulnerability including population composition and growth, number of households, household assets, economic activities, poverty incidence, land ownership, land use and cropping patterns, fisheries production, animal husbandry, types of structures and infrastructure. In addition, the baseline captures data on business activities, educational facilities and assets, healthcare facilities and assets, road and transport facilities, irrigation facilities, water supply & sanitation infrastructure, power facilities, and communication infrastructure. These data are to be incorporated into the flood data database, as well as being used in the formulation of flood risk management strategies and preparation of the demonstration projects.

Focus groups on community resilience: The survey team facilitated focus groups with local leadership, community/mass organizations and men and women living in the study area who represent different economic activities and wealth groups are used to collect qualitative information on the beneficial and detrimental effects of floods and erosion. A Guide for these discussions had been prepared to ensure that the various groups follow the same pattern and that results could be compared and analysed. The focus group discussions covered issues such as the history of flooding in the area, their perception of ‘good’ and ‘bad’ floods, benefits of floods for paddy cultivation and fishing, traditional coping mechanisms and strengths and weaknesses of community preparedness and resilience to flooding.

For each of the above mentioned approaches a survey tool was developed by the Consultant. The tools consist of questionnaires for the first three approaches and a guideline for the focus group discussions. For focal areas where bank erosion is the issue, a revised methodology has been developed to collect data at district level for each relevant river bank section; no household or business interviews and no focus group discussions were held there:

- Questionnaires for Provincial & District Inventory of direct flood damages/bank erosion
- Questionnaires for District Flood vulnerability/bank erosion baseline database
- Questionnaires for District flood events/bank erosion

- Questionnaires for District Indirect flood/bank erosion costs
- Guide for Focal Group discussion
- Household questionnaire
- Business questionnaire
- National Report outline

These documents have been translated into the local languages as required and spreadsheets for questionnaire analysis were prepared and were provided to the survey team, along with a guideline to prepare a national report.

Survey teams consisting of a team leader and a number of enumerators were contracted in each of the MRC-member countries to carry out the surveys. The Team Leaders were in charge of overall planning, translation of the survey tools (questionnaires) into the local language, the district and focal group discussions, data entering and the preparation of a National Report. The enumerators did the household and business interviews. The survey work was carried out in April-May 2008 in Laos, Cambodia and Vietnam. All surveys started with an introduction and orientation meeting at Provincial and District level of the concerned provinces and districts in order to inform the relevant authorities and to solicit their cooperation. All survey teams have been equipped with GPS-receivers to record the location of the individual households and businesses selected for the survey.

All teams were trained by the project consultant. In this training the purpose of the surveys was explained and the individual questionnaires were discussed in detail.

To process the data from the questionnaires, spreadsheets have been developed by the Consultant. The national survey teams have prepared country reports in which they reported their experiences with the questionnaires and the results of the focal group discussions, along an outline for these reports provided to them by the Consultant. An overview of the focal areas, districts, communes and the surveys conducted is presented in Table 1.1. The locations of the individual households and businesses surveyed under this project are shown on the map in Appendix A.

Samples of the questionnaires, the focus group discussion guide for the mainstream areas and a guideline to prepare Survey Reports are provided as soft copies in English and in the four local languages in the Flood Damage Database. This database is described in detail in Annex 9. In this database also the spreadsheet models for data processing are available.

1.6 Damage categories

For analysis purposes three main damage categories have been distinguished:

- Infrastructure & Relief includes educational facilities and materials, medical facilities, materials and equipment, irrigation infrastructure, bank erosion, fisheries infrastructure and equipment, transport infrastructure and equipment, communication infrastructure and equipment, industrial infrastructure and equipment, construction materials and equipment, drinking water and sanitation infrastructure and equipment, rescue operations, support and relief;
- Housing include collapsed and swept away houses, partly damaged or submerged houses, damaged roofs and other private property damage, cultural & historical structures, offices, small industrial units, markets & commercial centres and warehouses;
- Agriculture includes rice areas, flower & vegetable areas, other annual crops, perennial crops, large and small livestock and poultry, damaged agro-chemicals and erosion of farm land and housing land.

1.7 Flood levels for damage assessment

The flood levels used in the analysis are the levels simulated by the ISIS hydraulic model (see Appendix 7 to Annex 1) for the 97 years between 1910 and 2006. These levels are not identical to the observed levels at particular gauging stations, but cover the whole flood prone area of the Mekong Delta down stream of Kratie. For 2007 there are flood damage data available, but no ISIS-water levels, hence the 2007 flood damage data could not be used in the assessment. The 2007 flood was a small flood, so not using these damage data is not regarded as affecting the quality of the analysis much.

The flood damages to Infrastructure & Relief and to Housing have been assumed to be related mostly to the maximum flood level. Flood damages to Agriculture in the Vietnamese part of the Mekong Delta have been related to the highest flood level before 1 August, as the deep flooded areas have been fitted with flood protection dykes that under normal conditions protect the Summer-Autumn rice crop. This crop vacates the land before mid-August.

In Cambodia there is generally no protection against early flooding. Therefore in Cambodia the damages to Agriculture have been related to the maximum flood level as is used also for Infrastructure & Relief and for Housing.

For the damage assessment of the An Giang and Dong Thap provinces, the damages have been related to the observed water levels in the main rivers at Chau Doc (on Bassac) and at Tan Chau (on the Mekong) respectively.

The damages in the Vietnamese districts Chau Phu (An Giang), Tan Hong and Tam Nong (Dong Thap) have been related to the water levels at the district towns as simulated by ISIS for the ISIS-points LX963, TAN07987 and TCC33165 respectively.

The damages in the Cambodian districts Koh Andet (Takeo province), Koh Thom (Kandal province) and Kampong Trabek (Prey Veng province) have been related to the ISIS water levels of the district towns for Koh Andet (ISIS-point TKFP1) and Koh Thom (ISIS-point B280000). For Kampong Trabek they have been related to the water levels in Borey Cholsar (ISIS-point sp34d), as this location is more representative for the flooding in this district than the district town.

For the Xe Bangfai focal area in Laos, the Nongbok district flood damage data have been related to the annual maximum water levels in the flood plain on the right bank of the Xe Bangfai river (ISIS-point sp70d) for the categories Infrastructure & Relief and Housing, as the flood damages in these categories are expected to mainly depend on the maximum level of flooding.

The flood damages to Agriculture (mainly paddy cultivation) depend very much on the timing of the flood. There are two main seasons of paddy: (1) Wet season paddy is planted in June and harvested in November; and (2) Dry season paddy is planted in December and harvested in April where irrigation water available during the dry season. Flood damage to Agriculture is mainly for the wet season paddy. Unlike agriculture in the Lower Mekong in Vietnam, where the early flood would affect the paddy, in Nongbok Agriculture is affected by the main flood. Therefore the maximum flood water level has been used for the analysis of agricultural damages.

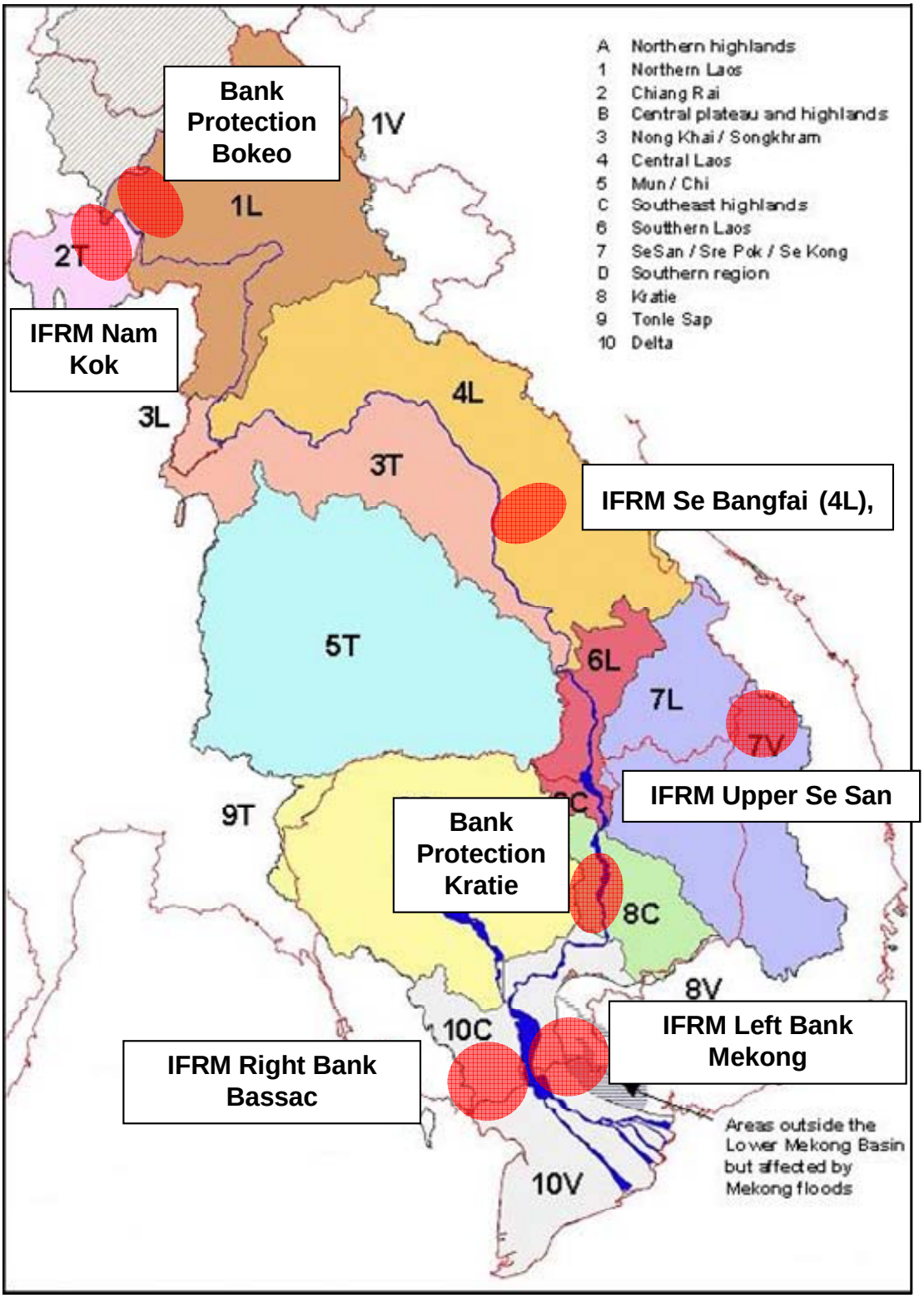


Figure 1.1 The location of focal areas

Table 1.1 Flood damage survey schedule

Focal Area	Country	Provinces	Districts	Communes/ Sub-district	Flood Issues	District-Level Flood vulnerability Baseline	District-Level Direct and Indirect Costs	District Flood Events	Direct flood/ erosion damage inventory	Focus Groups	Household Surveys	Business Surveys
RB Bassac	Cambodia	Takeo	Koh Andet	Prey Yuthka	Mainstream	Yes	Yes	Yes	No	No	2	14
				Rominh						Yes	38	1
				Pech Sar						Yes	41	
		Kandal	Koh Thom	Leuk Dek	Mainstream	Yes	Yes	Yes	No	Yes	45	
				Prek Thmey						Yes	45	2
LB Mekong		Prey Veng	Kampong Trabek	Cham	Mainstream	Yes	Yes	Yes	No	Yes	15	
				Kampong Trabek						Yes	45	
Kratie		Kratie	Kratie	Samboc, Thma Krae, Krakor, Kratie, Roka Kandal, Bos Leav	Bank erosion	Yes	Yes	Yes	No	No	No	No
Xe Bangfai	Lao PDR	Khammouane	Nongbok	Xe Bangfai	Combined: flash / mainstream	Yes	Yes	Yes	Yes	Yes	48	16
				Mekong bank					Yes	Yes	22	4
Bokeo		Bokeo	Houixai Ton Pheung		Bank erosion	Yes	Yes	Yes	Yes	No	No	No
Nam Kok	Thailand	Chiang Rai	1 district									
RB Bassac	Vietnam	An Giang (LQX)	Chau Phu	Vinh Thanh Trung	Mainstream	Yes	Yes	Yes	Yes	Yes	38	7
				Dao Huu Canh						Yes	34	11
LB Mekong		Dong Thap (POR)	Tan Hong	Tan Cong Chi	Mainstream	Yes	Yes	Yes	Yes	Yes	41	4
				Thong Binh						Yes	40	5
			Tam Nong	Phu Thanh A	Mainstream	Yes	Yes	Yes	Yes	Yes	32	13
				Phu Cuong						Yes	36	11

CHAPTER 2

DATA PROCESSING FOR VIETNAM

2 DATA PROCESSING FOR VIETNAM

2.1 Provincial data

For the Vietnamese provinces Dong Thap (Plain of Reeds) and An Giang (Long Xuyen Quadrangle) in the deeply flooded areas bordering Cambodia, a dataset was obtained at provincial level covering direct damages for selected years for the period 1978-1999 and a full set was obtained for the period 2000-2007. After analysis it was decided to use the latter set, as it seems more consistent. Moreover, many changes have taken place in the Vietnamese Mekong Delta, rendering the older data less relevant.

To make the damage data of the various years comparable with each other and with data of other MRC-member countries, the data have been converted to the 2007 price level and have been converted to USD.

From the Household and Business surveys for the districts Chau Phu (An Giang province) and Tam Nong and Tan Hong (Dong Thap province) a relation between direct and indirect damages was derived for 2006, see Table 2.1. For the Businesses only an average relation could be calculated, as the sample was rather small in absolute numbers. This relation was used to increase the direct damages as reported for the provincial level for the years 2000-2007 with 64% to obtain the total damages for the Housing category.

Table 2.1 Direct and indirect damages for households and businesses (2006, USD)

	Tam Nong	Tan Hong	Chau Phu	Total
Direct damages HH	1,319	1,550	3,363	6,231
Indirect damages HH	1,014	740	2,216	3,969
HH in Survey	68	81	72	221
HH in District	22,937	21,246	54,490	98,673
HH Survey Coverage	0.296%	0.381%	0.132%	0.224%
Weighted Indirect/Direct HH damages	77%	48%	66%	65%
Direct damages Businesses	206	0	7,563	7,769
Indirect damages Businesses	762	413	2,825	3,999
Businesses in Survey	9	24	18	51
Businesses in District	1,446	1,042	3,869	6,357
Business Survey Coverage	0.62%	2.30%	0.47%	0.80%
Average Indirect/Direct Bus. Damages				51%
Weighted Indirect/Direct HH & Business damages				64%

From the survey of district level indirect flood damage data for the districts Chau Phu, Tam Nong and Tan Hong a relation between direct and indirect damages for the Infrastructure & Relief category was derived for 2006, see Table 2.2. This relation was used to increase the direct damages as reported for the provincial level for the years 2000-2007 with 30% to obtain the total damages for this category.

Table 2.2 Direct and indirect damages for Infrastructure & Relief (2006, USD)

	Chau Phu	Tan Hong	Tam Nong	Total
Direct costs	6,938	209,938	113,125	330,000
Indirect costs	12,875	2,188	84,875	99,938
Indirect/Direct damages				30%

The provincial flood damage data have been related to the annual maximum water levels at Chau Doc (Bassac river) for An Giang and at Tan Chau (Mekong river) for Dong Thap for the

categories Housing and Infrastructure & Relief, as the flood damages in these categories are expected to mainly depend on the maximum level of flooding. However, comparing the flood damages for 2001 and 2002, it appears that the damages in 2002 are considerably lower than in 2001, although the height, timing and duration of these two floods were very similar. It could be that in 2001 there was more wind creating higher waves, resulting in larger damages. It could also be that people and governments learned from the 2001 flood to take more precautions to avoid damages in 2002. This was confirmed by the participants in the relevant focal group discussions carried out as part of the project surveys.

The flood damages in the Vietnamese part of the Mekong Delta to agriculture (mainly paddy cultivation) depend very much on the timing of the flood. Dong Thap and An Giang provinces have two dominant crops per year except for some small areas were three rice crops are planted under full flood protection. Summer-Autumn Paddy is planted during March-April and it is harvested during July to mid of August. Winter-Spring Paddy is planted during November-December and it is harvested during February-March.

The deep-flooded areas in the Plain of Reeds and the Long Xuyen Quadrangle are all fitted with flood protection dykes that have been designed to protect agricultural land in normal years against floods till the end of August, allowing safe harvesting of the Summer-Autumn crop. In case the flood comes early, this crop is damaged. Therefore the agricultural damages have been related to the highest flood levels at Chau Doc and Tan Chau before 1 August.

The flood damage data for Dong Thap (Plain of Reeds) and An Giang (Long Xuyen Quadrangle) are presented in Table 2.3, along with the flood levels according to the MRC-hydrological database in HYMOS. The data show that damages are low for low and normal floods, but then increase sharply for higher floods. These relations have been depicted in the figures below.

Table 2.3 Provincial flood damages and water levels Vietnam (2000-07, 2007 constant prices)

An Giang, Long Xuyen Quadrangle	**Unit**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Direct & indirect damages Infrastructure & Relief	M USD	81.752	13.160	5.459	3.010	0.597	3.064	0.897	0.391
Direct & indirect damages Housing	M USD	12.548	7.609	1.791	0.264	0.443	0.136	0.005	0.000
Damages Agriculture	M USD	5.184	0.788	0.306	0.299	0.020	0.029	0.000	0.000
Max flood level at Chau Doc on Bassac	masl	4.89	4.47	4.42	3.48	4.01	3.88	3.69	3.58
Max flood level at Chau Doc before 1 August	masl	3.74	2.50	2.39	1.66	1.86	1.83	1.80	1.28
Dong Thap, Plain of Reeds									
Direct & indirect damages Infrastructure & Relief	M USD	42.440	14.514	7.261	0.614	1.504	1.370	1.176	1.263
Direct & indirect damages Housing	M USD	30.571	20.568	8.825	0.152	0.847	0.000	0.999	0.320
Damages Agriculture	M USD	24.508	7.759	1.226	0.428	0.000	0.838	0.098	0.002
Max flood level at Tan Chau on Mekong	masl	5.04	4.77	4.81	4.03	4.39	4.33	4.16	4.08
Max flood level at Tan Chau before 1 August	masl	4.16	2.92	2.92	2.13	2.58	2.57	2.42	1.55
Deflation factor (2007=1)		1.347	1.339	1.299	1.270	1.188	1.124	1.078	1.000

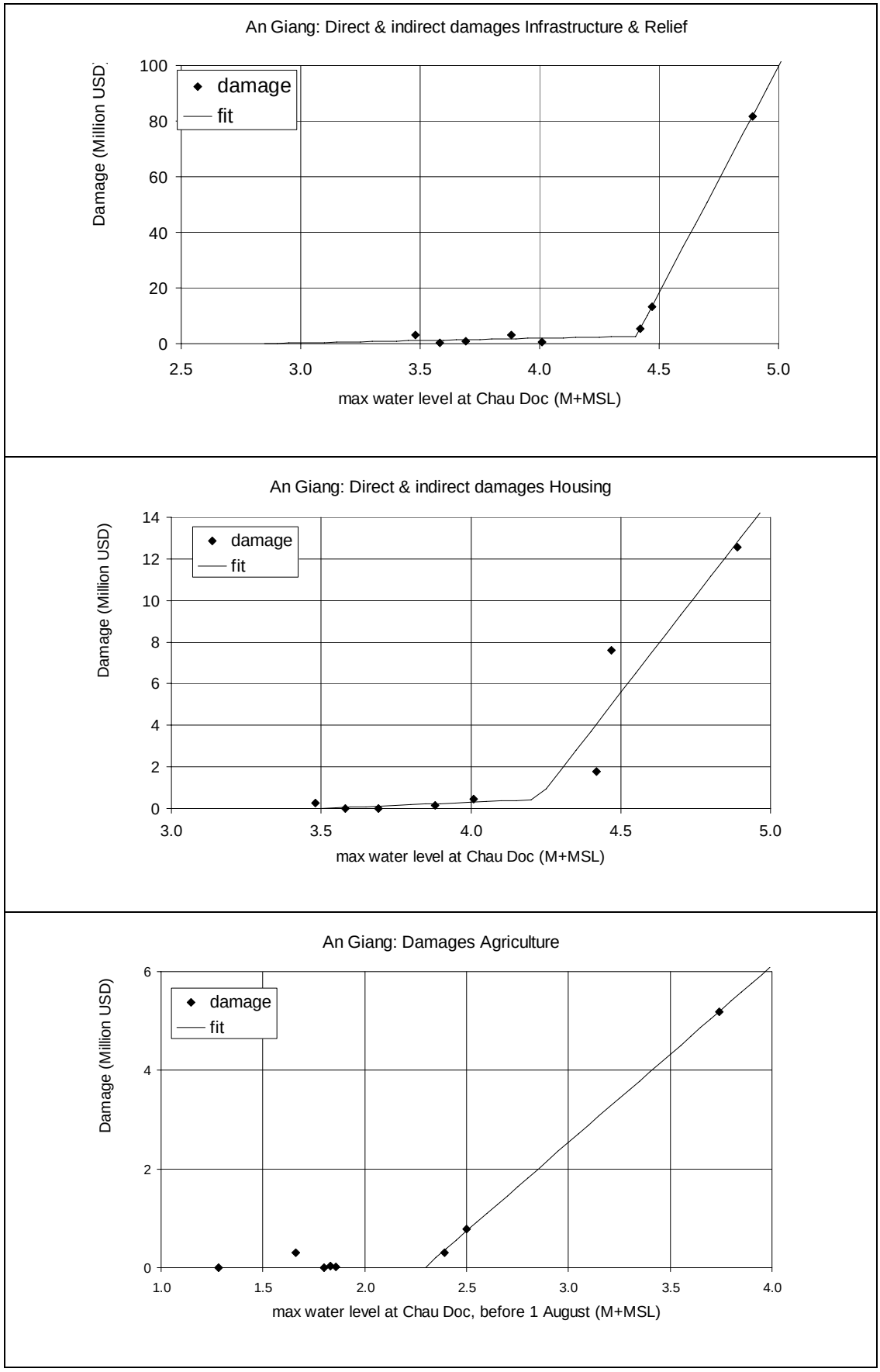


Figure 2.1 Provincial flood damage curves, An Giang

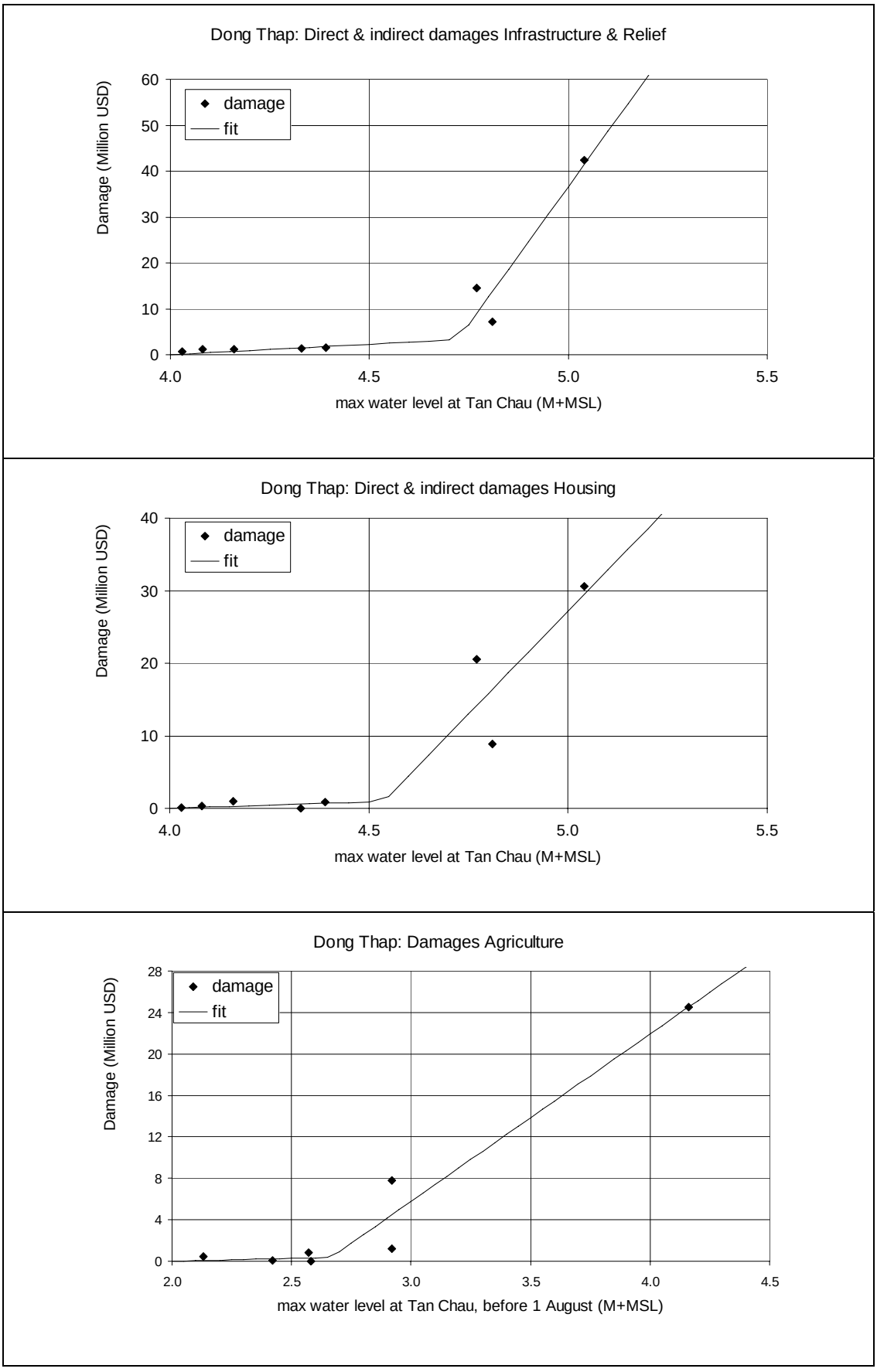


Figure 2.2 Provincial flood damage curves, Dong Thap

2.1.1 Damage and Probability for An Giang and Dong Thap Provinces

The damage curves presented for An Giang and Dong Thap provinces have been used to estimate the damages for the three categories for all the years between 1910 and 2006. Please note that these damages may differ from the actual historic damages for individual years, as the have been estimated using the damage curves presented above. The results are presented graphically in the two provincial graphs below.

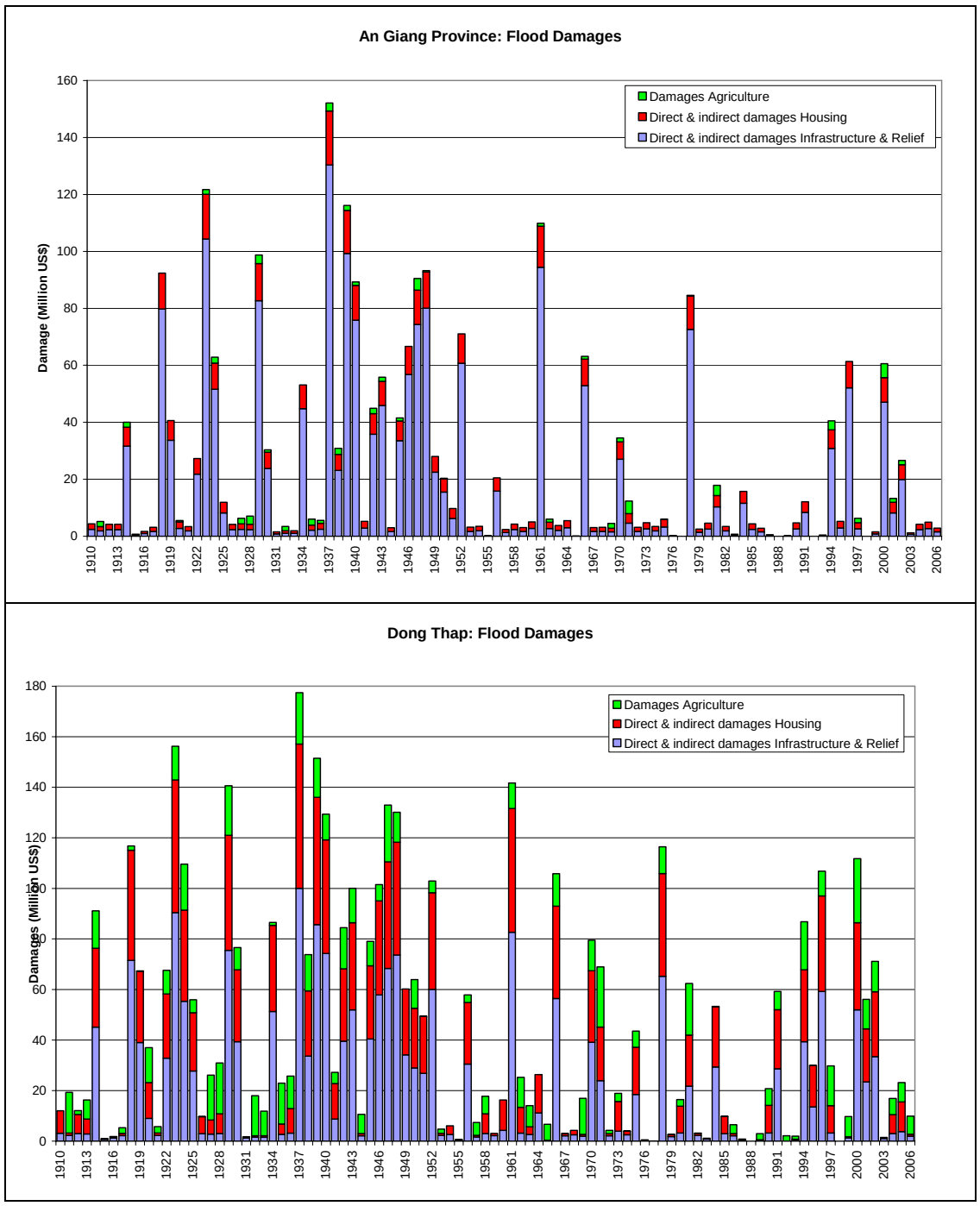


Figure 2.3 Total flood damages 1910-2006, An Giang and Dong Thap provinces

The results show that the Agricultural and Housing damages in Dong Thap are relatively more important than in An Giang.

All damages have been sorted and the totals are plotted in the graph below, showing the relation between total damage and probability in the two Vietnamese deeply flooded provinces. The curves clearly show that Dong Thap is more at risk than An Giang.

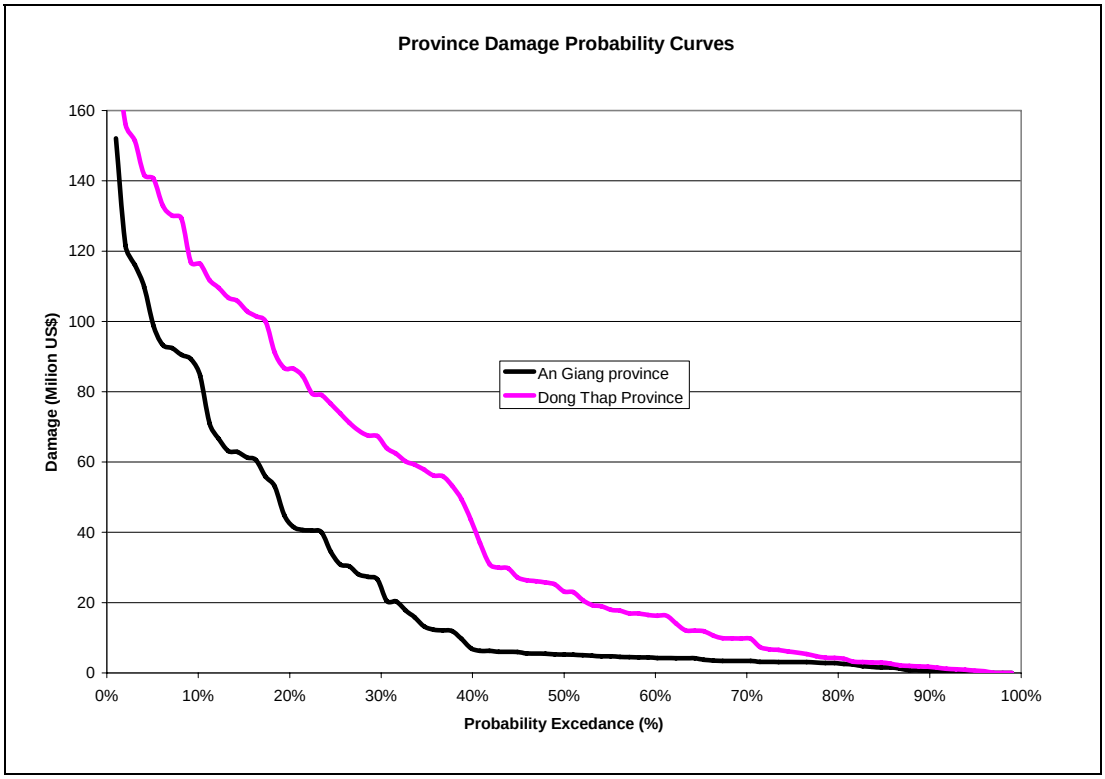


Figure 2.4 Provincial total flood damage probability curves, Vietnam

2.2 District Data

The direct flood damages for the selected districts in focal areas in Vietnam (Chau Phu District, An Giang Province; Tan Hong and Tam Nong Districts, Dong Thap Province) were obtained at provincial level covering the period 2000-2007.

From the Household and Business surveys and district indirect flood damage data for the 3 selected districts, a relation between direct and indirect damages was derived for 2006. The weighted average ratio between indirect and direct damages is 64% for the Housing category and 30% for Infrastructure & Relief, see Table 2.1 and Table 2.2. These weighted ratios are applied for estimating the total damages (direct and indirect) for Housing and Infrastructure for 3 districts. The damage data and corresponding water levels as generated by the MRC-Mekong Delta hydrological model in ISIS are presented in Table 2.4. To make damage data of different years comparable, a deflation factor has been used, based on the Consumer Price Index.

Table 2.4 District flood damages and water levels Vietnam (2000-07, 2007 constant prices)

Chau Phu District, An Giang Province	**Unit**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Direct & indirect damages Infrastructure & Relief	M USD	3.796	0.802	0.786	0.000	0.108	0.095	0.000	0.003
Direct & indirect damages Housing	M USD	0.748	0.429	0.339	0.000	0.046	0.014	0.005	0.000
Damages Agriculture	M USD	0.138	0.001	0.003	0.000	0.000	0.000	0.000	0.000
Max flood level at Chau Phu (ISIS)	m	3.90	3.74	3.77	3.11	3.50	3.57	3.31	3.90
Max flood level at Chau Phu before 1 August (ISIS)	m	2.88	2.18	2.24	1.38	1.72	1.71	1.83	2.88
Tan Hong District, Dong Thap Province									
Direct & indirect damages Infrastructure & Relief	M USD	3.777	1.282	0.545	0.000	0.241	0.144	0.203	0.041
Direct & indirect damages Housing	M USD	1.747	2.485	0.408	0.000	0.006	0.000	0.119	0.003
Damages Agriculture	M USD	2.633	0.178	0.000	0.000	0.000	0.021	0.000	0.000
Max flood level at Tan Hong (ISIS)		4.90	4.44	4.60	3.79	4.16	4.25	3.89	4.90
Max flood level at Tan Hong before 1 August (ISIS)		3.68	2.82	2.89	2.05	2.47	2.52	2.54	3.68
Tam Nong District, Dong Thap Province									
Direct & indirect damages Infrastructure & Relief	M USD	4.296	1.691	0.470	0.016	0.014	0.026	0.050	0.136
Direct & indirect damages Housing	M USD	2.340	2.353	0.505	0.012	0.051	0.000	0.141	0.017
Damages Agriculture	M USD	5.897	0.338	0.000	0.000	0.000	0.003	0.000	0.000
Max flood level at Tam Nong (ISIS)	m	4.38	4.01	4.19	3.52	3.90	3.94	3.62	4.38
Max flood level at Tam Nong before 1 August (ISIS)	m	3.32	2.37	2.48	1.70	2.04	2.05	2.06	3.32
Deflation factor (2007=1)		1.347	1.339	1.299	1.270	1.188	1.124	1.078	1.000

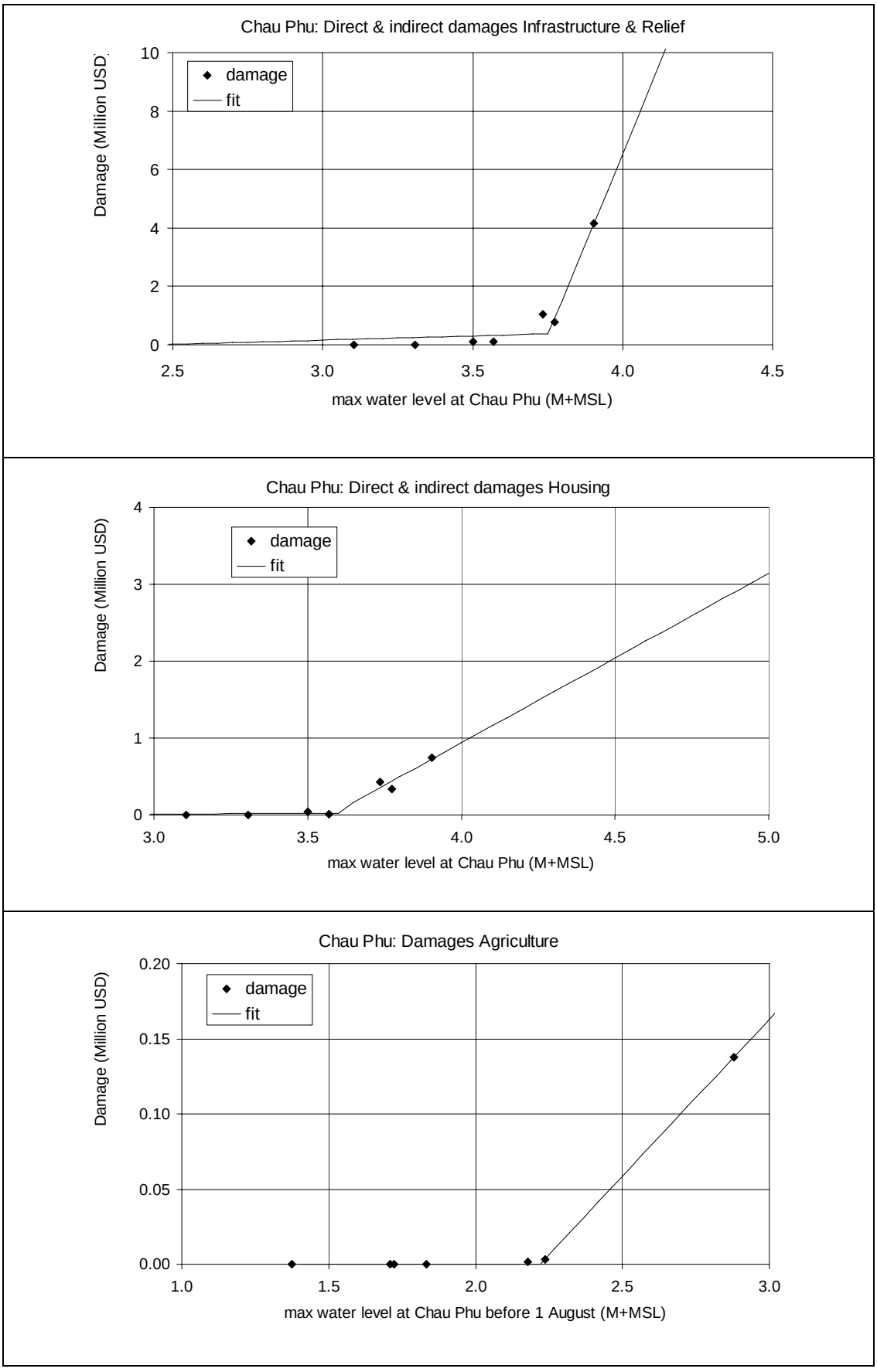


Figure 2.5 District flood damage curves, Chau Phu

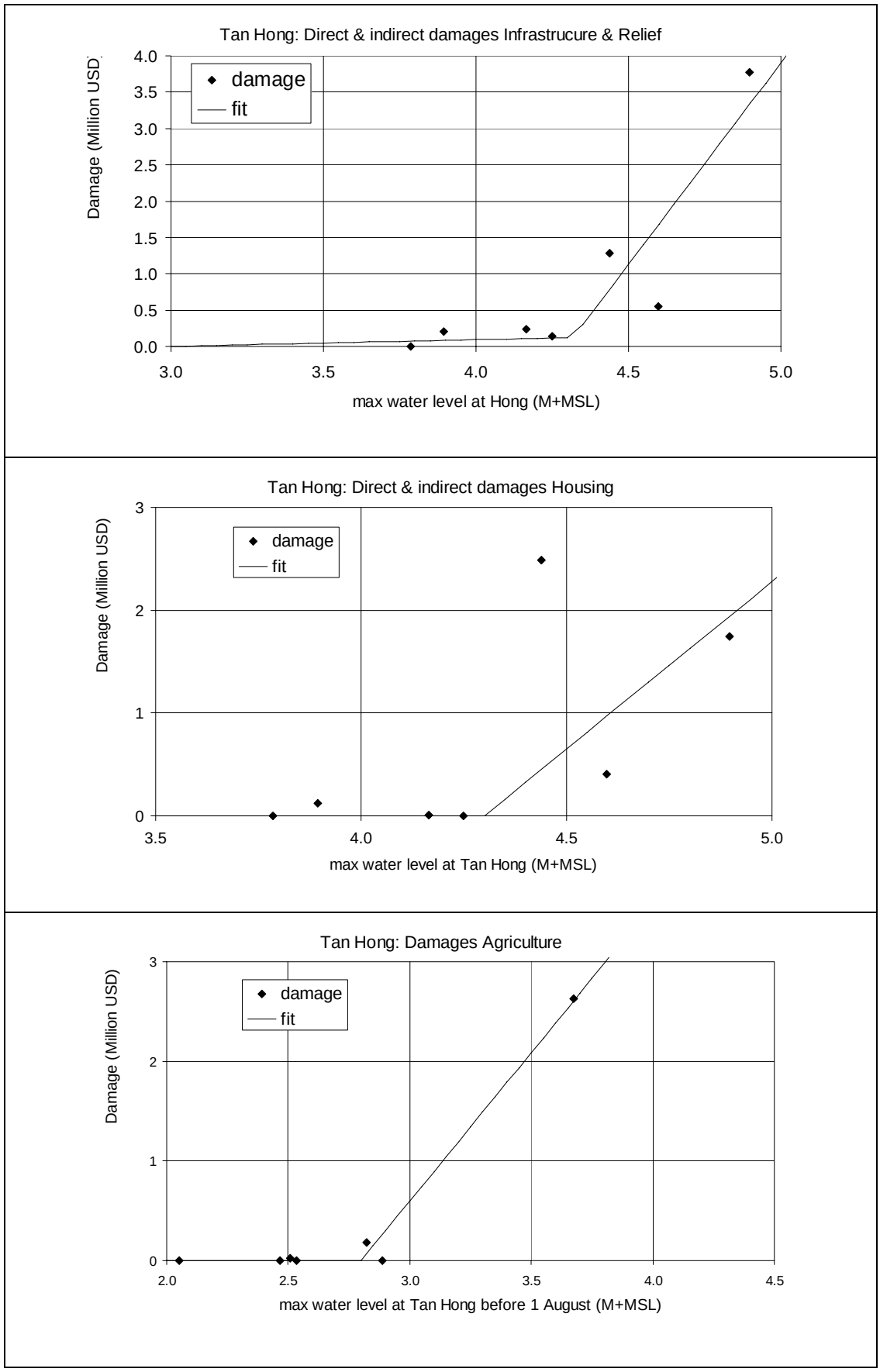


Figure 2.6 District flood damage curves, Tan Hong

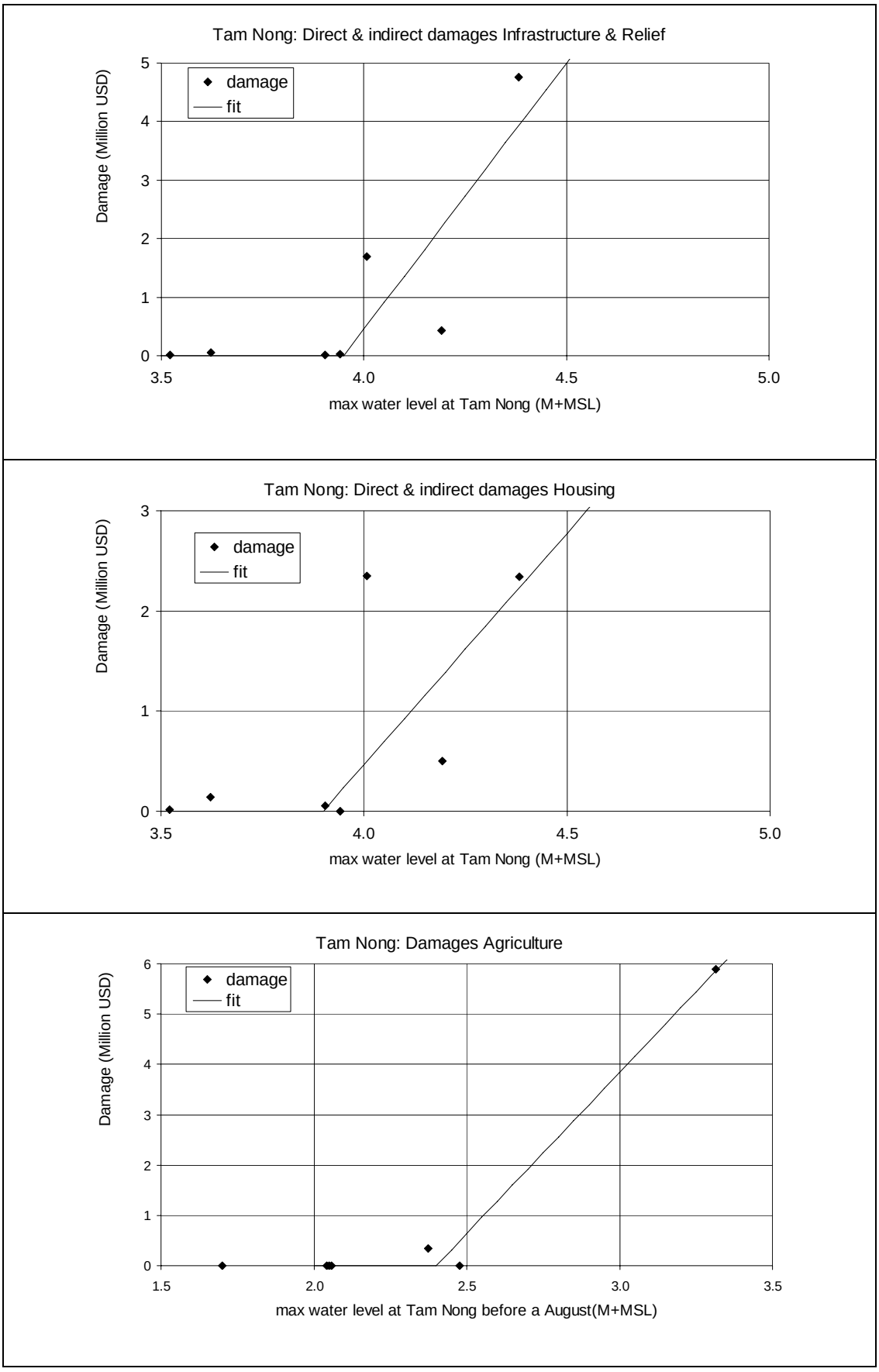


Figure 2.7 District flood damage curves, Tam Nong

2.2.1 Damage and Probability for Districts

The district damage curves above were used to estimate the damages for the three categories for all the years between 1910 and 2006. The results are presented in the three district graphs below.

The highest risk is found in Tam Nong District, where annual flood water is deeper than other area. It is followed by Tan Hong District. Lower risk is found in Chau Phu in Long Xuyen Quarangle where there is an early flood protection control structure (Tha La – Tra Su Rubber dams and embankment) is in place to allow the safe harvesting of Summer-Autumn Paddy by mid-August. Generally it can be seen that for floods with a return period of 2 years or less (probability of exceedance more than 50%), the flood risk is rather small. Serious damage occurs at floods with a return period of 10 years and above (probability of exceedance less than 10%).

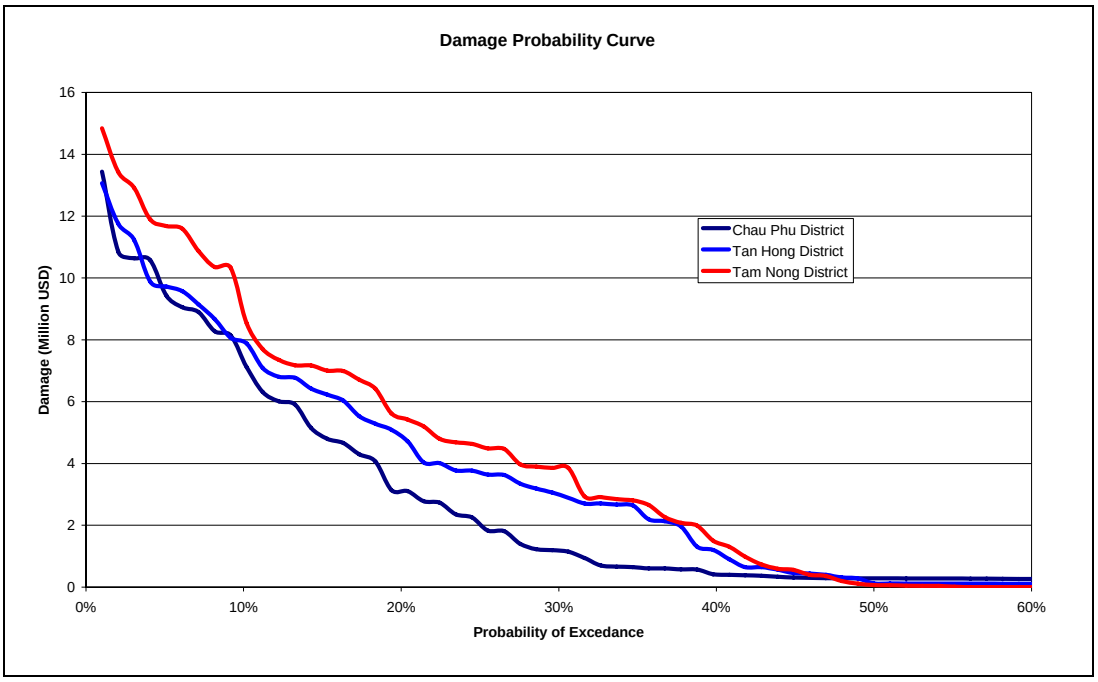


Figure 2.8 District total flood damage probability curves, Vietnam

A map showing the annual average flood risk for the three risk categories is presented in Appendix B.

2.2.2 District Population, Land Use and Structure

According to the 2006 District statistics, the population in the surveyed districts is about 251,000 in Chau Phu; 99,000 in Tam Nong; and 86,000 in Tan Hong. The average annual population growth rates during 2001-2006 in Chau Phu, Tam Nong and Tan Hong districts were 0.86%; 0.77%; and 2.15% respectively, see Table 2.5.

Most of the paddy land is under irrigation with 2 crops per year. The area of paddy land is nearly 38,000 ha in Chau Phu, 33,000 ha in Tam Nong and 25,000 ha in Tan Hong. The first paddy crop is planted during March-April and is harvested in July – mid of August. This crop suffers from early flooding in the Mekong Delta. Information from Focus Group Discussion showed that if an early flood overtops the embankment in mid of June, in mid of July and in mid of August, then the percentage of cultivated area affected by flooding would be 100%, 40-60% or 0%

respectively. The early flood protection embankment has a height compared to paddy field of 0.8-1.0 m in Chau Phu District, 1-2 m in Tan Hong, and 2-3 m in Tam Nong. The second paddy crop is planted during November-December and it is harvested during February-March. The second crop never suffers from flooding but could be affected by drought.

According to the District statistics, there are small crop areas under full flood protection in Chau Phu and Tan Hong Districts. They are about 1,900 ha occupying 6% of paddy field in Chau Phu and about 2,100 ha occupying 10% of paddy field in Tan Hong. As the price of rice in the world market has an increasing trend, this may have an impact on future expansion of the third crop in the deep flooded areas. The third paddy crop is plated in August and harvested in November, which is in main flood season of the Mekong Delta.

Table 2.5 District population and land-use Vietnam

Items		Unit or type	Chau Phu	Tan Hong	Tam Nong
POPULATION					
1	Population	Person	250,567	86,137	99,047
2	Number of HH	HH	54,490	21,246	22,937
3	Size of Family	Person	4.60	4.05	4.32
4	Poor household	HH	4,919	3,189	3,266
5	Population growth rate	%	0.86%	2.15%	0.77%
2006-LAND-USE		ha	43,431	31,115	47,425
1	Rice Land – Irrigated	ha	38,656	24,869	32,615
2	Rice Land – Rainfed	ha	0	0	0
3	Land – Upland crops	ha	423	62	136
4	Orchards	ha	705	253	700
5	Residential – Rural	ha	1,087	995	643
6	Residential – Urban	ha	52	98	64
7	Commercial / Industrial	ha	84	23	14
8	Institution	ha	49	27	25
9	Forest	ha	0	110	7,661
10	Communal land	ha	2,375	1,523	5,568
11	Others	ha		3,155	

Table 2.6 District crops and structures Vietnam

Items		Unit or type	Chau Phu	Tan Hong	Tam Nong
CROPS					
1	W-S Paddy (Nov-Mar)	ha	34,419	21,634	30,701
2	S-A Paddy (Apr-Aug)	ha	34,310	21,584	30,116
3	A-W Paddy (Aug-Nov)	ha	1,913	2,088	
4	Vegetables	ha	2,052	995	1,039
5	Beans	ha	57	55	
6	Watermelon	ha	37		20
7	Soybean	ha	84		7
8	Maize	ha	77	40	51
9	Sesame	ha			20
10	Sweet potato	ha		19	
11	Fruit trees	ha		199	
STRUCTURES					
	Residential structures	Permanent	3,721	995	1,610
		Semi-permanent	24,006	13,815	5,409
		Temporary	26,763	6,436	12,236
	Commercial structures	Permanent	730	NA	2,468
		Semi-permanent	6,526	NA	1,645
		Temporary	807	NA	0
	Industrial structures	Permanent	80	NA	3,702
		Semi-permanent	736	NA	411
		Temporary	0	NA	0
	Institutional structures	Permanent	12	NA	2,879
BUSINESS			3,869	1,042	1,446
1	Registered business	HH	1,510	451	1,018
2	Non-registered business	HH	2,359	591	428
3	Market vendors	Person	2,326	NA	561

2.2.3 Households and Business Survey

The survey sample was designed as at least 90 households and business in each selected district in the focal areas. The average value of the houses varies per district from 4,300 to 5,300 US$ with an area varying from 75 to 87 m^2. Average value of business structure varies from 5,000 to 25,600 US$ with an area varying from 62 to 290 m^2.

The damages to household in the 2006 flood was asked and potential damages to the house under the survey was investigated by asking how much the flood damage to the house would be if a flood water would have been higher than the 2006 flood by 0.5 m, 1.0 m, 1.5 m and 2.0 m. See the graphs below and Table 2.5 and Table 2.6.

The flood in 2006 was considered as a “good’ flood by people living in the Vietnamese part of the Mekong Delta, Vietnam, since it came late when crops were harvested from the field. There were 2 out of 72 household in Chau Phu district and 1 out of 81 household in Tan Hong under the survey said that their crop was partly damaged. There was no one in Tam Nong district said their crop damaged by flood 2006.

There were 4 out of 18 businesses in Chau Phu district and 2 out of 24 businesses in Tam Nong district said their business structure damaged by the 2006 flood.

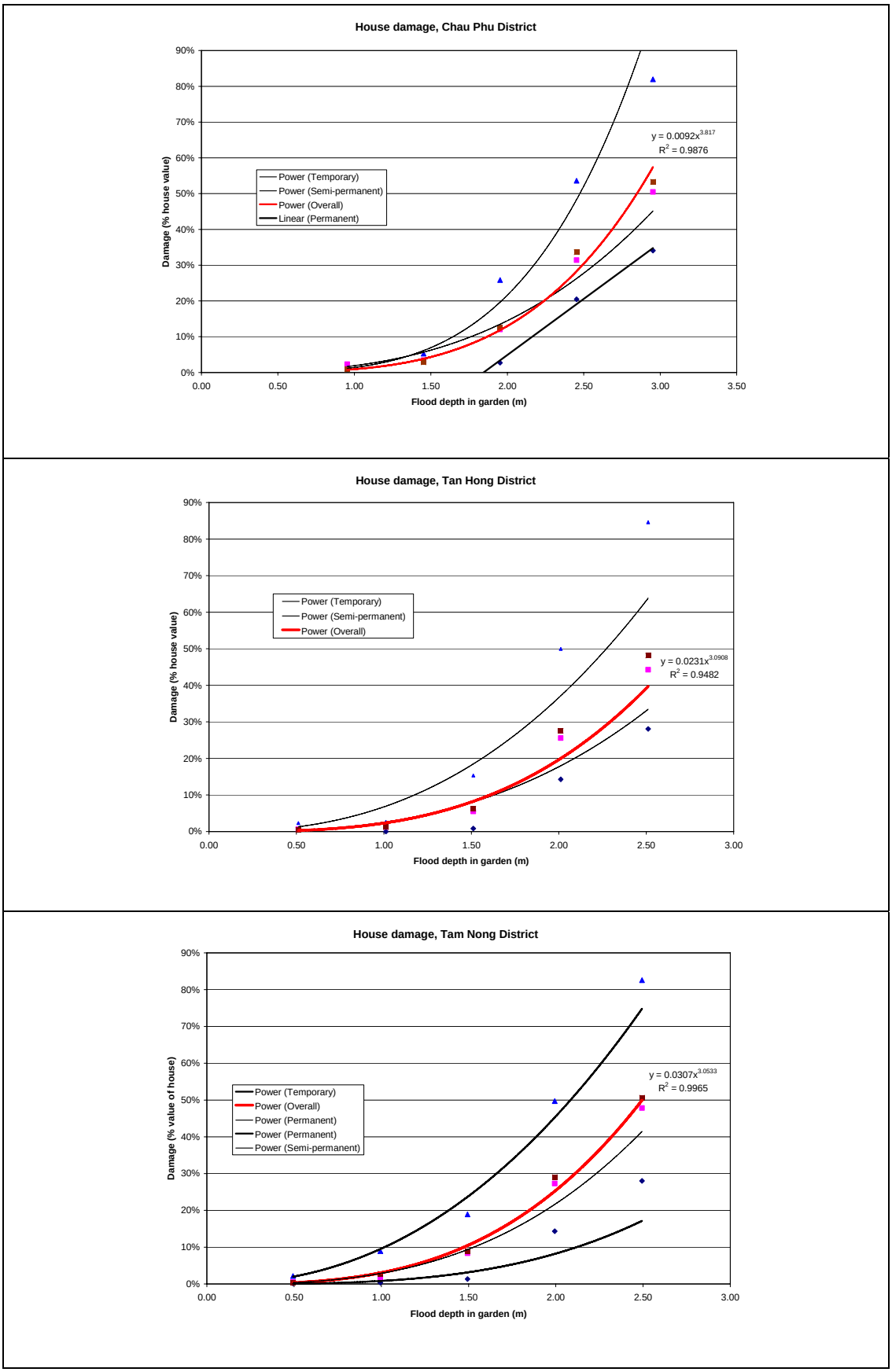


Figure 2.9 District relative damage curves for housing, Vietnam

Table 2.7 Household survey Vietnam

Items	Unit	Chau Phu	Tan Hong	Tam Nong
Total sample	**HH**	**72**	81	68
Permanent house	HH	22	18	15
Semi-permanent	HH	32	48	39
Temporary	HH	18	15	14
Value of house	**US$**	**5,331**	4,343	5,073
Permanent house	US$	10,241	8,542	12,771
Semi-permanent	US$	4,180	3,786	3,638
Temporary	US$	1,377	1,083	825
Housing area	**m^2**	**87**	75	81
Permanent house	m^2	128	90	139
Semi-permanent	m^2	80	76	70
Temporary	m^2	49	54	50
2006 flood depth in garden				
Permanent house	M	0.42	0.13	0.17
Semi-permanent	M	1.07	0.58	0.60
Temporary	M	1.39	0.75	0.56
Overall	M	0.95	0.51	0.49
Damages to housing				
2006 flood				
Permanent house	% house value	0.0%	0.0%	0.2%
Semi-permanent	% house value	2.3%	0.6%	0.5%
Temporary	% house value	1.1%	2.3%	2.2%
Overall	% house value	0.9%	0.4%	0.4%
2006 flood +0.5m				
Permanent house	% house value	0.0%	0.0%	0.3%
Semi-permanent	% house value	3.4%	1.3%	1.5%
Temporary	% house value	5.3%	2.7%	8.9%
Overall	% house value	2.8%	1.2%	2.8%
2006 flood +1.0m				
Permanent house	% house value	2.7%	0.8%	1.3%
Semi-permanent	% house value	12.0%	5.5%	8.4%
Temporary	% house value	25.8%	15.3%	18.9%
Overall	% house value	12.6%	6.3%	9.0%
2006 flood +1.5m				
Permanent house	% house value	20.5%	14.3%	14.3%
Semi-permanent	% house value	31.4%	25.6%	27.3%
Temporary	% house value	53.6%	49.9%	49.7%
Overall	% house value	33.6%	27.6%	29.1%
2006 flood +2.0m				
Permanent house	% house value	34.1%	28.1%	28.0%
Semi-permanent	% house value	50.5%	44.3%	47.8%
Temporary	% house value	81.9%	84.6%	82.6%
Overall	% house value	53.3%	48.1%	50.6%
Damages to paddy				
Not affected	HH	70	80	68
Affected	HH	2	1	0

Table 2.8 Business survey Vietnam

Items	Unit	Chau Phu	Tan Hong	Tam Nong
Total sample	**Business**	**18**	**9**	**24**
Permanent house	Business	9	4	7
Semi-permanent	Business	7	3	12
Temporary	Business	2	2	5
Value of house	**US$**	**25,590**	**8,924**	**5,013**
Permanent house	US$	45,139	10,469	8,304
Semi-permanent	US$	5,357	11,667	4,661
Temporary	US$	8,438	1,719	1,250
Housing area	**m^2**	**290**	**99**	**62**
Permanent house	m^2	438	62	36
Semi-permanent	m^2	121	162	67
Temporary	m^2	220	80	87
2006 flood depth in garden				
Permanent house	m	0.44	0.00	0.00
Semi-permanent	m	0.94	0.50	0.10
Temporary	m	1.15	0.00	0.00
Overall	m	0.72	0.17	0.05
Damages to structures				
2006 flood				
Permanent house	% house value	0.8%	0.0%	0.4%
Semi-permanent	% house value	11.2%	0.0%	0.0%
Temporary	% house value	1.5%	0.0%	0.0%
Overall	% house value	1.6%	0.0%	0.2%
2006 flood +0.5m				
Permanent house	% house value	1.1%	0.0%	0.7%
Semi-permanent	% house value	2.9%	0.0%	0.0%
Temporary	% house value	5.0%	0.0%	0.0%
Overall	% house value	2.2%	0.0%	0.2%
2006 flood +1.0m				
Permanent house	% house value	4.4%	0.0%	5.7%
Semi-permanent	% house value	12.9%	6.7%	3.3%
Temporary	% house value	15.0%	10.0%	11.0%
Overall	% house value	8.9%	4.4%	5.6%
2006 flood +1.5m				
Permanent house	% house value	21.7%	12.5%	20.0%
Semi-permanent	% house value	37.9%	25.0%	25.4%
Temporary	% house value	45.0%	42.5%	52.0%
Overall	% house value	30.6%	23.3%	29.4%
2006 flood +2.0m				
Permanent house	% house value	35.2%	25.0%	34.3%
Semi-permanent	% house value	60.0%	44.3%	46.3%
Temporary	% house value	67.5%	80.0%	84.0%
Overall	% house value	48.4%	43.7%	50.6%
2006 Damages				
Not affected	Business	14	9	22
Affected	Business	4	0	2

2.2.4 Damage curves for paddy cultivation

Based on information collected during the Focal Group Discussions, damage curves for paddy production in relation to flooding depths in the districts Chau Phu, Tan Hong and Tam Nong have been estimated. The results are presented in the graphs below, showing three levels of damage, depending of the timing of the flood.

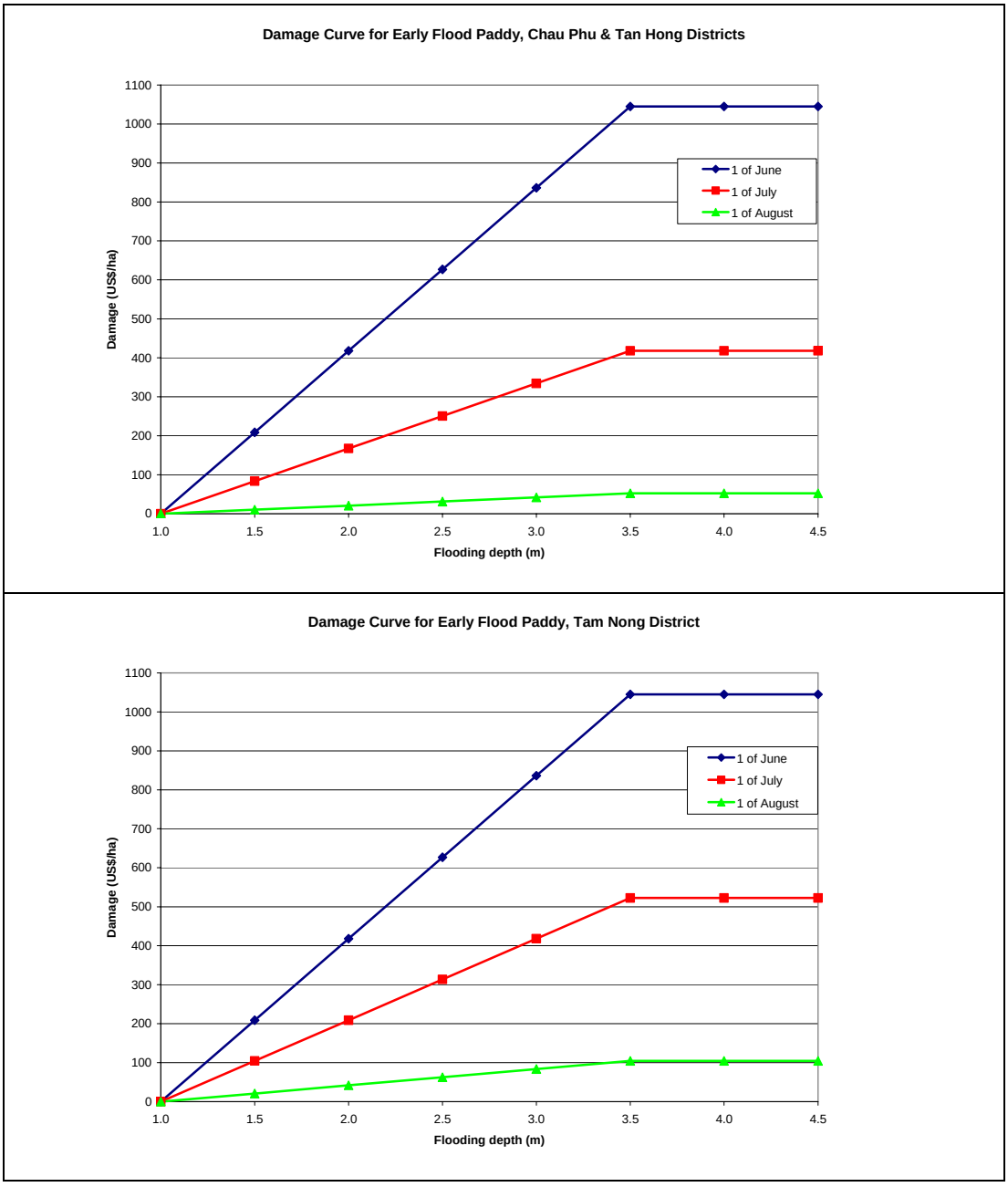


Figure 2.10 District relative damage curves for paddy, Vietnam

2.2.5 Potential Damages Reduction by Flood Control Measures

Potential damage reduction by flood control measures in the focal areas can be identified by the area under the damage probability curve up to the proposed probability of control (say controlling flood at 10% probability or 1 in ten year return period).

The damage-probability curves for the three selected districts and the whole Dong Thap and An Giang provinces were established as presented in the previous sections. For the purpose of flood control measure analysis, the potential damage reduction by levels of control of 1%, 4%, 10% and 50% probability were derived in focal areas, See Table 4.7. The annual flood damages reduction would be about 1.19 million US$ for the district under flood control measures at 10% probability.

At the same level of protection, potential damage reduction would be high in Dong Thap province compared to An Giang province. At the district level, the potential damage reduction would be high in Tam Nong district. It is followed by Tan Hong District and Chau Phu District. See Table 2.9.

Table 2.9 Potential Damages Reduction by Flood Control Measures Vietnam

	Population	**Land**	**Paddy**	**1%**	**4%**	**10%**	**50%**
	(person)	(ha)	(ha)	(M US$)	(M US$)	(M US$)	(M US$)
Districts							
Chau Phu	250,567	43,431	38,656	1.85	1.50	0.94	0.11
Tan Hong	86,137	31,115	24,869	2.27	1.90	1.34	0.04
Tam Nong	99,047	47,426	32,615	2.61	2.19	1.51	0.01
Provinces							
An Giang	2,231,000	340,000	238,500	22.99	19.01	13.16	1.35
Dong Thap	1,667,840	304,268	223,859	43.79	38.84	30.76	4.15

The potential damage reductions mentioned in Table 2.9 are established for the current (2006) situation of land-use. In case the proposed flood control measures would provide opportunities to increase the cropping intensity in agriculture, then the benefit from cultivation of the additional crop should be taken into account in the cost-benefit analysis of the measures. This may be the case for the Long Xuyen Quadrangle and the Plain of Reeds. Existing agriculture in these areas is double paddy cropping. If flood control measures could provide full flood control for these areas, a triple cropping system could be implemented. The additional paddy crop could have net benefits of about 900 US$/ha.

2.2.6 Benefits from Flooding

In the six Focus Group Discussions held in focal areas, farmers mentioned that floods have significant benefit for crop cultivation. After a big flood, application of fertilizers and pesticides to Winter-Spring Paddy (November-March) is less than in a normal flood year by total value of 2-3 million VND[2] per ha (about 100-200 US$/ha) but the yield is higher by 0.5-1.0 ton/ha. Flood benefits for agriculture would be 3-5 million VND/ha (about 200-300 US$/ha).

All most all families in the deep flooded area are fishing during the flood season. Duration for fishing varies between focal area, short duration for Long Xuyen Quadrangle (20-45 days) and longer duration for the Plain of Reeds (30-120 days) depending on the duration of the flood. The benefit of flood for capture fisheries of people in deep flooded areas are 1-5 million VND/household (about 100-300 US$/household) in normal flood years and about 2-12 million VND/household in big flood years. Details are presented in Table 2.10.

[2] 1 USD = 16,000 VND

Table 2.10 Benefits of Flooding, Vietnam

Items	Unit	Right Bank Bassac				Left Bank Mekong							
		FGD-1		FGD-2		FGD-3		FGD-4		FGD-5		FGD-6	
Province		An Giang		An Giang		Dong Thap		Dong Thap		Dong Thap		Dong Thap	
District		Chau Phu		Chau Phu		Tan Hong		Tan Hong		Tam Nong		Tam Nong	
Commune		Vinh Thanh Trung		Dao Huu Canh		Tan Cong Chi		Thong Binh		Phu Thanh A		Phu Cuong	
BENEFIT TO W-S PADDY AFTER FLOOD		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Paddy yield after normal flood	Ton/ha	7.30	7.30	7.20	7.30	6.50	6.70	6.50	7.00	6.00	6.50	6.00	6.50
Production cost after normal flood	Mil VND/ha	8.00	8.50	10.00	10.00	16.00	16.00	13.00	13.00	9.00	9.00	12.00	13.00
Net Benefit after normal flood	Mil VND/ha	10.25	9.75	8.00	8.25	0.25	0.75	3.25	4.50	6.00	7.25	3.00	3.25
Paddy yield after high flood	Ton/ha	8.00	8.00	7.70	7.80	7.00	7.00	8.00	8.00	7.00	7.00	7.00	7.00
Production cost after high flood	Mil VND/ha	6.00	6.00	8.00	8.00	14.40	14.40	11.00	11.00	7.00	7.00	9.00	10.00
Net Benefit after high flood	Mil VND/ha	14.00	14.00	11.25	11.50	3.10	3.10	9.00	9.00	10.50	10.50	8.50	7.50
Net Benefit from flooding	Mil VND/ha	**3.75**	**4.25**	**3.25**	**3.25**	**2.85**	**2.35**	**5.75**	**4.50**	**4.50**	**3.25**	**5.50**	**4.25**
BENEFIT FROM CAPTURE FISHERIES													
Number of HH in Commune	HH	6350	6350	2,600	2,600	2,672	2,672	3,129	3,129	2,400	2,400	2,200	2,200
Number of HH fishing	%	70%	80%	81%	81%			100%	100%	100%	100%	100%	100%
Number of HH fishing professional	HH	10%	10%	28%	28%	Coming from outside		24%	24%	50%	50%	25%	25%
Number of HH fishing non-professional	HH	90%	90%	72%	72%			76%	76%	50%	50%	75%	75%
Value of catch (professional)	VND/day	500,000	1,500,000	200,000	300,000	500,000	600,000	200,000	300,000	200,000	300,000	200,000	300,000
Value of catch (non-professional)	VND/day	30,000	50,000	50,000	50,000	30,000	50,000	30,000	50,000	20,000	50,000	20,000	30,000
Fishing duration (low flood)	day	0	0	0	0	0	0	0	0	0	0	0	0
Fishing duration (normal flood)	day	20	20	30	30	20	20	45	45	30	30	60	60
Fishing duration (high flood)	day	30	30	45	45	30	30	90	90	45	45	120	120
AVERAGE BENEFITS PER FISHING HH													
Total value of fish catched (normal flood)	Mil VND/year	1.54	3.9	2.76	3.6			3.186	4.95	3.3	5.25	3.9	5.85
Total value of fish catched (high flood)	Mil VND/year	2.31	5.85	4.14	5.4			6.372	9.9	4.95	7.875	7.8	11.7
TOTAL BENEFITS IN COMMUNE													
Fish catched in normal flood	Mil VND/year	6,845	19,812	5,813	7,582	0	0	9,969	15,489	7,920	12,600	8,580	12,870
Fish catched in high flood	Mil VND/year	10,268	29,718	8,719	11,372	0	0	19,938	30,977	11,880	18,900	17,160	25,740
AVERAGE BENEFITS PER HH													
Fish caught in normal flood	Mil VND/year	1.08	3.12	2.24	2.92			3.19	4.95	3.30	5.25	3.90	5.85
Fish caught in high flood	Mil VND/year	1.62	4.68	3.35	4.37			6.37	9.90	4.95	7.88	7.80	11.70
Principle benefits as mentioned in FGD	Text	Floods provide fertility and sediments to the field resulting in lower cost of production and higher yield of crop. Floods create opportunities for capture fisheries in rivers, streams and rice fields. Water quality is better in case of big floods. Better paddy field clearance by flood water for leaching acidity and toxicity from the soil. The largest benefits occur in big flood years. Some farmers grow floating vegetables and lotus to get additional income during big floods.											

From Focus Group Disussions in Focal Areas (April-May 2008) Estimated by Consultants

CHAPTER 3

DATA PROCESSING FOR CAMBODIA

3 DATA PROCESSING FOR CAMBODIA

3.1 District Flood Damages Data

The direct damages of flood in the 3 selected districts in focal areas were collected from district and provincial authorities from 2000-2007.

The indirect damages were derived from household and business survey and indirect damages by the flood collected from relevant departments in the selected districts. The weighted average indirect-direct ratio for household and business was estimated as 68% for the whole 3 districts. Details are presented in Table 3.1.

From the secondary data collection at district level, indirect and direct flood damage data for the districts Koh Andet, Koh Thom, and Kampong Trabek in the 2006 flood year were estimated. These data provide an overall indirect-direct ratio for the Infrastructure & Relief category. The overall ratio was estimated at 19%, see Table 3.2.

These indirect-direct ratios were used to increase the direct damages as reported for the provincial level for the years 2000-2007 with 68% for the Housing category and with 19% for the Infrastructure & Relief category. To make the damage data of the various years comparable with each other and with data of other MRC-member countries, the data have been converted to the 2007 price level and have been converted to US$.

Table 3.1 Direct and indirect damages for Households and Businesses (2006, USD)

Item	Koh Andet	Koh Thom	Kampong Trabek	TOTAL
Direct damages HH	4,826	6,907	421	12,153
Indirect damages HH	3,831	3,347	343	7,520
HH in Survey	82	90	90	262
HH in District	8,587	23,715	21,682	53,984
HH Survey Coverage	0.95%	0.38%	0.42%	0.49%
Weighted Indirect/Direct HH damages	79%	48%	81%	62%
Direct damages Businesses	161	0		161
Indirect damages Businesses	757	0		757
Businesses in Survey	15	2		17
Businesses in District	378	255		633
Business Survey Coverage	3.97%	0.78%		2.69%
Average Indirect/Direct Bus. damages	470%			470%
Weighted Indirect/Direct HH & Business damages				**68%**

Table 3.2 Direct and indirect damages for Infrastructure & Relief (2006, USD)

Item	Koh Andet	Koh Thom	Kampong Trabek	TOTAL
Direct damages	12,028	2,250	24,275	38,553
Indirect damages	2,000	4,000	1,490	7,490
Indirect/Direct damages	17%	178%	6%	**19%**

The district flood damage data have been related to the annual maximum water levels at the district towns for Koh Andet district (Takeo province) and Koh Thom district (Kadal province). For Kampong Trabaek district (Prey Veng province) the water levels at Borey Cholsar have been used, as these are more representative for the flooded parts of the district. The annual

maximum flood levels for the categories Infrastructure & Relief and Housing as the flood damages in these categories are expected to mainly depend on the maximum level of flooding.

In the Cambodian part of the Mekong Delta there are two main seasons of paddy: (1) Wet season paddy which is planted in shallow flooded areas in May and harvested in November; and (2) Dry season paddy planted in November and harvested in April. Flood damage to agriculture is mainly for the wet season paddy in the 3 surveyed districts. In the absence of August-flood protection as practised in Vietnam, the flood damages to agriculture (mainly paddy cultivation) depends more on the maximum annual level of the flood than on its timing. Therefore, also for Agriculture the maximum annual flood level has been used to analyse the flood damages.

A summary of the total flood damages for the 3 selected districts in the focal areas is presented in Table 3.3 along with the flood levels as generated by the MRC-Mekong Delta Model in ISIS. Damage curves for Infrastructure & Relief, Housing, and Agriculture were developed and are presented in the following graphs.

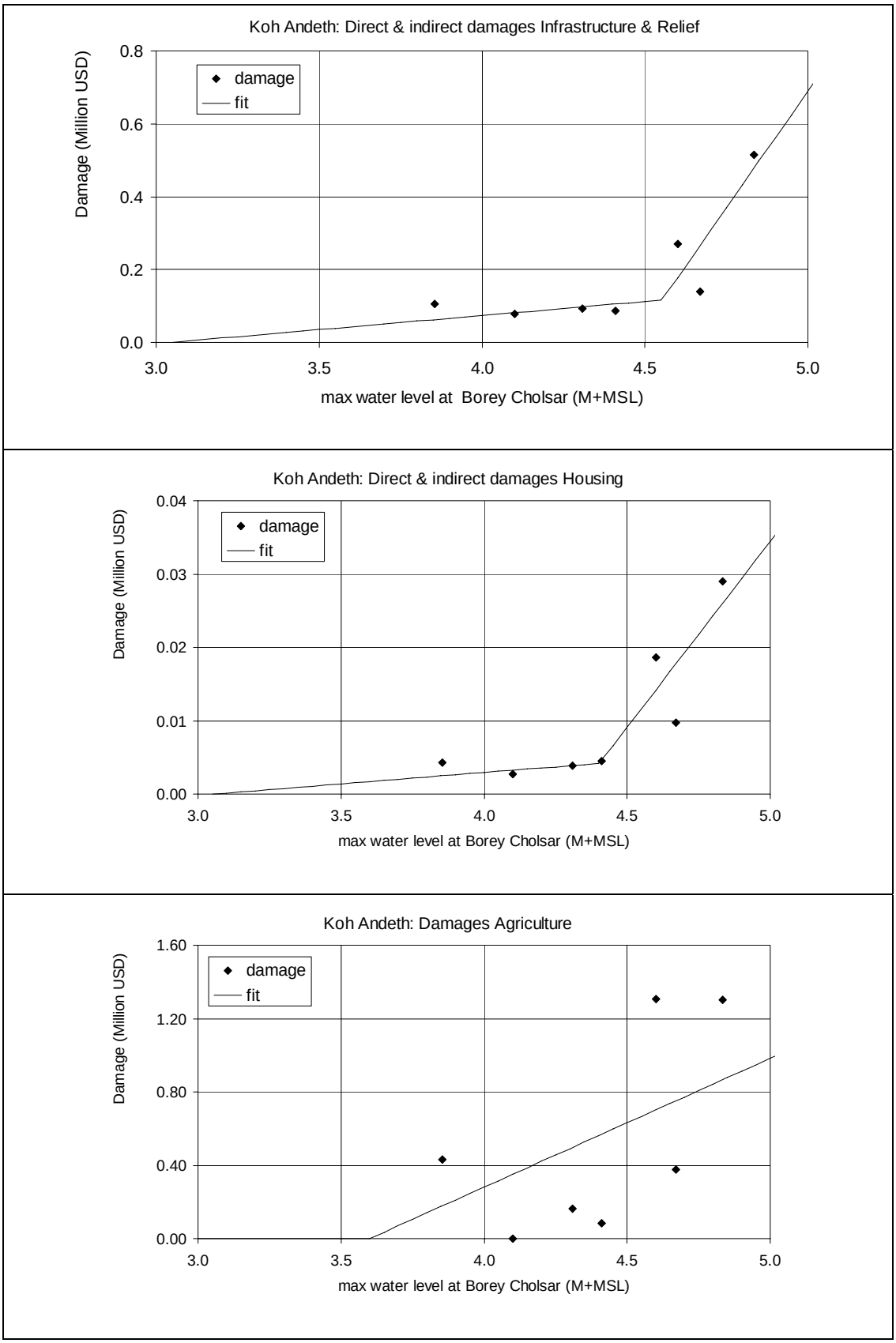


Figure 3.1 District flood damage curves, Koh Andet

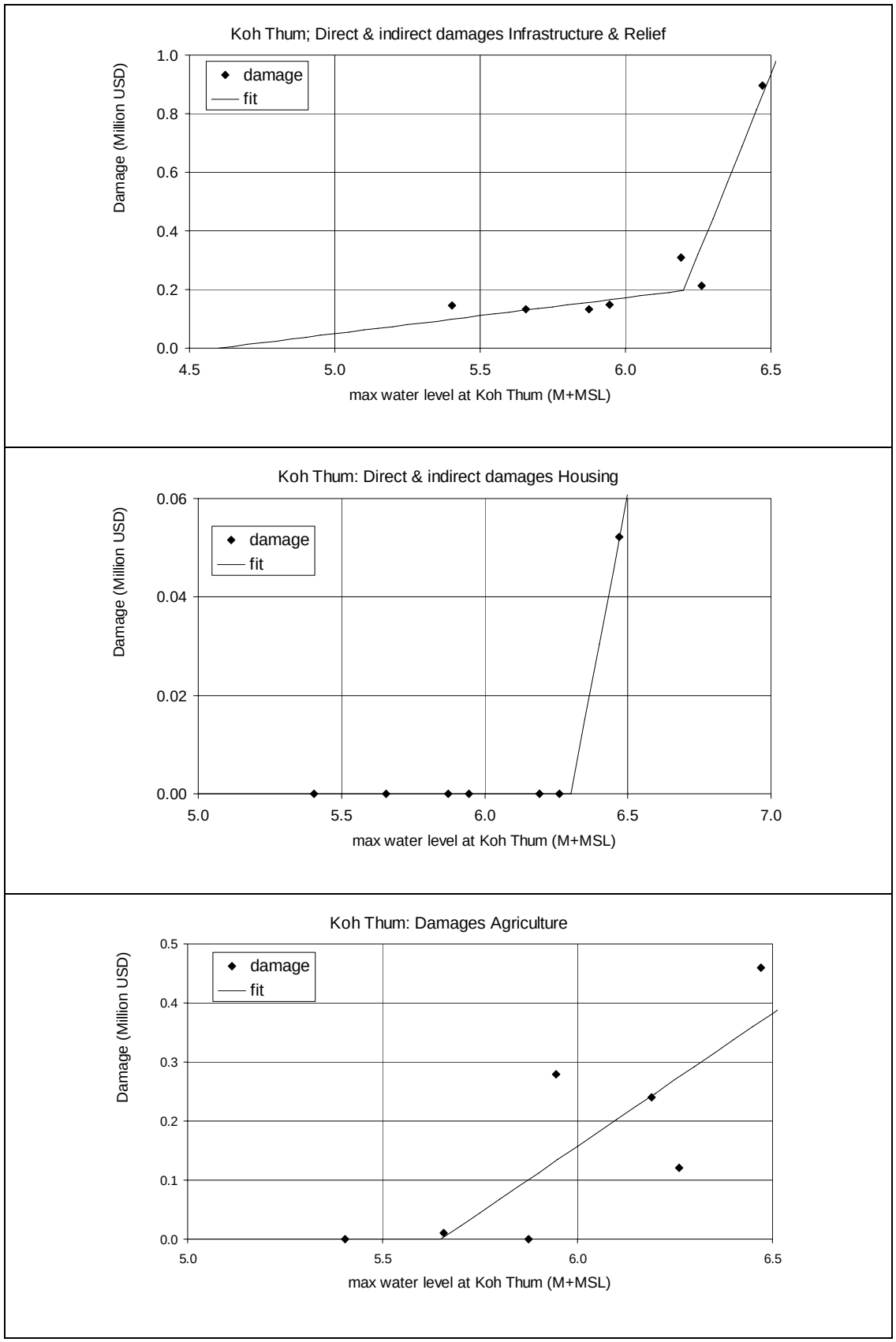


Figure 3.2 District flood damage curves, Koh Thom

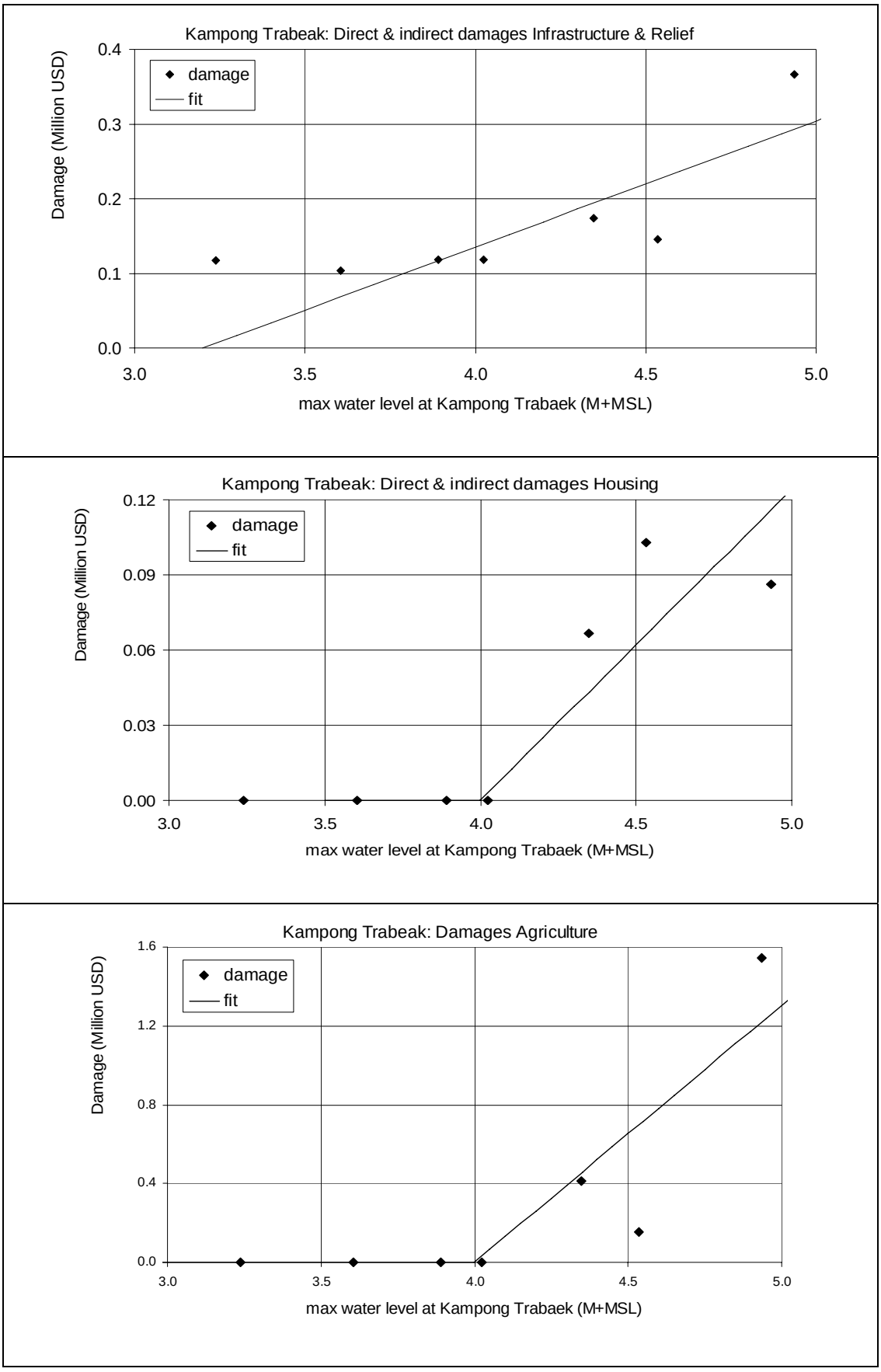


Figure 3.3 District damage curves, Kampong Trabek

Table 3.3 District flood damages and water levels Cambodia (2000-2007, 2007 constant prices)

Koh Andet District, Takeo Province	**Unit**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Direct & indirect damages Infrastructure & Relief	M USD	0.514	0.270	0.139	0.105	0.094	0.087	0.078	0.078
Direct & indirect damages Housing	M USD	0.029	0.019	0.010	0.004	0.004	0.005	0.003	0.003
Damages Agriculture	M USD	1.303	1.306	0.376	0.431	0.164	0.084	0.000	0.000
Max flood level at Koh Andet (ISIS)	m	4.83	4.60	4.67	3.86	4.31	4.41	4.10	4.83
Koh Thum District, Kadal Province									
Direct & indirect damages Infrastructure & Relief	M USD	0.895	0.310	0.212	0.146	0.131	0.148	0.133	0.130
Direct & indirect damages Housing	M USD	0.052	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Damages Agriculture	M USD	0.460	0.240	0.121	0.000	0.000	0.280	0.010	0.006
Max flood level at Koh Thum (ISIS)	M	6.47	6.19	6.26	5.40	5.87	5.95		
Kampong Trabek District, Pray Veng Province									
Direct & indirect damages Infrastructure & Relief	M USD	0.366	0.174	0.146	0.117	0.119	0.118	0.104	0.102
Direct & indirect damages Housing	M USD	0.086	0.067	0.103	0.000	0.000	0.000	0.000	0.000
Damages Agriculture	M USD	1.545	0.410	0.155	0.000	0.000	0.000	0.000	0.000
Max flood level at Borey Cholsar (ISIS)	M	5.77	5.33	5.43	4.50	4.86	4.91	4.57	5.77
Deflation factor (2007=1)		110%	109%	108%	107%	105%	104%	102%	100%

3.2 Damage and Probability for Districts

The district damage curves above were used to estimate the damages for the three categories for all the years between 1910 and 2006. The results are presented graphically in the graph below.

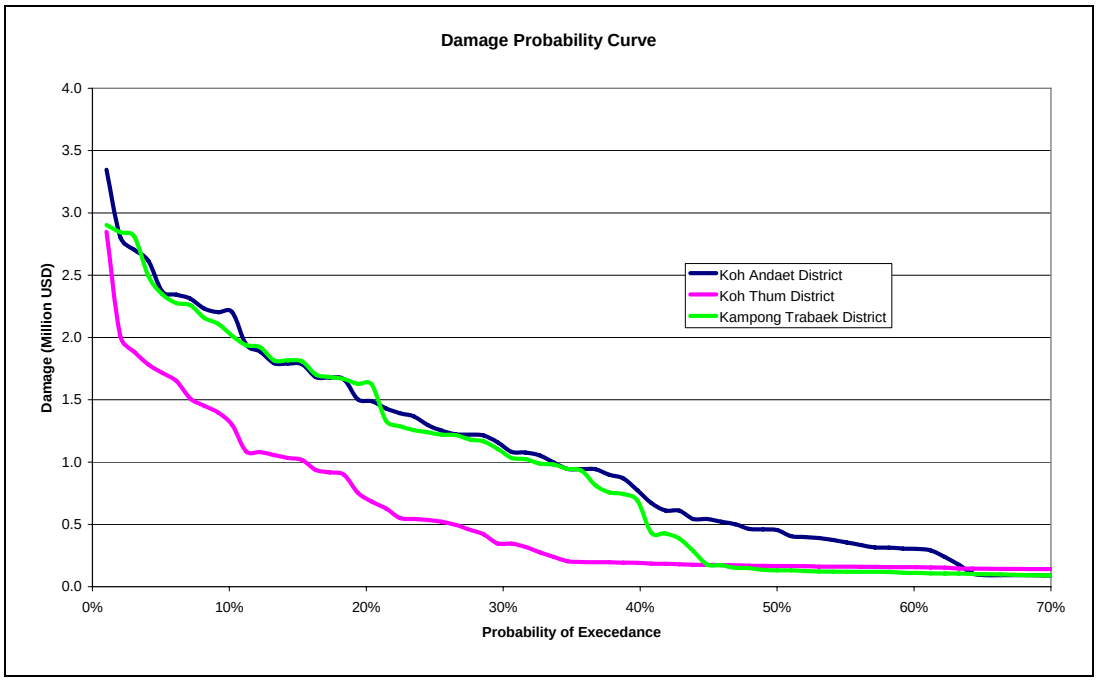


Figure 3.4 District total flood damage probability curves, Cambodia

A map showing the annual average flood risk for the three risk categories is presented in Appendix B.

3.3 District Population, Land Use and Structure

According to the District statistics, the population in 2006 was about 51,000 people in Koh Andet district; 151,000 people in Koh Thom district; and 125,000 people in Kampong Trabek district. The average annual population growth rates during the period 2003-2006 were 1.3-1.8% in the 3 selected districts in focal areas. Details are in Table 3.4.

Houses in all 3 districts are mainly of the semi-permanent category (59-81%). There are a small number of permanent houses (0.3-1%), the remaining houses belong to the temporary category.

Agricultural land is mainly used for cultivation of paddy in Koh Andet and Kampong Trabek districts. There is more agricultural crop diversify in Koh Thom district with paddy area of 66% of agricultural land. See details in Table 3.5.

Table 3.4 District population and land-use

	Items	Unit	Koh Andet	Koh Thom	Kampong Trabek
POPULATION			**H**	**G**	**I**
1	Population	Person	50,716	150,517	125,638
2	Number of HH	HH	8,587	23,715	21,682
3	Size of Family	Person	5.08	5.52	4.77
4	Poor household	HH	11,441	45,191	10,533
5	Population growth rate	2003-2006	1.59%	1.34%	1.81%
2006-LAND-USE		ha	22,969	41,003	91,722
1	Rice Land - Dry season	ha	10,833	12,979	6,865
2	Rice Land - Wet season	ha	13,353	2,178	24,490
3	Orchard Land	ha	0	7,168	37
4	Residential	ha	563	1,491	157
5	Commercial / Industrial	ha	NA	NA	NA
6	Institution	ha	NA	NA	NA
7	Forest	ha	NA	24,044	NA
8	Communal land	ha	NA	NA	NA
9	Other land: River, Lake	ha	NA	6,407	NA

Table 3.5 District structures, business and crops

	Items	Unit	Koh Andet	Koh Thom	Kampong Trabek
STRUCTURE					
1	Residential structures	Permanent	27	241	96
		Semi-permanent	7,669	19,682	14,266
		Temporary	1,822	5,006	9,778
2	Commercial structures	Permanent	0	2	0
		Semi-permanent	250	12	15
		Temporary	0	0	0
3	Industrial structures	Permanent	0	0	0
		Semi-permanent	0	0	0
		Temporary	0	0	0
4	Institutional structures	Permanent	15	0	0
		Semi-permanent	4	160	25
		Temporary	7	0	0
5	Agricultural structures	Permanent	0	0	0
		Semi-permanent	1,995	6,810	3,950
		Temporary	4,988	14,987	17,116
BUSINESS			378	255	697
1	Registered business		22	7	126
2	Non-registered business		356	248	571
3	Market vendors		63	77	162
CROPS					
1	Wet Season Paddy (May-Nov)	ha	13,353	2,177	24,490
2	Dry Season Paddy (Nov-Apr)	ha	10,833	12,979	6,865
3	Bean/Sesame	ha	0	2,483	37
4	Potato/Manioc	ha	0	255	0
5	Maize	ha	0	4,430	0
6	Vegetable	ha	0	74	0
7	Chili/Sweet pepper	ha	0	450	0

3.4 Household and Business Survey

The survey sample was designed as at least 90 households and business in each selected district in the focal areas. There were 3 selected districts in 3 provinces. They are Koh Andet District in Takeo province, Koh Thom district in Kandal province, and Kampong Trabek in Prey Veng province. The average value of the house varies from 1,000 to 1,500 US$ with an area varying from 50 to 60 m^2. Average value of business structure varies from 2,000 to 200,000 US$ with an area varying from 90 to 5,000 m^2.

The damages to Households in the 2006 flood was asked and potential damages to the house under the survey was investigated by putting questions how much the flood damage to house would be if a flood water higher than the 2006 flood by 0.5 m, 1.0 m, 1.5 m and 2.0 m. See Table 3.6 and 3.7 and the graphs below.

There was about 20-30% of households under the survey said their paddy/crop damaged by flood 2006.

There were 8 out of 15 businesses in Koh Andet district (Takeo province) damaged by the 2006 flood. There was no business in Koh Thom district (Kandal province) affected by the 2006 flood.

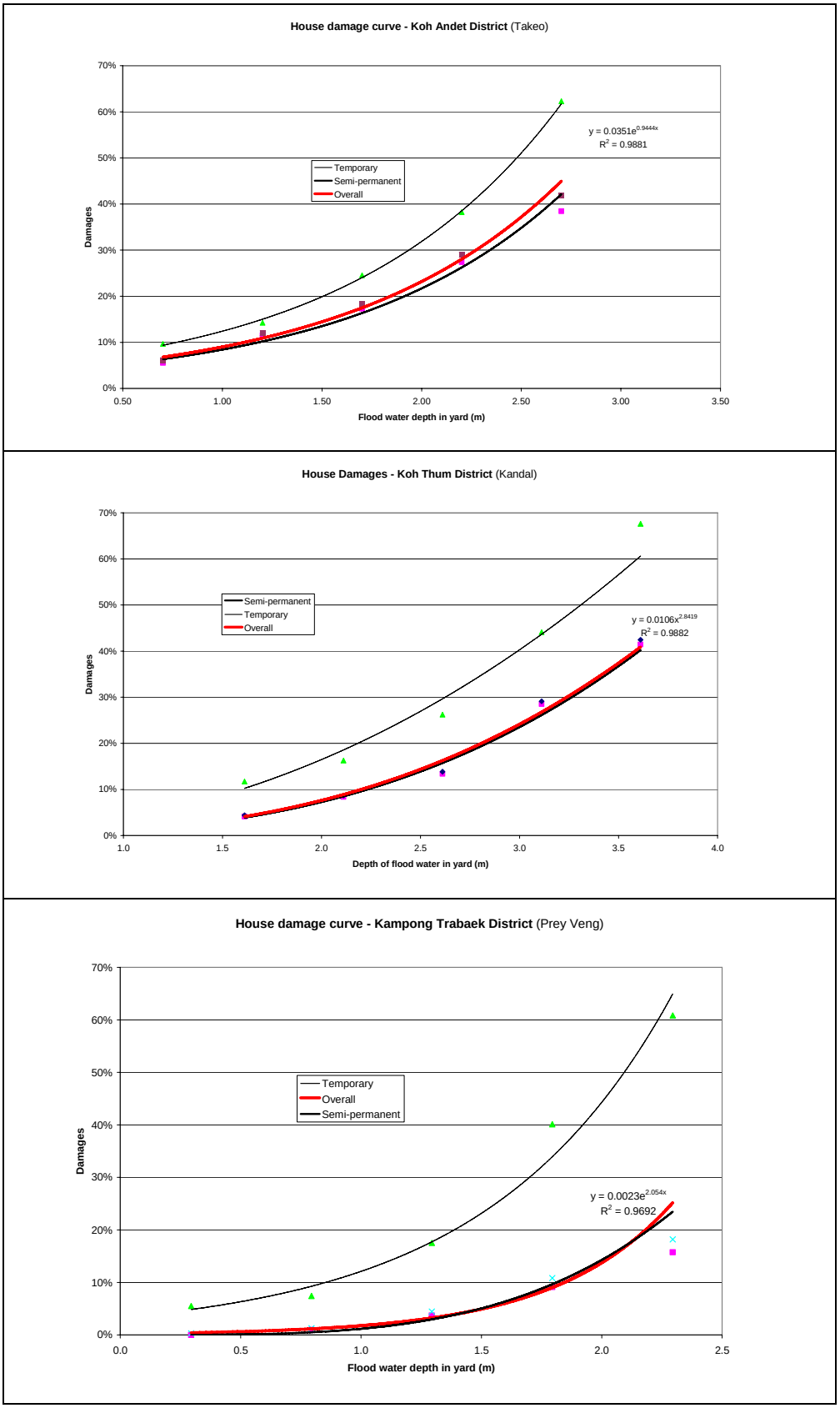


Figure 3.5 District relative flood damage curves for housing, Cambodia

Table 3.6 Household survey Cambodia

Province		**Takeo**	**Kadal**	**Prey Veng**
District		**Koh Andet**	**Koh Thom**	**Kampong Trabek**
Total sample	**HH**	**82**	**90**	**90**
Permanent house	HH			
Semi-permanent	HH	49	75	67
Temporary	HH	33	15	23
Value of house	**US$**	**957**	**1,739**	**1,503**
Permanent house	US$			
Semi-permanent	US$	1,369	2,009	1,908
Temporary	US$	344	393	322
Housing area	**m2**	**53**	**57**	**49**
Permanent house	m^2			
Semi-permanent	m^2	51	56	50
Temporary	m^2	56	61	48
2006 flood depth in yard				
Permanent house	m			
Semi-permanent	m	0.67	1.59	0.30
Temporary	m	0.74	1.74	0.27
Overall	m	0.70	1.61	0.29
Damages to structure				
2006 flood				
Permanent house	% house value			
Semi-permanent	% house value	5.6%	4.1%	0.0%
Temporary	% house value	9.7%	11.7%	5.5%
Overall	% house value	6.2%	4.4%	0.3%
2006 flood +0.5m				
Permanent house	% house value			
Semi-permanent	% house value	11.6%	8.4%	0.9%
Temporary	% house value	14.2%	16.3%	7.4%
Overall	% house value	12.0%	8.7%	1.3%
2006 flood +1.0m				
Permanent house	% house value			
Semi-permanent	% house value	17.3%	13.4%	3.7%
Temporary	% house value	24.6%	26.2%	17.5%
Overall	% house value	18.3%	13.9%	4.5%
2006 flood +1.5m				
Permanent house	% house value			
Semi-permanent	% house value	27.4%	28.5%	9.1%
Temporary	% house value	38.2%	44.1%	40.1%
Overall	% house value	29.0%	29.1%	10.8%
2006 flood +2.0m				
Permanent house	% house value			
Semi-permanent	% house value	38.5%	41.5%	15.7%
Temporary	% house value	62.3%	67.6%	60.8%
Overall	% house value	41.9%	42.4%	18.2%
Damages to paddy/crop				
Not affected	HH	55	72	74
Affected	HH	27	18	16

Table 3.7 Business survey Cambodia

Province		**Takeo**	**Kandal**
District	**Unit**	**Koh Andet**	**Koh Thom**
Total sample	**Business**	**15**	**2**
Permanent house	Business	3	2
Semi-permanent	Business	7	0
Temporary	Business	5	0
Value of house	**US$**	**2,089**	**200,000**
Permanent house	US$	10,000	200,000
Semi-permanent	US$	145	
Temporary	US$	64	
Housing area	**m^2**	**88**	5,150
Permanent house	m^2	411	5,150
Semi-permanent	m^2	8	
Temporary	m^2	7	
2006 flood depth in yard			
Permanent house	M	0.17	0.25
Semi-permanent	M	0.81	
Temporary	M	0.94	
Overall	M	0.73	0.25
Damages to structure			
2006 flood			
Permanent house	% structure value	0.0%	
Semi-permanent	% structure value	12.6%	
Temporary	% structure value	10.6%	
Overall	% structure value	0.5%	
2006 flood +0.5m			
Permanent house	% structure value	0.1%	
Semi-permanent	% structure value	20.0%	
Temporary	% structure value	30.9%	
Overall	% structure value	1.0%	
2006 flood +1.0m			
Permanent house	% structure value	0.3%	
Semi-permanent	% structure value	27.4%	
Temporary	% structure value	43.6%	
Overall	% structure value	1.6%	
2006 flood +1.5m			
Permanent house	% structure value	0.5%	
Semi-permanent	% structure value	41.0%	
Temporary	% structure value	48.7%	
Overall	% structure value	2.3%	
2006 flood +2.0m			
Permanent house	% structure value	7.5%	
Semi-permanent	% structure value	51.4%	
Temporary	% structure value	54.3%	
Overall	% structure value	9.4%	
Damages to business			
Not affected	Business	7	2
Affected	Business	8	0

3.5 Damage curves for paddy cultivation

Based on information collected during the Focal Group Discussions, damage curves for paddy production in relation to flooding depths in the districts Koh Thom, Koh Andet and Kampong Trabek have been estimated for Early Flood Paddy and for Rainy season paddy. The results are presented in the graphs below, showing three levels of damage, depending of the timing of the flood.

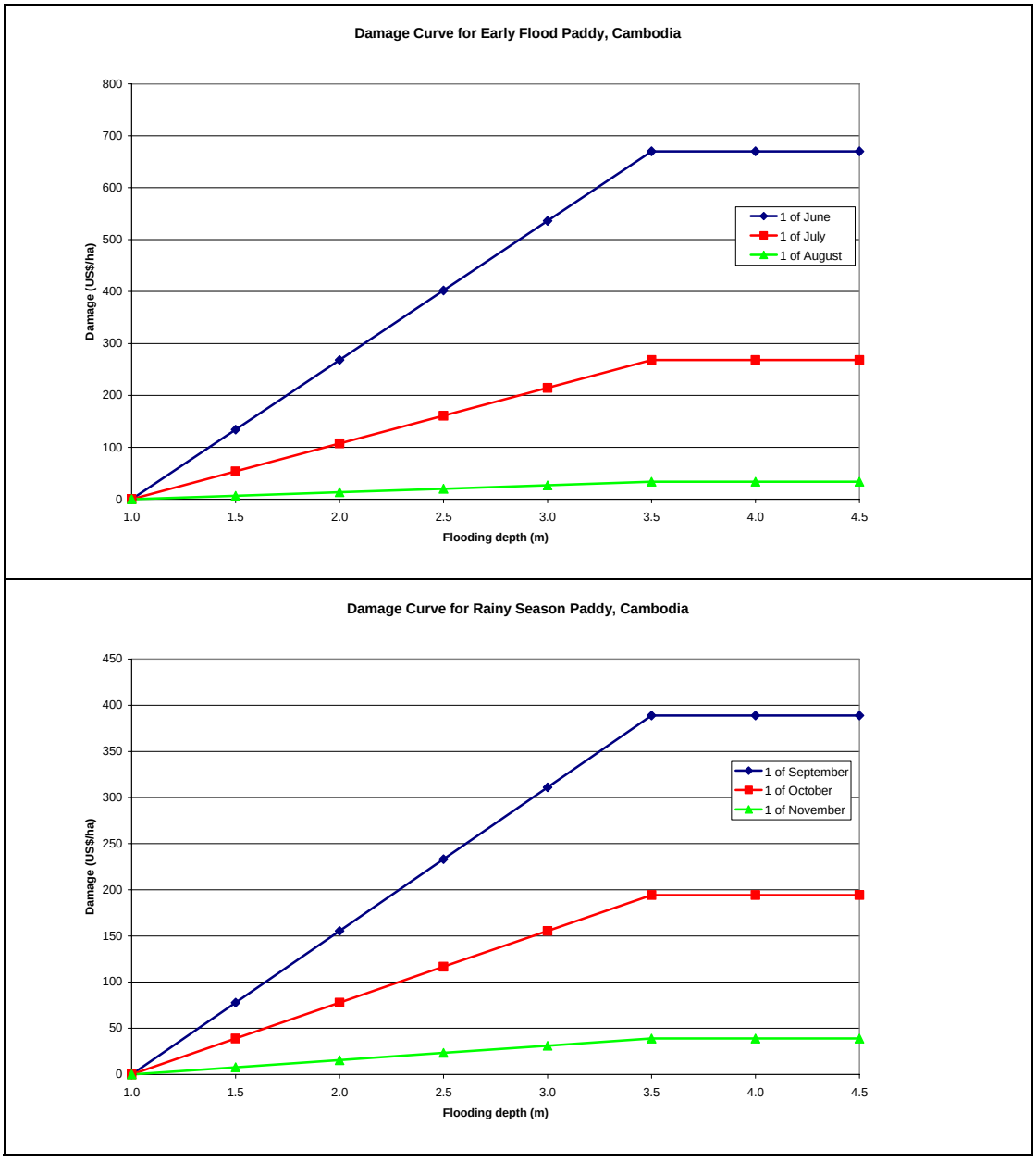


Figure 3.6 Relative flood damage curves for paddy, Cambodia

3.6 Potential Damages Reduction by Flood Control Measures

Potential damages reduction by flood control measures in focal areas can be identified by the area under the damage probability curve up to the proposed probability of control (say controlling flood at 10% probability or 1 in ten year return period).

The damage-probability curves for the three selected districts were established as presented in the previous section. For the purpose of flood control measure analysis, the potential damages reduction by control levels of 1%, 4%, 10%, and 50% probability were derived in focal areas.

At the same level of protection, potential damage reduction would be almost the same for the 3 selected districts. The annual flood damages reduction would be about half a million US$ for each district under flood control measures at 10% probability. See Table 3.8.

Table 3.8 Potential Damages Reduction by Flood Control Measures

District	Population	Land	Paddy	1%	4%	10%	50%
	(person)	(ha)	(ha)	(M US$)	(M US$)	(M US$)	(M US$)
Koh Andet	50,716	24,749	24,186	0.77	0.68	0.54	0.07
Koh Thom	150,517	47,860	15,157	0.42	0.35	0.26	0.06
Kampong Trabek	125,638	31,549	31,355	0.69	0.60	0.46	0.04

The potential damage reductions are established for the current situation of land-use. In case the proposed flood control measure provide additional opportunities to increase the cropping intensity in agriculture, then the net benefit from cultivation of the additional crop of about 500 US$/ha could be taken into account in the cost and benefit analysis.

There is a high development opportunity for the Cambodian Mekong Delta as the cropping intensity is still low. Flood control measures in combination with irrigation and drainage facilities could change all paddy land from 1 crop to 2 crops as in the deep flooded areas in the Vietnamese Mekong Delta.

A map showing the annual average flood risk for the three risk categories is presented in Appendix B.

3.7 Benefit from Flooding

In the Focus Group Discussion in the six surveyed communes farmers mentioned that floods have significant benefits for crop cultivation. After a big flood, the crop yield would be 1.5-2 ton higher than after a normal flood. The application of fertilizers and pesticides, however, is almost the same. Flood benefits for agriculture would be 0.62-0.93 million Riel[3]/ha (about 150-230 US$/ha).

Depending on the district, 30-100% of families in the deep flooded area are fishing during the flood season. Duration for fishing is reported as 2-3 months in five communes; in the Prek Thmey commune fishing lasts for 7 months. The benefit of flood for capture fisheries of people in deep flooded areas are 0.32–3.78 million Riel/fishing household (about 80 – 945 US$) in most communes and much higher in the Prek Thmey commune as they also fish outside the flood season. Details are presented in Table 3.9.

[3] 1 USD = 4000 Riel

Table 3.9 Benefits of flooding, Mekong Delta, Cambodia

Items	Unit	FGD-1		FGD-2		FGD-3		FGD-4		FGD-5		FGD-6	
Province		Takeo		Takeo		Kadal		Kadal		Prey Vieng		Prey Vieng	
District		Koh Andaet		Koh Andaet		Koh Thum		Koh Thum		Kompong Trabaek		Kompong Trabaek	
Commune		Pech Sar		Roming		Leuk Daek		Praek Thmey		Cham		Kompong Trabaek	
BENEFIT TO W-S PADDY AFTER FLOOD		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Paddy yield after normal flood	Ton/ha	3.00	4.00	4.00	5.00	4.00	5.00	4.00	5.00	5.00	6.00	4.00	5.00
Production cost after normal flood	Riel/ha	1,030,000	1,030,000	1,230,000	1,230,000	2,090,000	2,090,000	550,000	650,000	810,000	810,000	640,000	840,000
Net Benefit after normal flood	Riel/ha	830,000	1,450,000	1,250,000	1,870,000	390,000	1,010,000	1,930,000	2,450,000	2,290,000	2,910,000	1,840,000	2,260,000
Paddy yield after high flood	Ton/ha	4.50	5.50	5.00	6.00	5.00	6.00	5.00	6.00	6.00	7.00	5.00	6.00
Production cost after high flood	Riel/ha	1,030,000	1,030,000	1,230,000	1,230,000	2,090,000	2,090,000	550,000	650,000	810,000	810,000	640,000	840,000
Net Benefit after high flood	Riel/ha	1,760,000	2,380,000	1,870,000	2,490,000	1,010,000	1,630,000	2,550,000	3,070,000	2,910,000	3,530,000	2,460,000	2,880,000
Net Benefit from flooding	Riel/ha	**930,000**	**930,000**	**620,000**	**620,000**	**620,000**	**620,000**	**620,000**	**620,000**	**620,000**	**620,000**	**620,000**	**620,000**
BENEFIT FROM CAPTURE FISHERIES													
Number of HH in Commune	HH	1,682	1,682	2,162	2,162	2,769	2,769	3,822	3,822	2,626	2,626	1,869	1,869
Number of HH fishing	%	31%	31%	80%	80%	100%	100%	35%	35%	42%	42%	100%	100%
Number of HH fishing professional	%	3%	3%	25%	25%	80%	80%	86%	86%	5%	5%	80%	80%
Number of HH fishing non-professional	%	97%	97%	75%	75%	20%	20%	14%	14%	95%	95%	20%	20%
Value of catch (professional)	Kg/day	3	7	7	10	7	10	20	20	3	5	6	7
Value of catch (non-professional)	Kg/day	1	2	2	2	2	2	1	1	1	2	1	1
Fishing duration (low flood)	day												
Fishing duration (normal flood)	day	60	60	60	60	90	90	210	210	90	90	90	90
Fishing duration (high flood)	day	60	60	60	60	90	90	210	210	90	90	90	90
Average price of fish	Kip/kg	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
AVERAGE BENEFITS PER FISHING HH													
Total value of fish catched (normal flood)	Kip/year	318,000	645,000	975,000	1,200,000	2,700,000	3,780,000	18,207,000	18,207,000	495,000	967,500	2,250,000	2,610,000
Total value of fish catched (high flood)	Kip/year	318,000	645,000	975,000	1,200,000	2,700,000	3,780,000	18,207,000	18,207,000	495,000	967,500	2,250,000	2,610,000
TOTAL BENEFITS IN COMMUNE													
Fish catched in normal flood	Mil Kip/year	165.81	336.32	1,686.36	2,075.52	7,476.30	10,466.82	24,355.50	24,355.50	545.95	1,067.08	4,205.25	4,878.09
Fish catched in high flood	Mil Kip/year	165.81	336.32	1,686.36	2,075.52	7,476.30	10,466.82	24,355.50	24,355.50	545.95	1,067.08	4,205.25	4,878.09
AVERAGE BENEFITS PER HH													
Fish catched in normal flood	Kip/year	98,580	199,950	780,000	960,000	2,700,000	3,780,000	6,372,450	6,372,450	207,900	406,350	2,250,000	2,610,000
Fish catched in high flood	Kip/year	98,580	199,950	780,000	960,000	2,700,000	3,780,000	6,372,450	6,372,450	207,900	406,350	2,250,000	2,610,000
Principle benefits	Text	With a good flood people can receive some benefits, especially for agriculture. The good flood brings fertile land / alluvial soil to the rice field so that rice the yield will increase from 1.5 to more than 2 tons per ha. In case the water level rises slowly the rice can catch up with water level and will not rot. The retention of an adequate water level allows the rice crop to benefit and to prevents weeds.				With a good flood people can receive some benefits, especially for agriculture. The good flood rises in August so farmers have enough time to harvest their dry season rice. In the community, dry season rice is started in March – April and is harvested in July – August. The water of a good flood is good, there is no smell and clear because the water flows and quickly recedes below the high flood level. The health problem is not so acute. Fishing is a benefit from flood for all people in the commune		People can receive some benefits from flooding, especially for agriculture. The good flood brings fertile land / alluvial soil to the rice field so that rice yield will increase from 1.5 to more than 2 tons per ha for wet season rice and from 4 to 6 tons per hectare for dry season rice. In case the water level rises slowly and quickly recedes in the low tide with adequate water level, so that rice can catch up with water level and does not rot. In addition, other crops benefit too because there are not insects. Vegetables, home garden, perennial and fruit trees are not damaged. The water quality is good, no smell and clear because the water flows and quickly recedes below the high flood level. The environment is good.		With the good flood people can receive some benefits, especially for agriculture which is mainly rice cultivation. The good flood brings fertile land / alluvial soil to the rice file so that rice yield will be increased from 1.5 to more than 2 tons per ha (for wet season rice) and from 5 to 7 t/ha (for dry season rice). The floodwater level slowly rises and quickly recedes in the low tide, so that rice can catch up with water level and does not rot. The retention of adequate water level allows the rice crop to benefit and prevents weeds. Rats are killed by floodwater and insects also decrease.		Flood often make soil more productive in the villages located very close to branch of Mekong River. Every year flood has deposit alluvial/fertile land to villagers' rice fields which bring rich soil fertility to support agricultural crops. Also, floods are a natural means of removing farm parasites such as rats from the fields. Again in this case, the poor and landless households holding very small pieces of land are marginalized from this benefit. In normal or good flood year, the rice yield will increased from 1.5 to more than 2 tons per hectare. In bad flood years the rice yield is less than 500 kg per hectare. Floods in the wet season can provide habitat and nutrition for fish. The bigger flood, higher fish catch.	

Table 3.10 Level of protection for settlement and crops, Mekong Delta, Cambodia

Items	Unit	FGD-1		FGD-2		FGD-3		FGD-4		FGD-5		FGD-6	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Province		Takeo		Takeo		Kadal		Kadal		Prey Vieng		Prey Vieng	
District		Koh Andaet		Koh Andaet		Koh Thum		Koh Thum		Kompong Trabaek		Kompong Trabaek	
Commune		Pech Sar		Rominh		Leuk Daek		Praek Thmey		Cham		Kompong Trabaek	
TIMING OF FLOOD DAMAGES TO CROPS		Normal flood	Big flood	Normal flood	Big flood	Normal flood	Big flood	Normal flood	Big flood	Normal flood	Big flood	Normal flood	Big flood
Damages if flood water overtop in Mid June	%	60	100	80	100	100	100	100	100	100	100	100	100
Damages if flood water overtop in Mid July	%	40	100	50	100	20	50	10	90	30	100	40	100
Damages if flood water overtop in Mid August	%	20	100	30	100	5	20	0	70	10	70	20	20
Damages if flood water overtop in Mid September	%	10	100	10	100	0	0	80	90	0	50	0	0
Damages if flood water overtop in Mid October	%	10	100	10	100	0	0	100	100	0	50	0	10
Damages if flood water overtop in Mid November	%	10	100	10	100	0	0	100	100	50	100	10	30
Flood free settlement sites	Text	Before 2003, there was no major measure to protect this community from flood damage / losses. However, local authority and villagers have built a small dike by putting the soil in bags. Wealthier households have themselves raised the level of their house sites by increasing the level of earth or rubble or concrete. In 2003-2004 the Cambodian Government constructed the Pech Sar dyke to protect flood in Koh Andaet, Traing, Kiry Vong and Borey Chulsar district. The dyke plays an important role to protect rice fields from flooding. Since 2004 up to now, the flood damage has been reduced by 50 percent.				In the past 10 years there has no measure to protect this community from flood damage / losses. However, villagers have built their houses on stilts with mainly timber which are naturally water resistant. Some wealthier households have used concrete columns.		In the past 10 years there has not been any measure to protect this community from flood damage / losses. However in 2000 and 2001 local authorites and villagers have built a small dike by putting soilbags to protect against the flood around the community area 3,000 meters long and spent more than Riel 10,000,000. Wealthier households have themselves raised the level of their house sites by increasing the level of earth or rubble or concrete.		In the past 10 years there has not been any measure to protect this community from flood damage / losses. However, villagers have built their houses on stilts with mainly timber which are naturally water resistant. Wealthier households have themselves raised the level of their house sites by increasing the level of earth or rubble or concrete. After the big flood year 2000, about 50 percent of villagers spent around Riel 400,000 per household to raise the level of their house site. The local authorities reserve some safety places for people to relocate during the flood season. But since 2004 up to now, there has been no relocation because the floodlevels		Up to now, there has not been a major measure been taken to protect this community from flood damage / losses, except that local authorityies and villagers have repairs 15 community safety hills, one pagoda namely “Serey Sakor” and the side-walk of national road No. 1. Wealthier households have themselves raised the level of their house sites by increasing the level of earth or rubble or concrete. Traditionally, within a week before the flood water reaching the village, most of villagers prepare food and fuel woods, and increase the strength of struts and bracing timbers to cope with flood.	
Protection of crops	Text	The community is divided in two parts: 70% upland and 30% low land. When the flood water is less than 0.5 m it does not cause damage to the rice crop. In normal years (2006) the water level is about 0.7 to 0.8 m in the low land part, so the people can do well farming in all are (both upland and low land). In case the flood water remains for a long time on the field, it will cause a delay for people who farm dry season rice .				In the community there is no flood protection at all. In a normal flood year the water level is about 4 m and on a bad flood year it is more than 5 m above groundlevel. When the flood water is more than 4 m and quickly rose and remains high for a long time leading to damage to the dry season rice, because the farmers do not have enough time for harvesting.		In the community there is no flood protection at all. In normal flood year the water level is about 0.50 meters and bad flood year is more than 1.50 meters. When the flood water is more than 1 meter and quickly rose and remains high for a long time leading to damage to the wet season rice, because the crop will be rotten. Between year 2000 and 2002, the water level is from 1.50 to 2.00 meters. This situation is happened the same in all area of the community. When the flood water is around 0.5 meter it is without causing damage to the rice crop.		The community is divided in two parts: 50% upland and 50% lowland. When the flood water is less than 1.0 meter it is without causing damage to the rice crop. In normal years (2006) the water level is about 0.8 to 1.0 meter, at middle area between lowland and upland, so the people can do farming well in all are (both upland and lowland). In case the flood water remains for a long time, which can lead to a delay for people who farm dry season rice at the lowland.		In the community there is no flood protection at all. In normal flood year the water level is about 0.60 meters, it is without causing damage to the rice crop. In a bad flood year, the water level is more than 1.50 meters. When the flood water is more than 1 meter and quickly rose and remains high for a long time leading to damage to the wet season rice, because the crop will rot. Between 2000 and 2002, the water level was from 1.50 to 2.00 meters. This situation is happened the same in all area of the community.	

CHAPTER 4

DATA PROCESSING FOR LAO PDR

4 DATA PROCESSING FOR LAO PDR

4.1 District Flood Damages Data

The direct damages caused by flooding in the Nongbok district in the focal area belonging to Khammouane province were collected from district and provincial authorities for the period 1996-2006. River bank protection in Bokeo province has been processed separately and is presented in Chapter 0.

The indirect damages for Housing was derived from the Household and Business surveys. These rates were 227% of direct damages for household and 67% for businesses, resulting in a weighted average of 216%. See Table 4.1. This is much larger than in other areas, but is so because the damage to houses is rather small as the houses are built on stilts and are located on sandy ridges; the indirect costs relate largely to temporary relocation.

Indirect damages for Infrastructure & Relief for 2006 were collected from relevant departments in the Nongbok District. The total indirect costs in 2006 were US$ 125,098, mainly from irrigation, education and health departments. Other departments reported no indirect costs related to the 2006 flood. Direct flood damage in 2006 for Infrastructure & Relief was US$ 319,562. The indirect/direct rate was estimated as 39%. See Table 4.2. These indirect-direct rates were used to adjust the direct damages reported by local government for the years 1996-2006.

To make the damage data of the various years comparable with each other and with data of other MRC-member countries, the data have been converted to the 2007 price level[4] and have been converted to US$.

Table 4.1 Direct and indirect damages for households and businesses (2006, USD)

Items	Unit	Nongbok District
Direct damages HH	USD	368
Indirect damages HH	USD	836
HH in Survey	HH	70
HH in District	HH	7,593
HH Survey Coverage	%	0.92%
Weighted Indirect/Direct HH damages	%	227%
Direct damages Businesses	USD	778
Indirect damages Businesses	USD	518
Businesses in Survey	Business	20
Businesses in District	Business	564
Business Survey Coverage	%	3.55%
Average Indirect/Direct Bus. damages	%	67%
Weighted Indirect/Direct HH & Business damages	%	216%

[4] Using CPI of Laos http://www.photius.com/

Table 4.2 Direct and indirect damages for infrastructure (2006, USD)

Items	Nongbok District
Direct costs	319,562
Indirect costs Government	125,098
Indirect/Direct damages	39%

There was no information on house damages in the district flood inventory during 1996-2006. From the Household survey sample in Nongbok district, it showed that 10 out of 70 households had to fix the house after the 2006 flood for an average amount of 312,500 Kip[5] (37 US$) per affected house. From the Focus Group Discussions it emerged that most villages are located on high ground and many houses are built on poles of 2.5-3 m above ground level. Therefore flood damage to Housing is not significant.

According to the 2006 statistics, there were 7,593 households in Nongbok district and it was estimated that 14% of these households suffered from damages to the foundation and/or floor of their house. The total estimated flood direct damages in 2006 for housing would be 339 million Kip (US$ 39,879 equivalent).

The hydrological analysis for Xe Bangfaishowed that:

- Flooding takes place in the districts Thakek, Nong Bok, Se Bang Fai and Mahaxai. Major flooding takes place between the Mekong and Highway 13S, north of the Xe Bangfai River. Lowest areas are 140 masl, whereas Nongbok village is flood free at an elevation of 150 masl. Flooding here lasts several months;
- Design levels for flood protection at Donghuang range from 147 masl (5 year return period) to 148 masl (100 year return period);
- From the frequency curves of the daily average water levels of the Mekong at That Phanom near the Xe Bangfai river mouth (gauge zero = 127.94 masl and flood plain level = 139.50 masl) it is observed that the peaks in Xe Bangfai River are likely to coincide with high water levels on the Mekong.

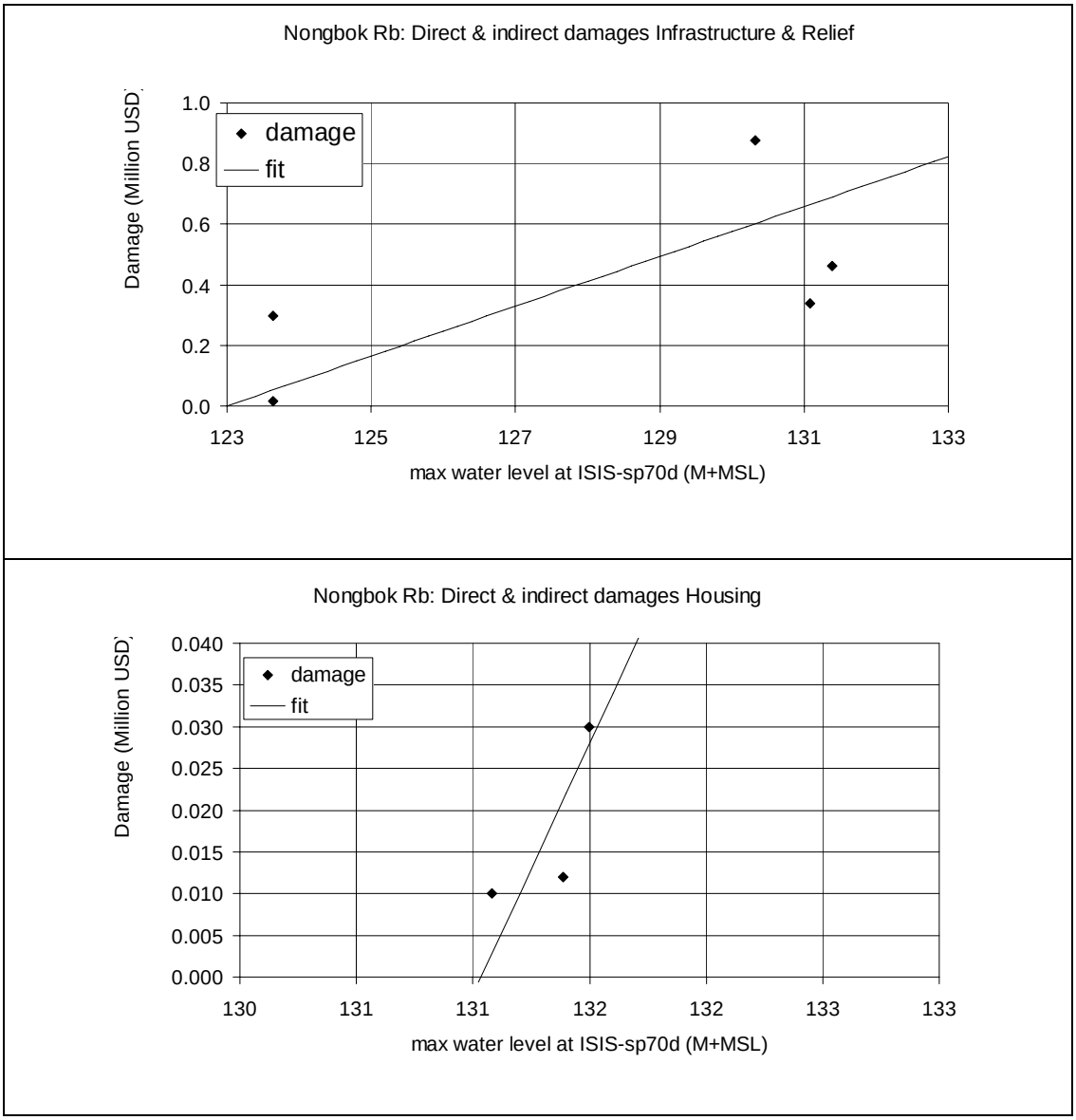
The district flood damage data have been related to the annual maximum water levels in the flood plain on the right bank of the Xe Bangfai River (ISIS-point sp70d) for the categories Infrastructure & Relief and Housing, as the flood damages in these categories are expected to mainly depend on the maximum level of flooding.

The flood damages to Agriculture (mainly paddy cultivation) depend very much on the timing of the flood. There are two main seasons of paddy: (1) Wet season paddy is planted in June and harvested in November; and (2) Dry season paddy is planted in December and harvested in April where irrigation water is available during the dry season. Flood damage to Agriculture is mainly for the wet season paddy. Unlike agriculture in the Lower Mekong in Vietnam, where the early flood would affect the paddy, in Nongbok Agriculture is affected by the main flood. Therefore the maximum flood water level has been used also for the analysis of agricultural damages.

A summary of the total flood damages for Nongbok district is presented in

[5] 1 USD=8,500 Kip

Table 4.3, along with the maximum water levels generated by the Xe Bangfai hydrological model in ISIS. The damage curves for Infrastructure & Relief; Housing and Agriculture were developed and are presented in the following graphs.



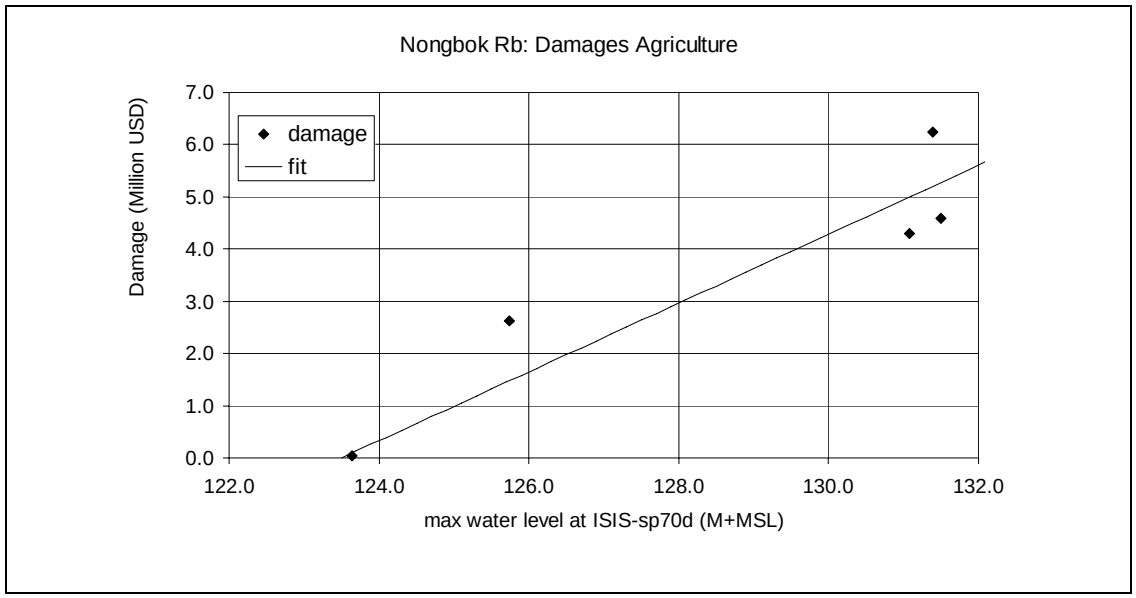


Figure 4.1 District flood damage curves, Lao PR

Table 4.3 Direct and indirect damages, Nongbok District (2007, USD)

Year	Total	Infrastructure & Relief	Housing	Agriculture	Max WL Sp70d
1996	2.43	0.876		1.554	132.37
1997	8.033	0.835		7.198	130.33
1998	0.151	0.035		0.116	123.63
1999	5.908	0.45		5.458	123.63
2000	4.996	0.384	0.03	4.582	123.63
2001	4.649	0.34	0.01	4.299	131.50
2002	1.685	0.296		1.389	131.08
2003	0.063	0.015		0.048	123.63
2004	2.953	0.327		2.626	123.63
2006	6.719	0.462	0.012	6.245	125.74

4.2 Damage and Probability for Districts

The district damage curves above were used to estimate the damages for the three damage categories for the return periods of 2, 10, 25 and 100 years. The resulting combined Damage Probability curve for Nongbok district is presented below.

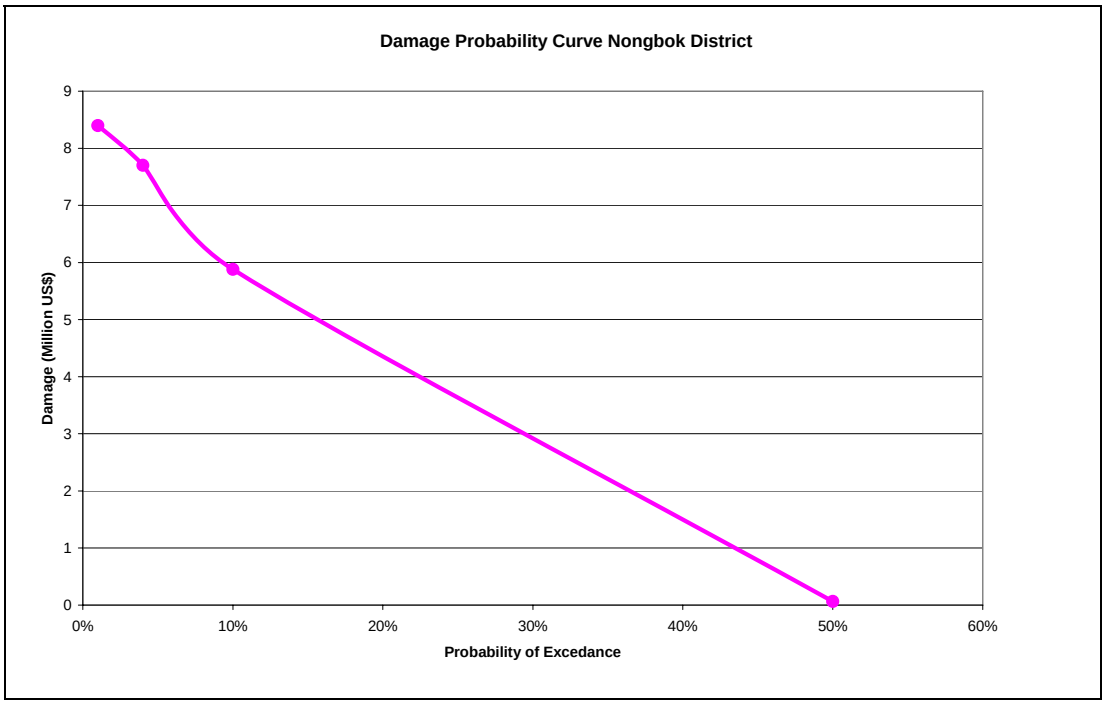


Figure 4.2 District flood damage probability curve, Lao PDR

4.3 District Population, Land Use and Structure

According to the Nongbok District statistics, the population in 2006 was about 41,000 people. The average annual population growth rate during the period of 2001-2006 was 0.49%. Land use in Nongbok district in 2006 was dominated by forest (41%), rainy seasonal paddy (34%), dry seasonal paddy (7%), upland crops (5%) and residential and industrial land (2%). Details are in Table 4.4.

Table 4.4 Population and land-use in Nongbok district, 2006

Items	Unit	Data
POPULATION		
Population	Person	41,103
Number of HH	HH	7,593
Size of Family	Person	5.41
Poor household	HH	0
Population growth rate (2001-2006)	%	0.49%
LAND-USE		
Rainy seasonal paddy (rainfed)	Ha	10,536
Dry season paddy (irrigated)	Ha	2,271
Crop Land	Ha	1,714
Plantation Land	Ha	100
Natural lake and ponds	Ha	2,726
Residential - Rural (including gardens)	Ha	512
Residential - Urban including Commercial / Industrial	Ha	126
Institution	Ha	10
Dry Dipterocarpus Forest	Ha	9,400
Communal land	Ha	360
Non-productive forests	Ha	3,545

Housing the Nongbok district consists mainly of semi-permanent structures (70%), followed by permanent house (20%) and temporary house (10%). There were 957 commercial structures, 14 industrial structures, 79 institutional structures, and 7,593 temporary agricultural structures.

Agricultural land is mainly used for paddy cultivation. There was a small upland crop area for onions, chilly and corn. See details in Table 4.5.

Table 4.5 Houses & crops in Nongbok district, 2006

Items	Unit	Data
Residential structures	Permanent	1,596
	Semi-permanent	5,586
	Temporary	798
Commercial structure	Permanent	197
	Semi-permanent	760
	Temporary	0
Industrial structures	Permanent	0
	Semi-permanent	14
	Temporary	0
Institutional structures	Permanent	32
	Semi-permanent	0
	Temporary	47
Agricultural structures	Permanent	0

Items	Unit	Data
	Semi-permanent	0
	Temporary	7,593
CROPS		
Rainy Seasonal Paddy (Jun-Nov)	Ha	10,535
Dry season paddy (December-April)	Ha	1,500
Dry seasonal tobacco	Ha	31
Onion	Ha	156
Green Onion	Ha	199
Chilly	Ha	137
Corn	Ha	149

4.4 Household and Business Survey

The survey sample was designed as 90 households and business in each selected district in the focal areas. The average value of the houses varies from 4,000 to 5,000 US$ with an area varying from 60 to 70 m^2. Average value of business structure varies from 1,400 to 9,000 US$ with an area varying from 60 to 200 m^2.

The damages to houses in 2006 was 0.11% of the house value for Households and 0.74% for Business. However, the investigation on potential flood damages was not obtained. See details in Table 4.6. The graph below presents the consultant's estimate, based on the structure of the houses and on survey results from Vietnam and Cambodia. The houses and businesses in Nongbok are built on stilts; hence there is now damage to be expected from inundations less than 2 m.

Table 4.6 Household & Business survey in Nongbok district

Items		Household	Business
Total sample	**Nos**	**70**	**20**
Permanent house	Nos	59	20
Semi-permanent	Nos	11	0
Temporary	Nos	-	0
Value of house	**US$**	**4,723**	**5,288**
Permanent house	US$	4,679	5,288
Semi-permanent	US$	4,960	
Temporary	US$		
Housing area	**m2**	**67**	124
Permanent house	m2	66	124
Semi-permanent	m2	70	
Temporary	m2		
2006 flood depth in garden			
Permanent house	m	0.64	0.65
Semi-permanent	m	0.68	
Temporary	m		
Overall	m	0.65	0.65
2006 flood depth on field	m	2.50	
Damages to housing			
2006 flood	%	0.11%	0.74%
2006 flood +0.5m	%	NA	NA
2006 flood +1.0m	%	NA	NA
2006 flood +1.5m	%	NA	NA
2006 flood +2.0m	%	NA	NA

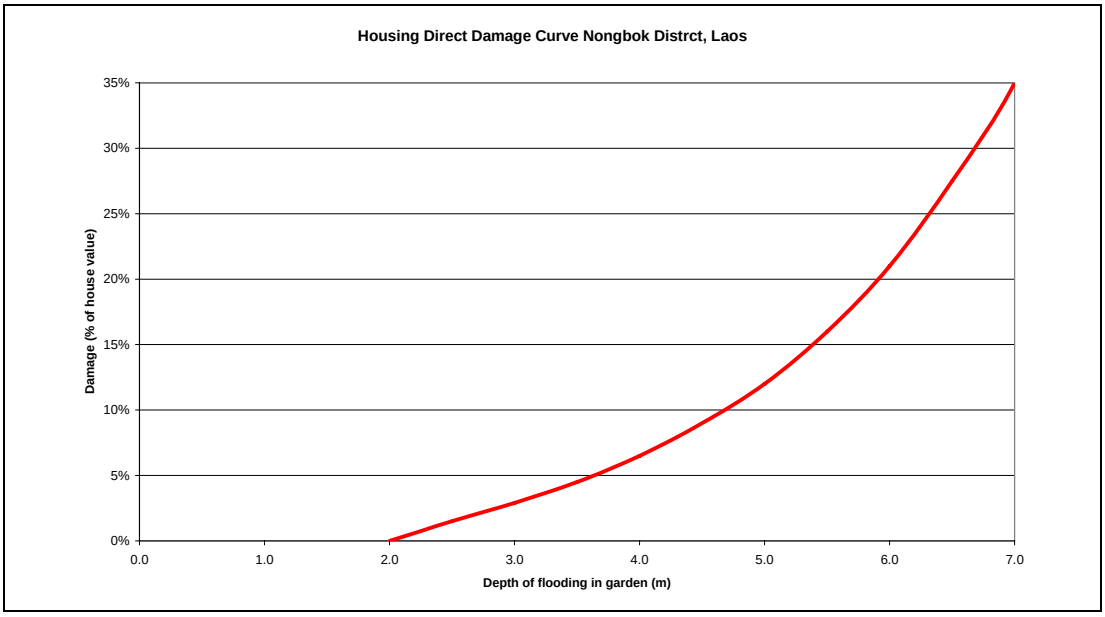


Figure 4.3 District relative flood damage curve for paddy, Lao PDR

4.4.1 Damage curves for paddy cultivation

Based on information collected during the Focal Group Discussions, damage curves for paddy production in relation to flooding depths in the Nongbok district have been estimated. The results are presented in the graph below, showing three levels of damage, depending of the duration of the flood. In this area, the timing of the flood is less relevant.

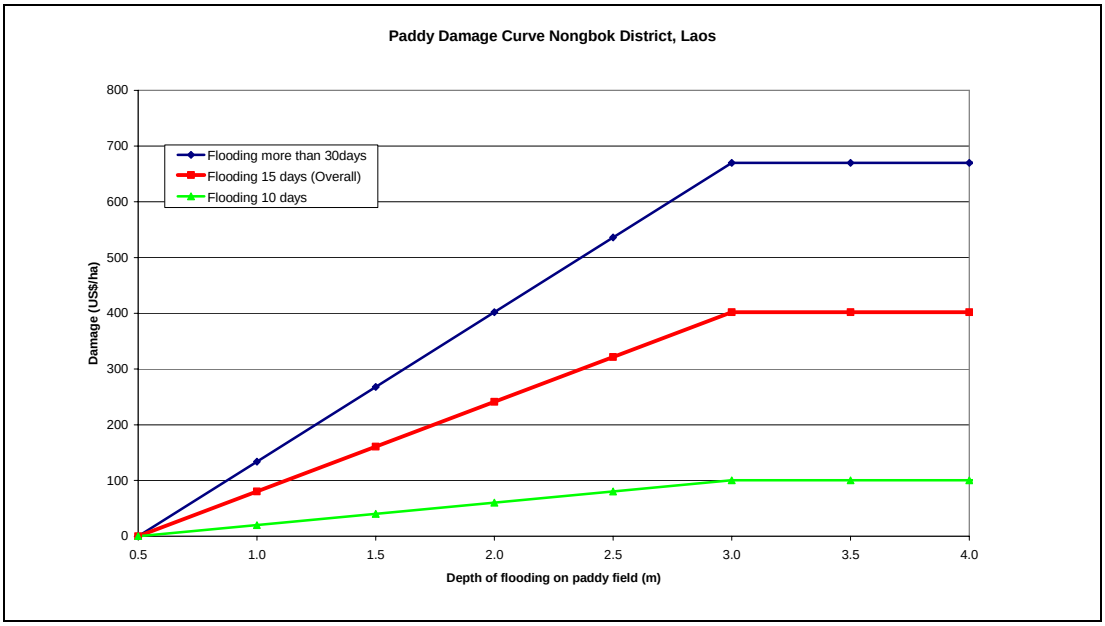


Figure 4.4 District relative flood damage curve for paddy, Lao PDR

4.5 Potential Damages Reduction by Flood Control Measures

Potential damages reduction by flood control measures in focal areas can be identified by the area under the damage probability curve up to the proposed probability of control (say controlling flood at 10% probability or 1 in ten year return period). For the purpose of flood

control measure analysis, the potential damage reduction by levels of control of 1%, 4%, 10% and 50% probability were derived in focal areas, See Table 4.7. The annual flood damages reduction would be about 1.19 million US$ for the district under flood control measures at 10% probability.

Table 4.7 Potential Damages Reduction by Flood Control Measures

District	Population	Land	Paddy	1%	4%	10%	50%
	(person)	(ha)	(ha)	(M US$)	(M US$)	(M US$)	(M US$)
Nongbok	41,103	31,300	12,800	1.84	1.60	1.19	0.003

The potential damage reductions mentioned in Table 4.7 are established for the current situation of land-use. In the case proposed flood control measure provides additional opportunity to increase cropping intensity in agriculture, then the net benefits from cultivation of the additional crop of about 400 US$/ha could be taken into account in cost and benefit analysis.

There is a high opportunity for the district to increase cropping intensity by providing flood control measures in combination with irrigation facilities.

4.6 Benefit from Flooding

The two Focus Group Discussion reports show that there are no benefits from the flooding to Agriculture in terms of sedimentation and soil fertility, acidity leaching and pest control to the land. Most of households, however, are engaged in capture fisheries in the rivers and paddy fields. 70-80% household are fishing for sale, the remaining households only fish for their daily consumption. The duration of fishing is reported as 10-20 days. The benefit from capture fisheries per household are US$ 150-3,200 for average flood and US$ 290-6,400 for big flood, see Table 4.8.

Table 4.8 Benefits of Flooding, Laos

Items	Unit	FGD-1		FGD-2	
Province		**Khammuan**		**Khammuan**	
District		**Nongbok**		**Nongbok**	
Commune		**Mekong side, Nonglom Village**		**Sebangfai, Hatxaiphong village**	
BENEFIT TO W_S PADDY AFTER FLOOD		Min	Max	Min	Max
Paddy yield after normal flood	Ton/ha	5.00	6.00	5.00	6.00
Production cost after normal flood	Mil Kip/ha				
Paddy yield after high flood	Ton/ha	5.00	6.00		
Production cost after high flood	Mil Kip/ha				
BENEFIT FROM NATURAL FISHING					
Number of HH in Commune	HH	173	173	70	70
Number of HH fishing	%	100%	100%	100%	100%
Number of HH fishing professional	%	80%	80%	70%	70%
Number of HH fishing non-professional	%	20%	20%	30%	30%
Value of catch (professional)	Kg/day	50	1,000	50	1,000
Value of catch (non-professional)	Kg/day	20	500	20	500
Fishing duration (low flood)	day	5	5	5	5
Fishing duration (normal flood)	day	10	10	10	10
Fishing duration (high flood)	day	20	20	20	20
Average price of fish	Kip/kg	3,000	3,000	3,000	3,000
AVERAGE VALUE PER FISHING HH					
Total value of fish catched (normal flood)	Mil Kip/year	1.32	27	1.23	25.5
Total value of fish catched (high flood)	Mil Kip/year	2.64	54	2.46	51
TOTAL VALUE IN COMMUNE					
Fish catched in normal flood	Mil Kip/year	228	4,671	86	1,785
Fish catched in high flood	Mil Kip/year	457	9,342	172	3,570
AVERAGE VALUE PER HH					
Fish catched in normal flood	Mil Kip/year	1.32	27.00	1.23	25.50
Fish catched in high flood	Mil Kip/year	2.64	54.00	2.46	51.00
Principle benefits	Text	There is no difference in fertilizer application and crop yields between big and normal flood years. People catch fish and process it as fermented fish and sell it a few months after the flood. They still make less money out of it if compared to that they catch the fish in the river at that time and sell it fresh. A few greedy households who try to block some channels to stop water from flowing out off the paddies to increase the duration of flood make 20 to 30 million Kip per year. They gain but others lose. Large number of paddy field owners have been complaining about this practice.			

CHAPTER 5

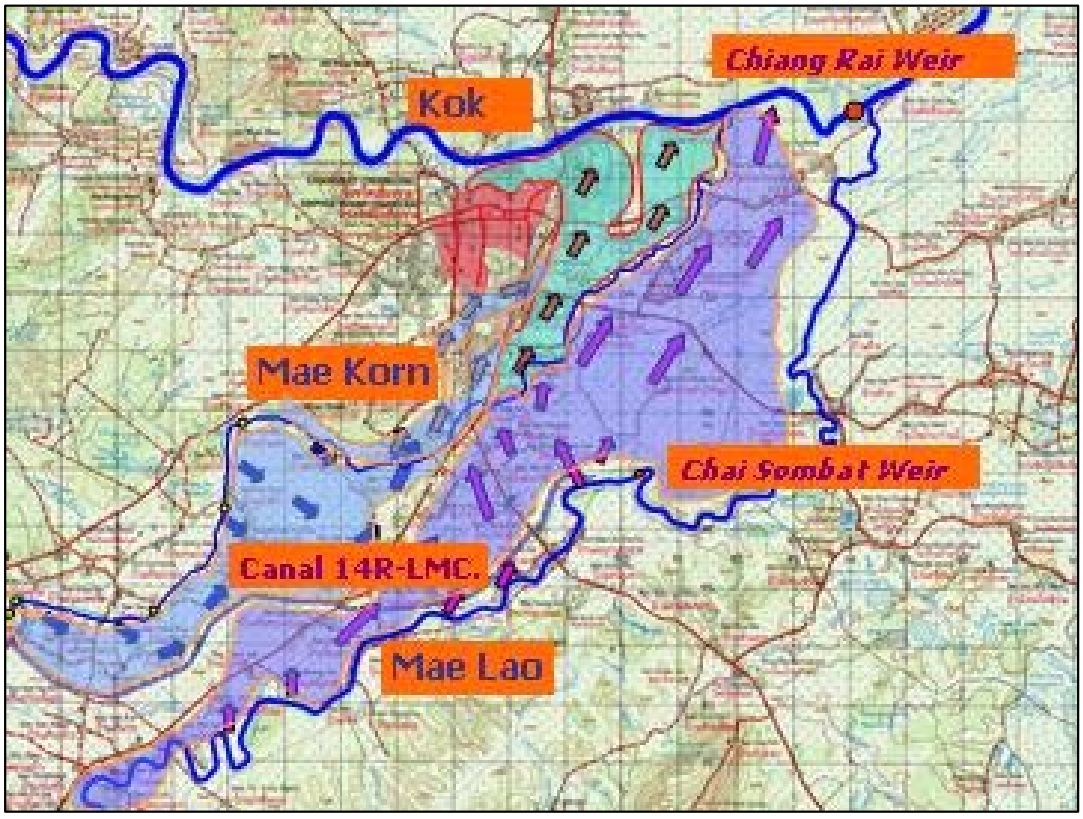
DATA PROCESSING FOR THAILAND

5 DATA PROCESSING FOR THAILAND

5.1 Introduction

In Chiang Rai Province flooding takes place near the city of Chiang Rai, located at the confluence of the Nam Mae Kok and Nam Mae Lao. The city is flood prone when the rivers convey large discharges. The last major flood of 2006 came from the Nam Mae Lao and a small creek named Nam Mae Korn. The Nam Mae Lao drains downstream of Chiang Rai weir, whereas the Nam Mae Korn, draining an area immediately south of Chiang Rai, joins the Nam Mae Kok 2.9 km upstream of the Chiang Rai weir. The latter two streams are interconnected by the Canal 14R-LMC. The canal joins the Nam Mae Lao at the Chai Sombat weir, about 3 km downstream of the Highway Bridge across the river

One of the solutions studied by the TNMC is a bypass canal from the Korn to the Kok west of Chiang Rai, d/s of the Korn-Lao connection. This bypass increases the discharge of the Nam Mae Kok in the city and it will only reduce the flow from the Korn to the Lao if the canal flow is fully controlled. The survey of flood damages at Mueang Chiang Rai district in Chiang Rai city and Chieng Saen district near the Kok river mouth were carried out.



5.2 District Flood Damages Data

The direct damages caused by flooding in the two selected districts in the focal area were collected from district and provincial authorities for the period 2000-2008. During the first data collection in 2008, the survey team only collected the data from 2006-2008 with several items

missing. The consultants and the survey team leader went to visit related departments[6] in Chiang Rai province in March 2009 to see if additional flood damage data could be collected. The mission found out that there were more data available in related departments that the survey team did not collect last year. Additional data collection on direct flood was done and sent to the consultant in April 2009. The district direct flood damage inventory was 6 years from 2003-2008. Most of damages were from agricultural production occupying 80-90% in Mueang Chieng Rai district and 90-95% in Chieng San district. The infrastructure affected by flood is only rural roads and bridges. No flood damages for public infrastructure and utilities have occurred for education, health, irrigation, power & water supply, post & telecommunication, government office & market. See Table 5.1 and details in

[6] Regional/Provincial Disaster Prevention & Mitigation, Royal Irrigation Department, Regional/provincial Rural Road Development, Town Planning Office, Provincial Statistic Office, Agricultural Extension Services, Chiang Rai Fishery Department,

Table 5.2 and Table 5.3

Table 5.1 Direct flood damages 2003-2008 (1000 US$)

Items	2003	2004	2005	2006	2007	2008
Mueang CR	**1,425**	**2,614**	**806**	**232**	**247**	**55**
Housing	56	131	41	4	11	3
Agriculture	1,287	2,309	714	207	233	45
Infrastructure	83	174	51	22	3	7
Chieng Saen	**781**	**1,065**	**909**	**2,323**	**1,019**	**1,986**
Housing	8	19	33	78	26	74
Agriculture	735	990	851	2,208	968	1,872
Infrastructure	39	56	24	37	24	40

Direct Flood damage inventory, Thailand

The indirect damages for Housing was derived from the Household and Business surveys. It includes cost for relocation, re-establishment and temporary flood protection. The household survey showed that there were 96 out of 224 household under the survey suffered from the 2006 flood damages to their houses at different scale. Overall average damages by 2006 to houses were 520 US$/HH in Mueang Chiang Rai and 409 US$/HH in Chieng Saen district.

In the business survey there were 13 out of 34 businesses reported that their properties damaged by the 2006 flood. The overall average damages by 2006 were 1,045 US$/Business in Mueang Chiang Rai district and 136 US$/Business in Chieng Saen district.

The rate of indirect damages were 14.4% for household and 40% for business in Mueang Chiang Rai district. The rate were 3.4% for household and 15.9% for business in Chieng Saen district. The number of business were not available, therefore the weighted average for household and business was numerically calculated at 27% for Mueang Chiang Rai and 10% for Chieng Saen district. Overall indirect-direct ratio applied for the focal areas in Chiang rai province would be 20%. Details are presented in Table 5.2

Table 5.2 Direct and indirect damages for households and businesses (2006, USD)

Items	Unit	Mueang CR	Chieng Saen
Direct damages HH	USD	69,709	36,849
Indirect damages HH	USD	9,814	1,251
HH in Survey	HH	134	90
HH in District	HH	18,870	10,685
HH Survey Coverage	%	0.7	0.8
Weighted Indirect/Direct HH damages	%	14.1	3.4
Direct damages Businesses	USD	13,580	2,851
Indirect damages Businesses	USD	5,431	454
Businesses in Survey	Business	13	21
Businesses in District	Business	n/a	n/a
Business Survey Coverage	%	n/a	n/a
Average Indirect/Direct Bus. damages	%	40.0	15.9
Weighted Indirect/Direct HH & Business damages	%	27	10

Household and business survey, Thailand

Indirect damages for Infrastructure & Relief for 2006 were collected from relevant departments in the two selected districts. In Mueang Chiang Rai district, the total indirect costs in 2006 were US$ 118,086, from transportation department. Other departments reported no indirect costs related to the 2006 flood. Direct flood damage in 2006 for Infrastructure & Relief was US$ 118,086. The indirect/direct rate was estimated as about 8%. See Table 5.3. It seems to be under estimation of direct costs since data was not available for the team during the survey. There is no information on direct and indirect damages in 2006 in Chieng Saen district. This indirect-direct rate was used to adjust the direct damages reported by local government for the years 2006-2008.

To make the damage data of the various years comparable with each other and with data of other MRC-member countries, the data have been converted to the 2007 price level[7] and have been converted to US$. The general CPIs were 102%, 107.6%, 113%, 117%, 122.4% for 2003-2007 respectively.

Table 5.3 Direct and indirect damages for infrastructure 2006 (USD)

Items	Mueang CR	Chieng Saen
Direct costs	1,514,286	n/a
Indirect costs Government	118,086	n/a
Indirect/Direct damages	7.8%	-

Floods along the Nam Mae Fang and In Chiang Rai province are classified as tributary flood. High flood water level is normally in August-September. The major rice is in August-December and corn is in July-December which are fall in the main flood season, therefore maximum flood water level would be selected as the key factor in damage function for crops, housing and infrastructure.

There are two key control hydrological stations in the focal area: (i) Chiang Rai station, which is located down stream of the Chiang Rai town with 26 years data available from 1978-2005. The

[7] Using CPI reported by Chiang Rai Statistic Office 2003-2007

flood water level of the station would be used for flood damage assessment for Mueang Chiang Rai district; and (ii) Chieng Saen station on the Mekong river with 47 years data available 1961-2007. The flood water level of Chieng Saen station would be used for flood damage assessment for Chieng Saen district.

In Chieng Saen district, flood damage for infrastructure in 2003 and 2004 was out of the range of the relationship (high flood damage at low water level). It may be the damage in these years included the investment of rural road/bridges for the following years. It needs further investigation on these. See Table 5.4.

Table 5.4 Flood direct and indirect damages (1000 US$), at 2007 fixed price

Year	Total	Housing	Agriculture	Infrastructure	Max WL
Mueang Chiang Rai District					
2003	1,732	80.2	1,544.1	107.3	4.31
2004	3,019	178.4	2,626.4	214.1	4.57
2005	887	53.0	773.9	59.8	4.29
2006	245	4.5	216.0	24.7	NA
2007	250	13.2	233.0	3.7	NA
2008	54	3.7	43.3	7.0	NA
Chieng Saen District					
2003	943	11.6	881.5	50.0	6.79
2004	1,220	25.4	1,126.4	68.6	8.40
2005	993	43.1	922.3	28.0	8.59
2006	2,450	97.8	2,309.5	42.3	9.71
2007	1,026	31.6	968.3	25.9	8.15
2008	1,940	86.0	1,812.3	41.9	NA

District flood damage inventory, Thailand and consultant estimates

5.3 Damage and Probability for Districts

As evaluated in Annex 1: Flood Hazard, the mathematical hydraulic model of the Nam Mae Kok and Nam Mae Lao was developed by DWR/TNMC in 2006 for the case study:" Flood/drought for Kok river basin". However, the quality of the model was considered to be insufficient for reliable flood hazard assessment in the Chiang Rai region. So no hydraulic model was available for translation of hydrological hazard into flood hazard as flooding depth and duration. Therefore flood damage assessment for the focal area could only done by the Absolute Approach[8] Methodology.

Absolute flood damage curves for infrastructure, housing, and agriculture were established for the two districts in the Nam Mae Kok focal area. See Figure 5.1 and Figure 5.2.

[8] See The Best Practice Guidelines for Flood Risk Assessment, FMMP_C2

Damage probability curve for the districts was developed by historical flood water levels recorded at Chiang Rai and Chieng Saen stations in a combination with absolute flood damage curves.

The flood risk in Mueang Chiang Rai district is very low compared to one in Chieng Saen district. See Figure 5.3 and Figure 5.4.

Table 5.5 Direct flood damage inventory, Mueang Chiang Rai district

Types	Items	Unit	Year: 2003		Year: 2004		Year: 2005		Year: 2006		Year: 2007		Year:2008	
			Quantity	Cost (THB)	Quantity	Cost (THB)	Quantity	Cost (THB)	Quantity	Cost (THB)	Quantity	Cost (THB)	Quantity	Cost (THB)
Human	Number of causalities	Person	0		0		0		0		0		0	
	Number of affected households	Family	1,812		3,388		773		310		384		90	
	Number of affected people	Person	5,721		10,661		2,136		851		1,116		360	
Housing	Collapsed/swept away houses	Nos	0	0	0	0	0	0	0	0	0	0	0	0
	Partly damaged or submersed houses	Nos	286	1,949,976	379	4,574,043	121	1,427,627	34	124,780	42	383,750	17	111,266
Agriculture	Damaged rice area	Rai	6,566	31,556,196	13,298	63,910,188	2,917	14,019,102	879	4,224,474	152	730,512	266	1,278,396
	Damaged field crops	Rai	1,206	4,868,622	3,131	12,639,847	749	3,023,713	563	2,272,831	1,661	6,705,457	33	133,221
	Damaged plantation and other	Rai	5	109,560	10	219,120	55	1,205,160	4	87,648	7	153,384	0	0
Fishery	Aquaculture pond effected	Rai	1,250	8,500,479	546	4,040,690	901	6,757,190	87	643,160	62	564,253	16	154,917
Education			No Damage		No Damage		No Damage		2	0	No Damage		No Damage	
Health care			No Damage		No Damage		No Damage		No Damage	0	No Damage		No Damage	
Structures			No Damage		No Damage		No Damage		No Damage	0	No Damage		No Damage	
Irrigation			No Damage		No Damage		No Damage		No Damage		No Damage		No Damage	
Transport	Damaged roads	Meter	980	2,147,579	2,438	4,856,652	526	1,370,972	249	764,226	45	119,622	83	234,609
	Damaged bridges/culverts	Nos	2	750,453	3	1,243,760	1	418,923	No Damage	0	No Damage	0	No Damage	0
	Damaged others	Nos	No Damage		No Damage		No Damage		No Damage		No Damage		No Damage	
Post & Telecom			No Damage		No Damage		No Damage		No Damage		No Damage		No Damage	
Industry			No Damage		No Damage		No Damage		No Damage		No Damage		No Damage	
Construction			No Damage		No Damage		No Damage		No Damage		No Damage		No Damage	
Water & Sanitation			No Damage		No Damage		No Damage		No Damage		No Damage		No Damage	
			(1000 USD)	(1000 THB)	(1000 USD)	(1000 THB)	(1000 USD)	(1000 THB)	(1000 USD)	(1000 THB)	(1000 USD)	(1000 THB)	(1000 USD)	(1000 THB)
	Grand Total		1,425	49,883	2,614	91,484	806	28,223	232	8,117	247	8,657	55	1,912
	Direct damages Housing		56	1,950	131	4,574	41	1,428	4	125	11	384	3	111
	Direct Damages Agriculture		1,287	45,035	2,309	80,810	714	25,005	207	7,228	233	8,154	45	1,567
	Relief&emergency		0	0	0	0	0	0	0	0	0	0	0	0
	Infrastructures		83	2,898	174	6,100	51	1,790	22	764	3	120	7	235

Table 5.6 Direct flood damage inventory, Chieng Saen district

Types	Items	Unit	Year: 2003		Year: 2004		Year: 2005		Year: 2006		Year: 2007		Year:2008	
			Quantity	Cost (THB)	Quantity	Cost (THB)	Quantity	Cost (THB)	Quantity	Cost (THB)	Quantity	Cost (THB)	Quantity	Cost (THB)
Human	Number of causalities	Person	0		0		0		0		0		0	
	Number of affected households	Family	544		739		1,272		2,215		941		2,107	
	Number of affected people	Person	1,557		2,286		4,149		7,627		3,359		5,771	
Housing	Collapsed/swept away houses	Nos	0		0		0		0		0		0	
	Partly damaged	Nos	97	281,507	120	650,180	193	1,159,513	375	2,727,051	134	920,992	326	2,591,144
Agro-forest	Damaged rice area	Rai	4,670	22,444,020	6,369	30,609,414	2,879	13,836,474	6,896	33,142,176	2,393	11,500,758	5,989	28,783,134
	Damaged field crops	Rai	392	1,582,504	597	2,410,089	3,120	12,595,440	3,171	12,801,327	4,394	17,738,578	6,577	26,551,349
	Damaged plantation and other	Rai	18	394,416	26	569,712	100	2,191,200	1,317	28,858,104	167	3,659,304	400	8,764,800
Fishery	Aquaculture pond effected		168	1,289,750	144	1,067,450	158	1,178,200	333	2,465,475	105	991,596	152	1,427,813
Education			No Damage		No Damage		No Damage		2	0	No Damage		No Damage	
Health care			No Damage		No Damage		No Damage		No Damage	0	No Damage		No Damage	
Structures			No Damage		No Damage		No Damage		No Damage	0	0		0	
Irrigation			No Damage		No Damage		No Damage		No Damage		No Damage		No Damage	
Transport	Damaged roads	Meter	370	552,791	487	742,357	259	344,239	509.00	846,841	205	331,532	452	671,902
	Damaged bridges/culverts	Nos	2	798,690	3	1,210,875	1	494,702	1	462,408	1	509,089	2	732,311
	Damaged others	Nos	No Damage		No Damage		No Damage		No Damage		No Damage		No Damage	
Post & Telecom			No Damage		No Damage		No Damage		No Damage		No Damage		No Damage	
Industry			No Damage		No Damage		No Damage		No Damage		No Damage		No Damage	
Construction			No Damage		No Damage		No Damage		No Damage		No Damage		No Damage	
Water & sanitation			No Damage		No Damage		No Damage		No Damage		No Damage		No Damage	
			(1000 USD)	(1000 THB)	(1000 USD)	(1000 THB)	(1000 USD)	(1000 THB)	(1000 USD)	(1000 THB)	(1000 USD)	(1000 THB)	(1000 USD)	(1000 THB)
	Grand Total		781	27,344	1,065	37,260	909	31,800	2,323	81,303	1,019	35,652	1,986	69,522
	Direct damages Housing		8	282	19	650	33	1,160	78	2,727	26	921	74	2,591
	Direct Damages Agriculture		735	25,711	990	34,657	851	29,801	2,208	77,267	968	33,890	1,872	65,527
	Relief&emergency		0	0	0	0	0	0	0	0	0	0	0	0
	Infrastructures		39	1,351	56	1,953	24	839	37	1,309	24	841	40	1,404

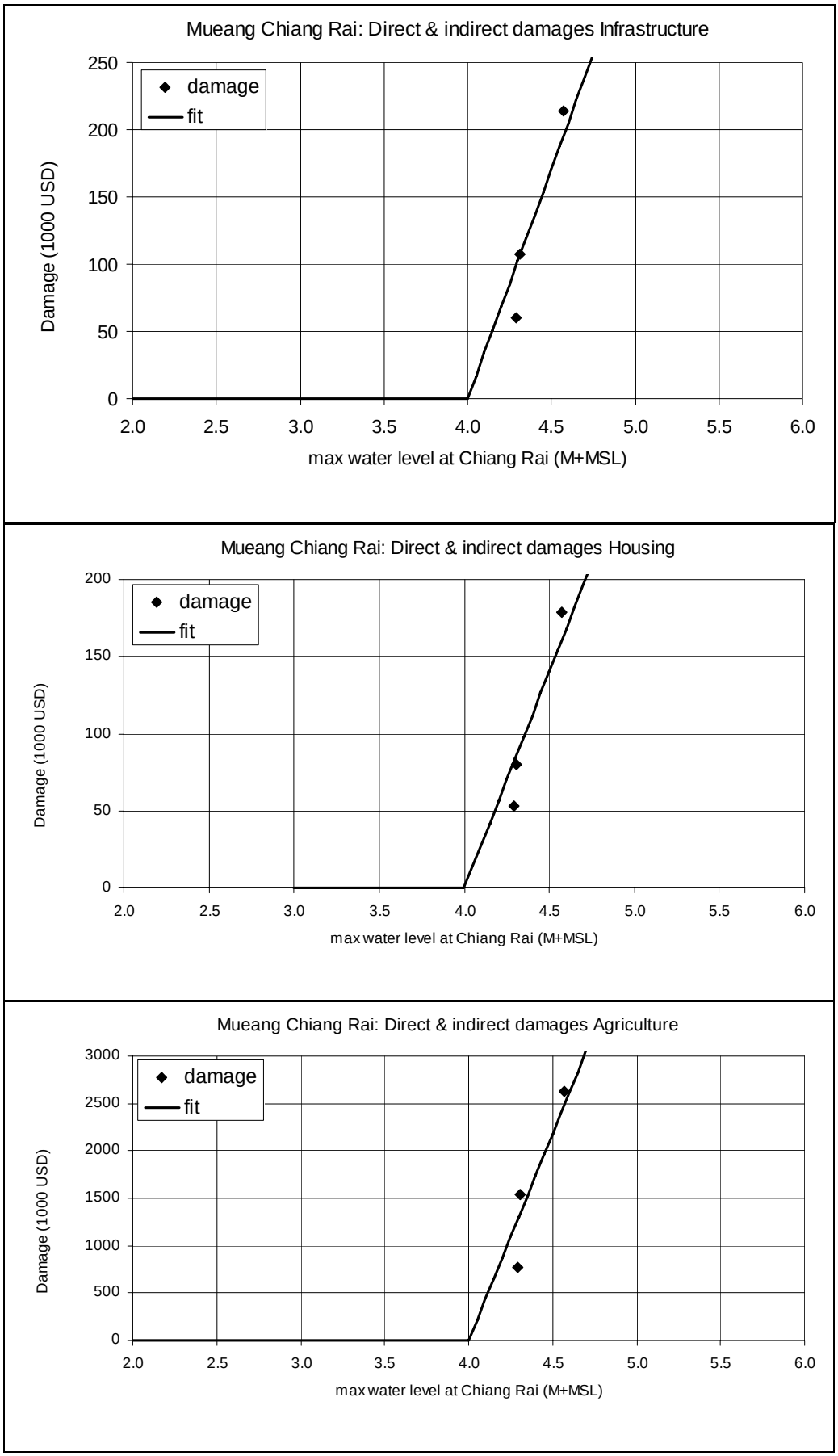


Figure 5.1 Absolute Damage Curves for Mueang Chiang Rai District

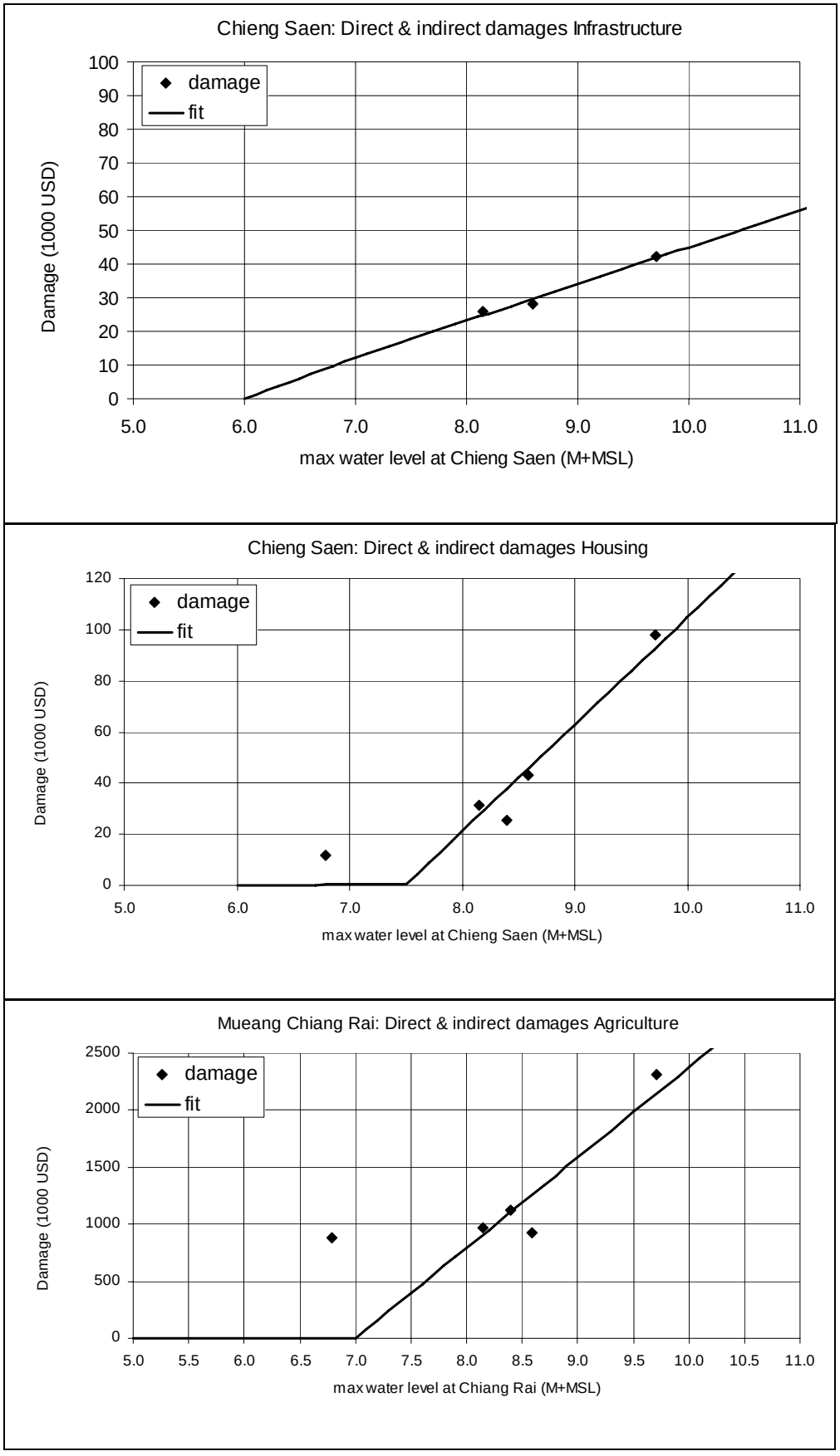
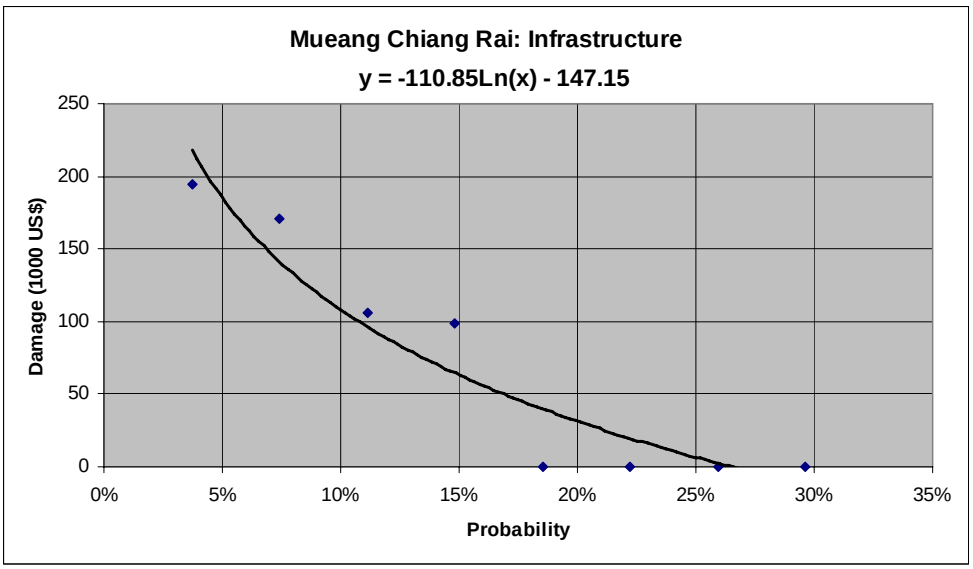
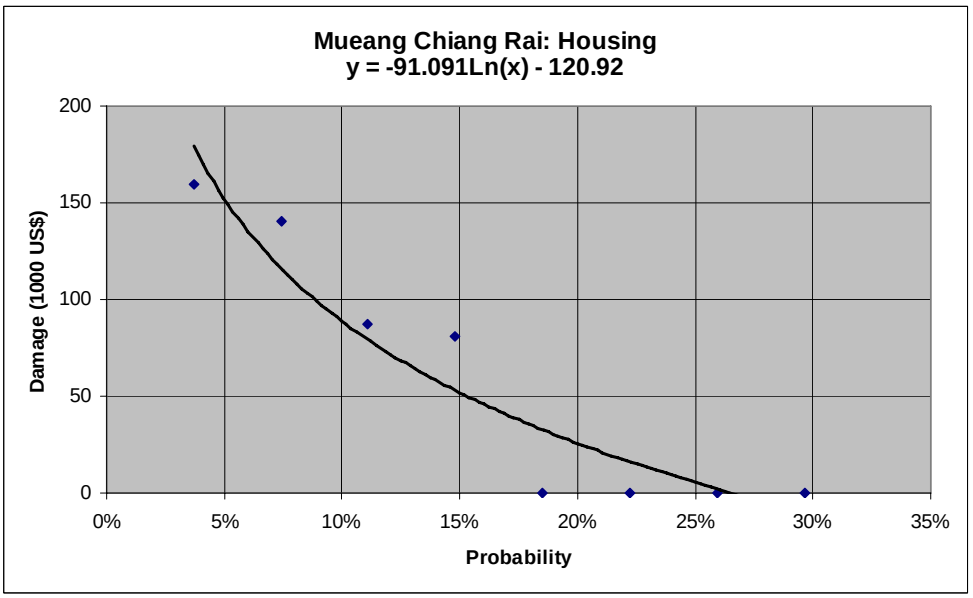


Figure 5.2 Absolute Damage Curves for Chieng Saen District





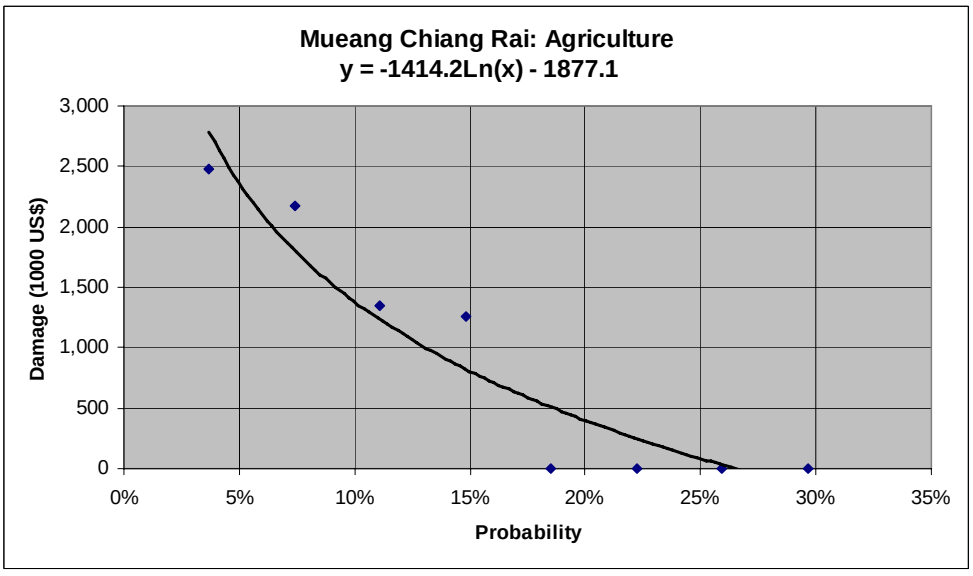
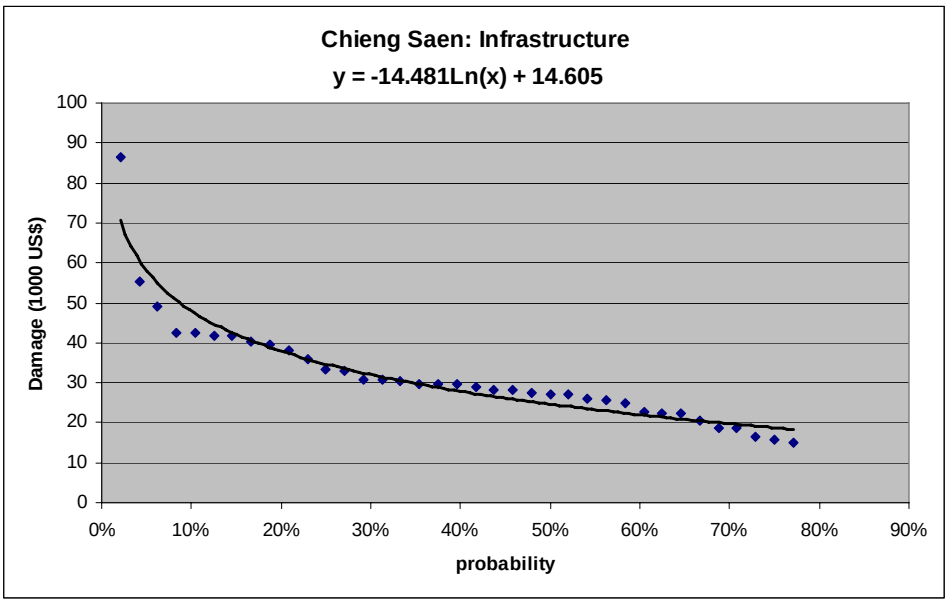
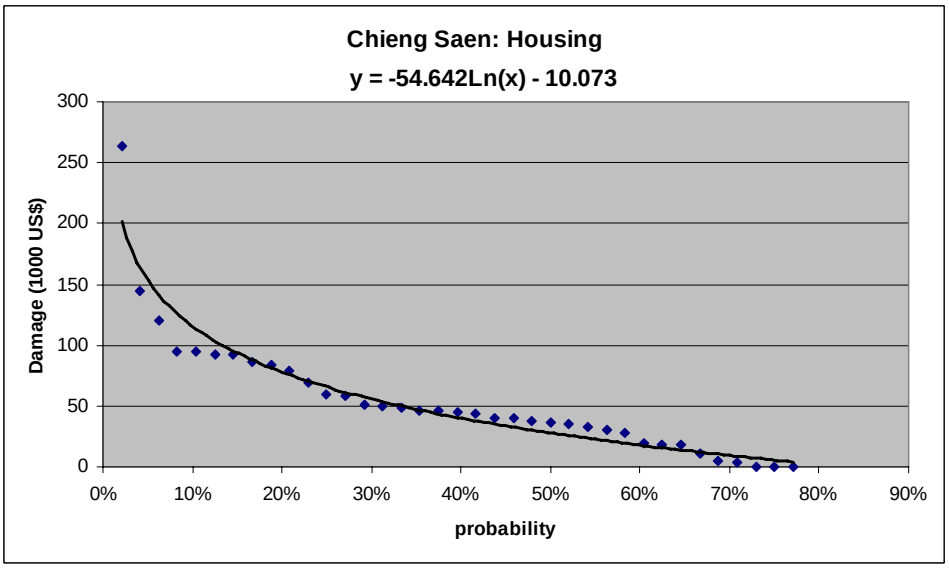


Figure 5.3 Damage probability curves for Mueang Chiang Rai District





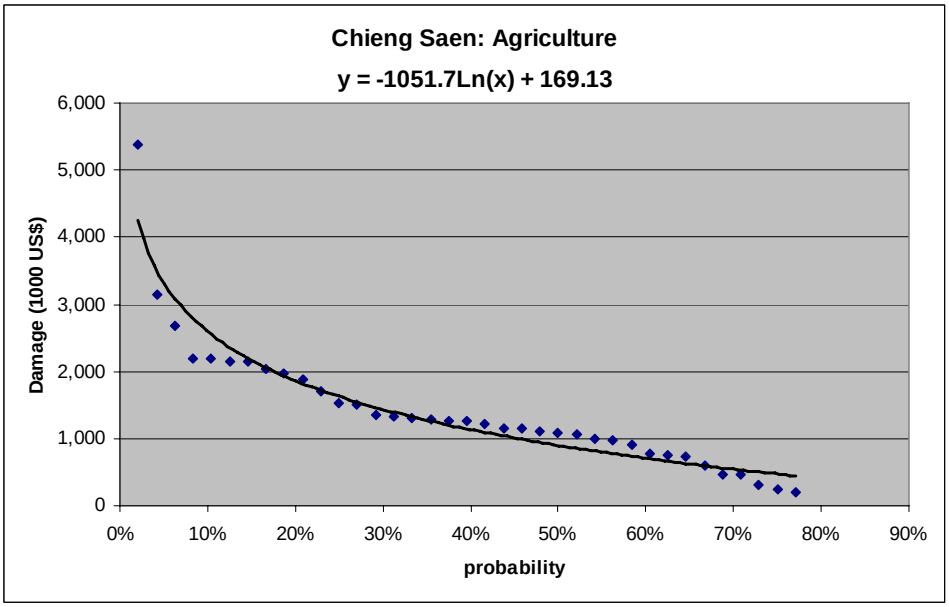


Figure 5.4 Damage probability curve for Chieng Saen District

5.4 District Population, Land Use and Structure

According to the District statistics, the population in 2006 was about 77,000 people in Mueang Chiang Rai district and about 54,000 people in Chieng Saen district. The average annual population growth rate during the period of 2001-2006 was 1.76% in Mueang Chiang Rai and 1.9% in Chieng Saen.

In Mueang Chiang Rai district, land use in 2006 was as agricultural land including plantation of 45% and forest land of 45%, the remaining are residential and infrastructure.

In Chieng Saen district, land use in 2006 was as agricultural land including plantation of 41% and forest land of 54%, the remains are residential and infrastructure.

Table 5.7 Population and land-use in selected districts, 2006

Items	Unit	Mueang Chiang Rai	Chieng Saen
POPULATION			
Population	Person	76,818	53,537
Number of HH	HH	18,870.00	10,685
Size of Family	Person	4.07	5.01
Poor household	HH	n/a	n/a
Population growth rate (2001-2006)	%	1.76%	1.90%
LAND-USE			
Rice Land – Irrigated	Ha	4,907	-
Rice Land - Not irrigated or rain-fed	Ha	41,309	11,594
Crop Land	Ha	28,004	9,772
Plantation Land	Ha	19,892	24,782
Residential - Rural (including gardens)	Ha	6,526	1,537
Residential – Urban	Ha	6,643	265
Commercial / Industrial	Ha	466	7
Institution	Ha	1,662	24
Forest	Ha	93,256	60,911
Communal land	Ha	4,801	4,849

District flood vulnerability & flood event, Thailand

There is no information on type of house in the district statistics provided to the survey team. However, from field observation it is noted that most houses are in permanent and semi-permanent.

Agricultural land is mainly used for paddy cultivation in Mueang Chiang Rai. There was a small upland crop area for corn, pineapple, Vegetables, cassava and longan fruit tree. The land use for upland crops in Chieng Saen district has higher percentage than that in the Mueang Chiang Rai district. See details in.Table 5.8

Table 5.8 Crops in selected districts, 2006

Items	Unit	Mueang Chiang Rai	Chieng Saen
Rice	Ha	2,545	11,594
Upland crops	Ha		11,892
Plantations	Ha		577
Corn	Ha	605	
Pine apple	Ha	172	
Vegetables	Ha	226	415
Cassava	Ha	226	
Mango fruit tree	Ha	14	
Longan fruit tree	Ha	258	

District flood vulnerability & flood event, Thailand

5.5 Household and Business Survey

The survey sample was 147 households and business in Mueang Chiang Rai and 111 households and businesses in Chieng Saen district in the focal area. The survey showed that 58% of respondents reporting that their house and/or business damaged by the 2006 flood.

The average value of the houses varies from 11,000 to 16,000 US$ with an area varying from 80 to 120 m^2. Average value of business structure varies from 9,000 to 43,000 US$ with an area varying from 250 to 4600 m^2.

The damages to houses in 2006 was 3-6% of the house value for Households and 1-3% for Business. The hypothetic investigation on potential flood damages if flood level being higher than the 2006 level was tested. The graph below presents the relative damages curves for house and business structure in the two selected districts. See Figure 5.5 and Figure 5.6

Table 5.9 Household & Business survey in the selected districts

Items	Unit	Mueang Chiang Rai		Chieng Saen	
		Household	Business	Household	Business
Total sample	**HH**	**134**	**13**	**90**	**21**
Permanent house	HH	123	9	84	19
Semi-permanent	HH	10	4	6	1
Temporary	HH	1	0	-	1
Houses affected by 2006	**HH**	**66**	**9**	**71**	**4**
Value of house	**US$**	**16,497**	**43,077**	**11,216**	**8,592**
Permanent house	US$	16,878	60,000	11,460	9,316
Semi-permanent	US$	11,886	5,000	7,810	571
Temporary	US$	15,714		-	2,857
Housing area	**m2**	**117**	**4,563**	**81**	**251**
Permanent house	m2	116	5,845	81	272
Semi-permanent	m2	121	1,678	82	36
Temporary	m2	160	-	-	60
2006 flood depth in garden					
Maximum	m	3.0	2.0	3.0	1.5
Overall	m	1.0	1.5	1.3	0.9
2006 flood depth on field					
Maximum	m	3.3	-	5.0	-
Overall	m	1.2	-	2.6	-
2006 flood depth in house	**m**	**0.5**	**0.8**	**1.1**	**0.7**
Damages to housing					
2006 flood	%	3.4	2.4	5.4	1.6
2006 flood +0.5m	%	4.0	4.9	6.5	8.8
2006 flood +1.0m	%	5.1	7.9	7.7	18.5
2006 flood +1.5m	%	10.1	13.8	11.2	32.3
2006 flood +2.0m	%	17.8	30.1	17.8	40.3

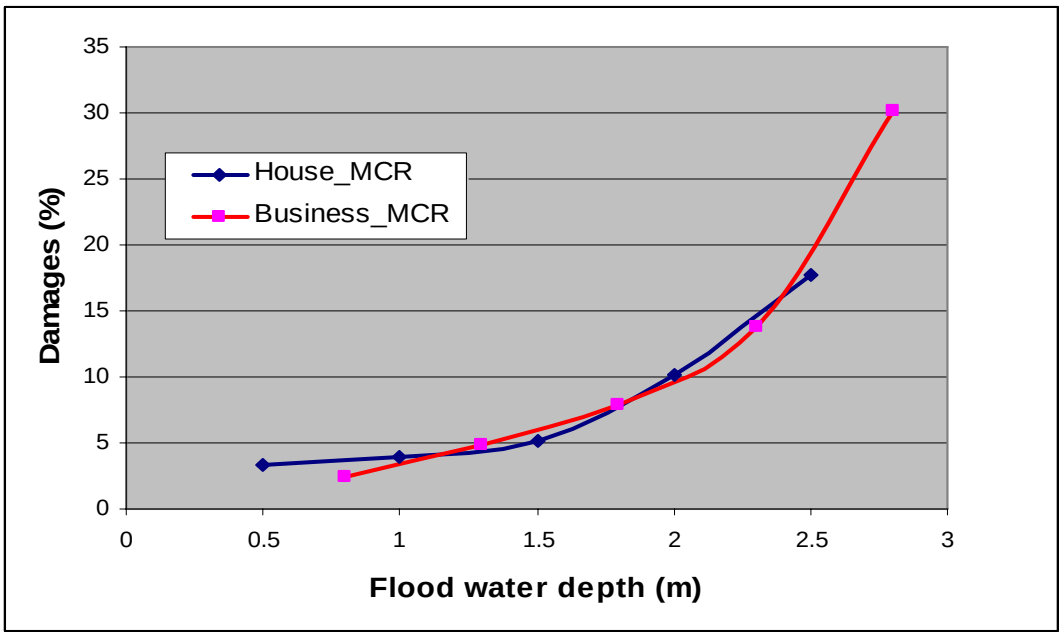


Figure 5.5 District relative flood damage curve for housing in Mueang Chiang Rai

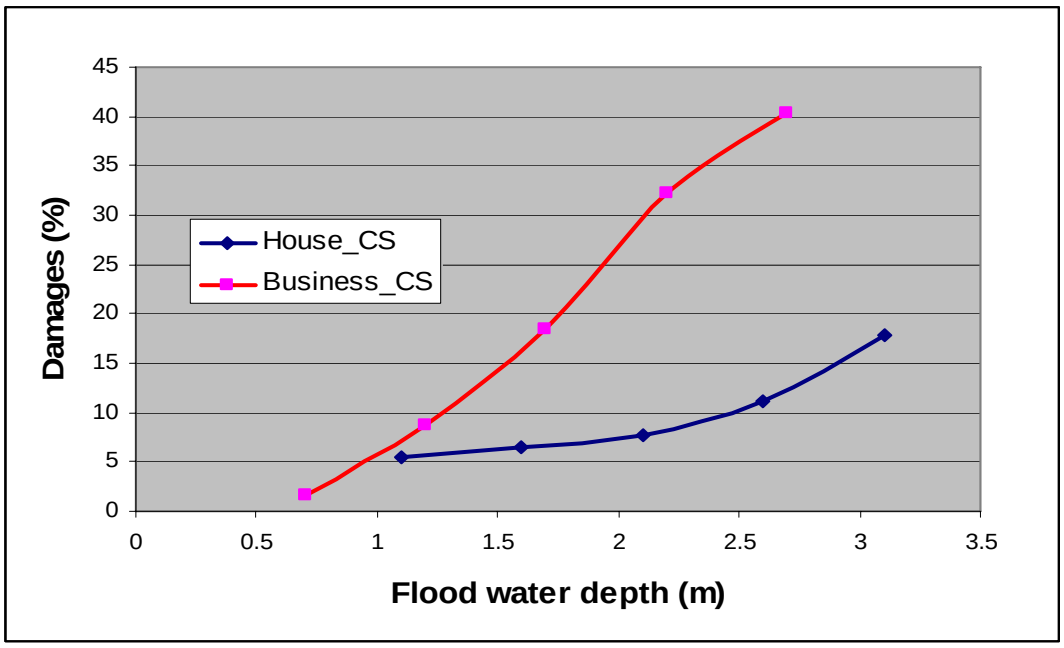


Figure 5.6 District relative flood damage curve for housing in Chieng Saen

5.5.1 Damage curves for paddy cultivation

Based on information collected during the Focal Group Discussions, main paddy crop planted during May-June and harvested during November-December. The crop cycle falls in flood season. Floods would cause damage to rice crops in a period of Mid of September – Mid of October for a normal flood year; and in a period of Mid of August – Mid of October for a big flood year.

High flood flow in the area often occurs during August-September which is almost at the middle of the crop cycle. The damage to paddy depends on (i) depth of flood water; and (ii) duration of flood. The household survey on 2006 flood events and damages to crops in the two selected districts showed that:

- The rice crop suffers from flood damages when flood duration last more than 5 days;
- In most of the cases, when flood depth of 1.5m or more and flooding duration of more than 13 days, the damages to rice was estimated as 100%;
- Potential paddy yield in household survey for the two representative districts was 0.9 ton/rai equivalent to 5.6 ton/ha. The maximum total production losses would be 1,285 US$/ha;
- It is assumed that depth of flooding of 0.5m would not affect the paddy. At flooding depth of 1.5 m or more 100%, 85%, 65%, and 40% damage if flood duration of more than 13 days, 11 days, 9 days and 7 days respectively.

There are two relative damage curves for paddy prepared for flexibility in using it depending on application. The first curve shows relationship between depth of flooding, flooding duration with paddy damage in term of % of total production. The second curve shows the relationship between depth of flooding, flooding duration with paddy damage in term of US$/ha affected.

The first damage curve would have a wide application than the second one. Since the second one is for the area under the survey where paddy yield of about 5.6 ton/ha/crop.

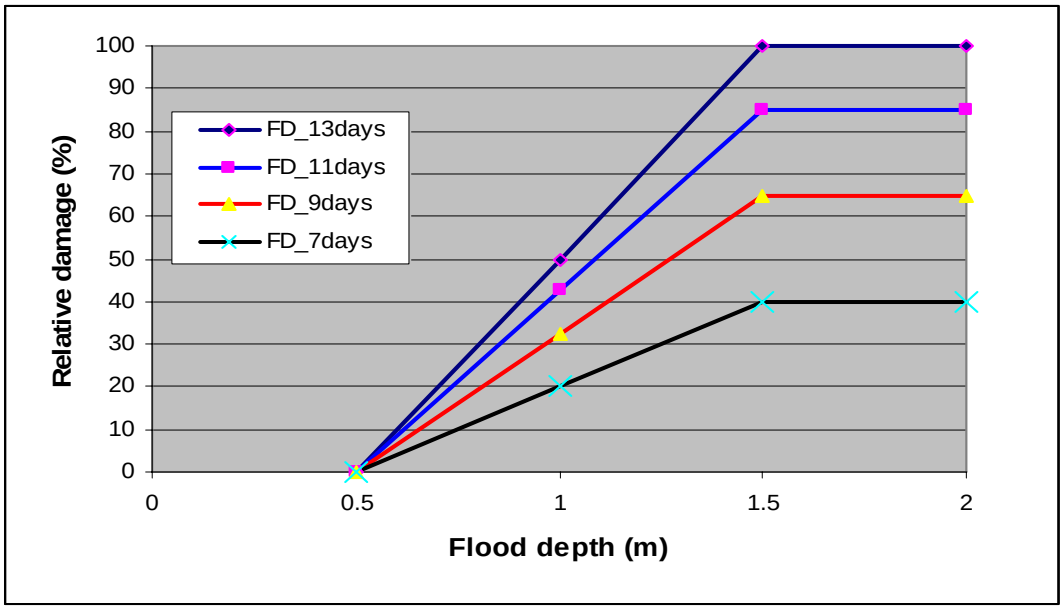


Figure 5.7 Relative damage curve for paddy in Nam Mae Kok Focal area (%)

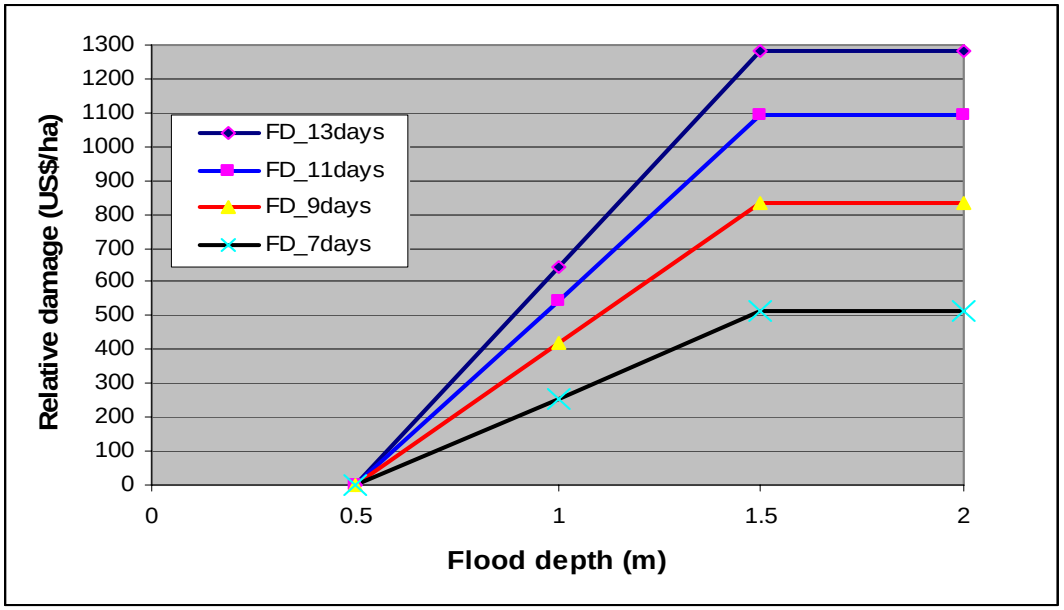


Figure 5.8 Relative damage curve for paddy in Nam Mae Kok Focal area (US$/ha)

5.6 Potential Damages Reduction by Flood Control Measures

Mueang Chiang Rai District

Since the flooding risk in Mueang Chiang Rai district is low, especially for housing and infrastructure. See Table 5.10. The potential damage reduction for flood control measure at 50 years return period would be 20, 25 and 316 thousand US$/year for housing, infrastructure, and agriculture respectively. Details presented in Table 5.7.

Table 5.10 Damage curves for Mueang Chiang Rai District (1000 US$)

T (year)	**100**	**50**	**25**	**10**	**5**	**2**
Probability	1%	2%	4%	10%	20%	50%
Infrastructure	363	286	210	108	31	0
Housing	299	235	172	89	26	0
Agriculture	4,636	3,655	2,675	1,379	399	0
TOTAL	5,297	4,177	3,057	1,576	456	0

Table 5.11 Potential damage reduction for Mueang Chiang Rai (1000 US$/year)

T (year)	**100**	**50**	**25**	**10**	**5**	**2**
Probability	1%	2%	4%	10%	20%	50%
Infrastructure	29	25	19	9	1	0
Housing	24	20	15	7	1	0
Agriculture	372	316	241	110	17	0
TOTAL	425	361	275	126	19	0

Chieng Saen District

Flooding risk in Chieng Saen district is much more than that in Mueang Chiang Rai district. Flooding risk in the area is mainly for agriculture. Flood risk for housing and infrastructure are low. See Table 5.12. The potential damage reduction for flood control measure at 50 years return period would be 28, 42 and 1,161 thousand US$/year for infrastructure, housing and agriculture respectively. Details presented in Table 5.10.

Table 5.12 Damage curves for Chieng Saen District (1000 US$)

T (year)	**100**	**50**	**25**	**10**	**5**	**2**
Probability	1%	2%	4%	10%	20%	50%
Infrastructure	81	71	61	48	38	25
Housing	242	204	166	116	78	28
Agriculture	5,012	4,283	3,554	2,591	1,862	898
TOTAL	5,335	4,558	3,781	2,754	1,978	951

Table 5.13 Potential damage reduction for Chieng Saen district (1000 US$/year)

T (year)	**100**	**50**	**25**	**10**	**5**	**2**
Probability	1%	2%	4%	10%	20%	50%
Infrastructure	29	28	27	23	19	11
Housing	45	42	38	29	19	5
Agriculture	1,217	1,161	1,073	883	657	293
TOTAL	1,290	1,230	1,138	935	694	308

The consultants visited the flood plain (from Chiang Rai town to the river mouth of Kok river in Chieng Saen district). The following observations were made:

1. Almost all houses are located on the side of hill and/or on the high ground level, excepting temporary huts on cultivation field for taking care the crops. It is hard to see significant impacts of flooding to housing. The Chiang Rai City has already had flood protection measures to diverse flood water from Mae Lao to Kok river by diversion canal up stream of the city and embankment around the city;

2. The same situation is applied for infrastructure and public utilities, where they have been located on the high ground, excepting some section of rural roads at a low level still affected by flood;
3. Cropping system along the Kok river in a section near Chiang Rai city, where three gravity irrigation schemes exist, is mainly double rice. On the higher land is mainly one rain-fed rice or upland crops (corn, bean, soy-bean, peanut). The mission stopped at the bridge on road 1098 crossing Kok river at a mid way from Chiang Rai City to the Kok river mouth. The area along Kok river is as a narrow valley have elevation 5-6m about water level in the dry season. The area are planted upland crops (mainly corn). See photos.
    - The main season corn is planted in April and harvested in June-July, normally before the flood comes;
    - The second corn is planted in November and harvested in March-April with supplement irrigation.

    Discussion with farmers who are living in the area, they said that "the field would be submerged by big flood normally after harvesting period at a depth of 1.5-3.0m, except some early flood events. The yield of main crop is about 1.5 ton/rai but the second crop is much lower (about 50% of the first crop) since insufficient irrigated. The price of corn is 3,000 TBT/ton and total production cost is about 65% total production value.

    Cropping systems in Chieng Saen district (down stream section of Kok river) are mainly
    - Double rice in an area near the natural lake;
    - Corn and tobacco on the high land.

From the flood risk assessment and observations from the site visits, the Consultants view the Nam Mae Kok flood plain as:

1. The impact of flooding on houses and infrastructure are insignificant;
2. There is a certain level of crop damage caused by flood, however it is just a narrow trip a long the river;
3. Flood protection for crop in the area seems to be not economically feasible, since the high embankment associate with high cost of construction.
4. The irrigation facility for the area seems to be the option for providing opportunity to change land-use and crop varieties to avoid flooding;
5. The Kok river focal area is not fit properly in the FMMP_C2, It would be in integrated water resource development with main components of providing irrigation water and land use.


Photo 1 and 2: View at the bridge on road 1098 crossing Mae Kok at mid way from Chiang Rice City to river mouth. There is the second crop of corn at the harvesting period


Photo 3 and 4: View at Mae Kok river mouth: (3) Tobacco and temporary hut; (4) Corn will be harvested in April

5.7 Benefit from Flooding

The summary of Focus Group Discussions with communities in Mueang Chiang Rai and Chieng Saen districts show that there are benefits from the flooding to Agriculture in terms of sedimentation and soil fertility to the land. In Ban Tha Sai sub-district, at normal situation, cost of fertilizer application is around 2,700 Baht/hectare. The cost of fertilizers application would be lower at around 2,500 Baht/hectare and the same for other inputs to keep the same crop yield. The net benefit from flooding for agriculture would be 200 Bat/ha or equivalent to a value of 6 US$/ha.

The FGDs mentioned that many people are engaged in capture fisheries in the rivers and paddy fields and it is considered natural fish in flood season being main protein source for local people. No information on fish catch and/or approximated fish value.

CHAPTER 6

DATA PROCESSING FOR RIVER BANK EROSION SITES

6 DATA PROCESSING FOR RIVER BANK EROSION SITES

6.1 Introduction

Two river bank erosion focal areas were selected for study by FMMP-C2 namely: Kratie in Cambodia and Bokeo in Lao PDR. Socio-economic data collection for the erosion in the focal areas consisted of (i) District vulnerability and flood events; (ii) Direct damages caused by erosion; and (iii) Indirect damages caused by erosion. No Household or Business surveys were undertaken and no Focus Group Discussions were held in these two focal areas.

6.2 Data collected in Kratie District

There were six communes in Kratie District under the investigation: Sambok, Thma Krae, Krakor, Kratie, Roka Kandal, and Bos Leav. Socio-economic data collection from these communes included: the base line in 2006 for population, land & structure, business, education, health, road, irrigation, electricity, water supply and communication. The indirect erosion damages in 2006 by the above sectors were collected from the local authorities. The results of the investigation are summarised in Table 6.1 and Table 6.2. There seemed not to have been significant erosion damages in 2006. Site visits in July 2008 could also not confirm the existence of significant river erosion. The noticed gully erosion of the Mekong banks was generally caused by drainage water from the roads running parallel to the river.

The indirect cost spent by local authorities was investigated. Total indirect cost in 2006 among six communes in Kratie district were 14.94 Mil Riel (US$ 3,735) of which 10.0 Mil Riel in Roca Kandal, 2.54 Mil Riel in Bos Leav, and 2.4 Mil Riel in Krakor. The high indirect cost has been found in the irrigation sector where farmers had to pay extra cost to overcome irrigation disruption. See Table 6.1.

Table 6.1 Population & land use, erosion sites, Kratie, Cambodia, 2006

Item	Unit	Sambok	Thma Krae	Krakor	Kratie	Roka Kandal	Bos Leav	SUB-TOTAL
POPULATION								
Population	Person	5,890	5,569	2,819	3,665	4,891	5,628	28,462
Number of HH	HH	1,253	1,060	637	791	1,004	1,090	5,835
Size of Family	Person	4.70	5.25	4.42	4.63	4.87	5.16	29
Poor household	HH	437	287	235	241	292	260	1,752
Population growth	03-06	1.96%	-0.05%	0.77%	-1.48%	0.27%	0.04%	0.34%
2006-LAND-USE								
Rice Land – Dry	ha	355	216	150	0	535	815	2,071
Rice Land – Wet	ha	772	458	97	0	176	224	1,727
Orchard Land	ha	41	0	5	0	127	118	291
Residential	ha	105	99	54	18	86	66	428
Commercial	ha	Na	na	Na	Na	na	na	0
Institution	ha	Na	na	Na	Na	na	na	0
Forest	ha	23,647	827	Na	0	na	124	24,598
Communal land	ha	Na	na	Na	Na	na	39	39
River, Lake..	ha	0	2,244	Na	0	0	0	2,244
FUTURE LAND-USE								
Rice Land – Dry	ha	355	216	150	0	535	815	2,071
Rice Land – Wet	ha	772	458	97	0	176	224	1,727
Orchard Land	ha	41	0	5	0	127	118	291
Residential	ha	105	99	54	18	86	66	428
Commercial	ha	Na	na	Na	Na	na	na	0
Institution	ha	Na	na	Na	Na	na	na	0

Item	Unit	Sambok	Thma Krae	Krakor	Kratie	Roka Kandal	Bos Leav	SUB-TOTAL
Forest	ha	23,647	827	Na	0	na	124	24,598
Communal land	ha	Na	na	Na	Na	na	39	39
River, Lake, Canall	ha	0	2,244	0	0	0	0	2,244

Table 6.2 Structure & business, erosion sites, Kratie, Cambodia, 2006

COMMUNES	Unit	Sambok	Thma Krae	Krakor	Kratie	Roka Kandal	Bos Leav	SUB-TOTAL
STRUCTURE								
Residential structures	Permanent	0	2	0	137	5	0	144
	Semi	621	690	544	610	753	678	3,896
	Temporary	440	338	19	22	147	293	1,259
Commercial structure	Permanent	0	0	0	Na	0	0	0
	Semi	0	0	0	Na	7	0	7
	Temporary	0	0	0	0	0	0	0
Industrial structures	Permanent	0	0	0	Na	0	0	0
	Semi-	0	0	0	Na	0	0	0
	Temporary	0	0	0	0	0	0	0
Institutional structures	Permanent	0	0	0	Na	0	0	0
	Semi-	5	7	4	Na	4	4	24
	Temporary	0	0	0	0	0	0	0
Agricultural structures	Permanent	0	0	0	0	0	0	0
	Semi-	46	24	24	0	20	32	146
	Temporary	580	400	190	0	210	500	1,880
CROPS								
Wet Season Paddy	ha	772	458	97	0	176	224	1,727
Dry Season Paddy	ha	355	216	150	0	535	815	2,071
Bean/Sesame	ha	0	10	0	0	0	28	38
Potato/Cassava	ha	0	10	0	0	0	20	30
Maize	ha	12	11	5	0	127	70	225
Vegetable	ha	0	0	0	0	0	10	10
Chili/Sweet pepper	ha	0	0	0	0	0	0	0
BUSINESS								
Registered	Business	0	0	35	146	46	0	227
Non-registered	Business	0	59	Na	25	31	65	180
Market vendor	Person	0	24	12	190	0	0	226

Table 6.3 Indirect cost, erosion sites, Kratie, Cambodia, 2006

Sub-total	Unit	Total	Education	Health	Irrigation
Flood protection cost	RIEL	0	0	0	0
Emergency shelter	RIEL	1,500,000	500,000	1,000,000	0
Out of service	Day	140	15	30	35
Pupil not go to school	Person	480	480	0	0
Teacher affected	Teacher	12	12	0	0
Customer affected	Person	7,880	0	7,800	0
Temporary facilities	RIEL	0	0	0	0
Additional cost	RIEL	1,000,000	0	1,000,000	0
Clean-up cost	RIEL	2,440,000	2,400,000	40,000	0
Clean-up cost	man-day	0	0	0	0
Extra cost for farmer	RIEL/ha	200,000	0	0	200,000
Total area affected	Ha	70	0	0	70

Sub-total	Unit	Total	Education	Health	Irrigation
Total area not planted	Ha	0	0	0	0
Cost after flood	RIEL	0	0	0	0
TOTAL	**Million RIEL**	**14.94**	**2.90**	**2.04**	**10.00**
Equivalent to	**US$**	3,735	725	510	2,500

6.3 Data collected in Bokeo Province

The data collection was carried out for Houayxai and Ton Pheung districts in Bokeo Province. Total direct erosion losses from 1997-2007 was 47,606 Mill Kip (5.6 Mil US$) in Ton Pheung district and 835 Mil Kip (98,300 US$) in Houayxai district. Details are in Table 6.4. Indirect costs spent by local departments were investigated. There were no indirect costs reported for 2006.

Table 6.4 Socio-economic summary, erosion sites, Lao PDR, 2006

Items	Unit	Ton Pheung	Houayxai
POPULATION			
Population	Person	26,886	60,851
Number of HH	HH	4,879	10,761
Size of Family	Person	6	6
Poor household	HH	1,310	1,472
Population growth rate (2001-2006)	%	0.41%	5.37%
2006-LAND-USE			0
Rainy seasonal paddy (rain-fed)	ha	32,714	277,606
Dry season paddy (irrigated)	ha	4,192	58,134
Crop Land	ha	3,084	30,708
Plantation Land	ha	200	12,016
Natural lake and ponds	ha	NA	0
Residential - Rural	ha	400	861
Residential - Urban	ha	200	300
Institution	ha	20	100
Dry Dipterocarpus Forest	ha	0	0
Communal land	ha	52	110
Non-productive forests	ha	34,833	98,651
FUTURE LAND-USE		NA	NA
STRUCTURE			
Residential structures	Permanent	2,127	3,920
	Semi-perm.	1,542	3,498
	Temporary	102	3,343
Commercial structure	Permanent	704	327
	Semi-perm.	301	140
	Temporary	0	0
Industrial structures	Permanent	13	483
	Semi-perm.	5	154
	Temporary	0	0
Institutional structures	Permanent	93	200
	Semi-perm.	0	50
	Temporary	0	0
Agricultural structures	Permanent	0	0
	Semi-perm.	3,415	8,584
	Temporary	1,464	0
CROPS			0
Rainy Seasonal Paddy (Jun-Nov)	ha	4,192	277,606
Dry season paddy (December-April)	ha	183	3,655
Upland paddy	ha	3,714	58,134
Cash crops	ha	3,083	3,693
Fruit trees	ha	13,000	1,011
Teak	ha	100	11,005

Table 6.5 Direct losses from erosion, Lao PDR, 1997- 2007

No	Items	Unit	Ton Pheung 1997-2007 Quantity	Ton Pheung 1997-2007 Cost (Mil Kip)	Houayxai 1997-2007 Quantity	Houayxai 1997-2007 Cost (Mil Kip)
Human	Affected households	Family	787		30	
	Affected people	Person	4,717		180	
Housing	Collapsed/swept away	Nos	26	1,456	0	
	Partly damaged	Nos	403	677	0	
Education	Affected schools	Nos	2	765	0	
	Damaged classrooms	Nos	10	3.825	0	
	Damaged houses	Nos	0	0	0	
	Damaged desks & chairs	Set	120	40.32	0	
Structures	Cultural/historical structures	Nos	2	84	0	
	Head offices	Nos	3	168	0	
	Market/commercial centers	Nos	0	0	0	
	Warehouses	Nos	0	0	0	
	Rice Bins	Nos	787	4,351	0	
Agro-forest						
Rice	*+Lost completely*	ha	3	104.16	0	
	+Productivity decreased	ha	3	33.60	0	
Flower/veget	*+Lost completely*	ha	53	1,335.60	1	25.20
	+Productivity decreased	ha	53	356.16	1	6.72
Corn	*+Lost completely*	ha	520	13,104	0	
	+Productivity decreased	ha		3,494.40	0	
Tobacco	*+Dead*	ha	42	282.24	0	
	+Productivity decreased	ha	42	282.24	0	
Fruits	*+Dead*	ha	2,500	210	1	25.20
	+Productivity decreased	ha	2,500	210	300	126
	Damaged seeds	ton	12	3.36	0	
	Dead big livestock	Nos	54	226.80	0	
	Dead poultry	Nos	1,500	42	0	
	Farm land eroded w/o R	ha	0	0	87	487.20
	Housing land eroded/lost	ha	38	213.36	0	
Fishery	Boats and ships lost	Nos	7	490	0	
Transport	Damaged national roads	m	10,000	1,955	200	
	Damaged rural roads	m	2,000	102	0	
	Damaged bridges/culverts	Nos	3	420	0	
	Damaged ports	Nos	2	28	0	
	Damaged boats/vehicles	Nos	7	490	0	
	Damaged factories & plants	Nos	4	8,490	0	
	Damaged machines	Nos	4	1,120	0	
Water-Envi	Damaged wells	Nos	14	129	0	
	Flood prevention costs	Kip	0	4,900	400	
	Temporary relocation sites		0	500		
	Foods & medicine supplied		0	200		
	Costs for rescue		0	0		165
	Productive land allocation		0	150		
Other costs				1189		
	TOTAL	Mil Kip		47,606		835
		Mil US$		5.6007		0.0983

CHAPTER 7

ENVIRONMENTAL RISKS OF FLOODING

7 ENVIRONMENTAL RISKS OF FLOODING

7.1 Introduction

Under natural conditions flooding is part of the natural cycle of many ecosystems and plays an important role in maintaining ecosystem functioning and biodiversity. Society benefits from flooding because of the provision of a number of ecosystem products and services. This is described in detail in the Inception Report. However, when human interference with the natural system disturbs the natural processes, flood events may result in long-term, undesirable impacts on the environment.

The desired condition of an ecosystem is long-term capacity to maintain biodiversity and ecosystem functioning. Because of the complexity of ecological systems, the assessment of ecosystem condition requires identification of a number of general indicators that can be measured or monitored over time. In the following a number impacts of flooding on ecosystem condition will be discussed. Impacts of floods that cause changes in ecosystem condition that contribute to degradation in the long term of either diversity or function are considered negative. It is important to take the time scale (long term) into account: in the short term, ecological impacts of a flood may seem very negative or even destructive, with death and injury or even local extinction of plants and animals, in the longer run it may turn out that this rejuvenation of the ecosystem works out positive and adds to ecosystem viability and biodiversity.

There are 5 main characteristics of a flood that together make up for the environmental impacts or risks of flooding. They are: the magnitude of the discharge, the velocity of the flow, the duration of the flood, the timing or seasonality of the event and the flood frequency.

7.2 Ecological impacts

Flooding not only has an impact on floodplain ecology, also the ecology of the river channel itself and the riparian zone may be affected. Besides, estuarine ecosystems and even coastal marine biota may be influenced. The mechanisms through which these ecosystems are affected may vary from one case to another but generally they are related to either changes in water quality or direct physical disturbance.

7.2.1 Water quality induced impacts

The quality of river water may change considerably during a flood. Turbidity levels of the river generally rise sharply as compared to the turbidity in low flow periods. High turbidity is primarily the result of the contribution of sediment rich surface runoff to the flood and erosion of the river bed and banks. However, also an increased growth of algae, induced by increased levels of nutrients, may add to turbidity. High sediment contents may have a negative impact on aquatic organisms: fish gills may clog and decreased penetration of light in the water column results in decreased photosynthesis and lower water temperatures. As a consequence oxygen levels in the water may drop, a phenomenon that may be more serious when exotic plants that are intolerant of extended inundation are flooded, since decay of the organic matter extracts oxygen from the water.

Flooding of rural areas may result in increased levels of pesticides and herbicides and nutrients from fertilizers. This may certainly be the case when storage facilities of these agro-chemicals flood. Animal and human waste, either from open pit latrines or flooded septic tanks, contaminates the flood water with organic material and pathogens. High organic waste levels may result in reduced oxygen levels affecting aquatic life. Pathogen contamination is a threat to human health. Flooding of open solid waste dumps is another source of pollution, depending on

the nature of the wastes this may result in increased levels of organic matter, chemical pollutants or microbiological pollutants in the flood water. Esthetical impacts, floating debris, may also result from flooding of dump sites.

Flooding of urban areas entails much higher environmental risks, sewage systems may overflow or break, resulting in contamination with organic matter and pathogens, industrial plants may flood, possibly resulting in the spread of toxic materials. Gas filling stations, garages/workshops etc. may form a source of pollution with hydro-carbons. Open solid waste dumps in or near urban areas are another source of organic, chemical and pathogen pollution, as well as of floating debris.

High nutrient contents, nitrogen and phosphorous, may be limiting to the growth of the native floodplain and riparian plants and may enhance the growth of invasive species. Poor water quality in general may result in fish kills and impact on other aquatic biota.

High concentrations of sediments, nutrients, phytoplankton and possibly pollutants, together with the consequent increased turbidity in the flood plume may affect coastal marine ecosystems, e.g. sea grass communities are very sensitive to a decrease in light penetration. Since sea grass meadows are an important habitat for a variety of fauna, including fish, shellfish, turtles and dugongs, many species may be effected. On the other hand, nutrients washed into the sea and the consequent growth of algae, may have a positive effect on commercially important fish stocks.

7.2.2 Physical disturbance induced impacts

Impacts related to physical disturbance are often related to forces acting upon biota, for example, destruction of riparian vegetation (stripping) results in a decrease in size and connectivity of habitats and thus in reduced structural complexity of the riparian zone. Loss of the riparian vegetation has a negative impact on the stability of the river banks.

Another form of physical disturbance is the coverage of flora and sometimes fauna with a layer of sediment. This may result in mortality of floodplain plants and fauna. Mortality may also be the result of prolonged inundation.

Yet another form of physical processes inducing impacts is the spread of organisms with the flood water. Exotic species, e.g. floating weeds, can be flushed out of the river into the floodplains and become invasive in floodplain ecosystems over large areas. Flood events also may be important in the release of exotic fish species from outside aquaculture ponds.

Table 7.1 summarises risks of flooding for the environment and human health. Ultimately the final highest order impact (not given in the table) of the induced changes will be a loss of biodiversity and a reduced ecosystem functioning, including a reduction in stocks of fish for human consumption.

Table 7.1 Summary of environmental risks of flooding

Impact cause	1st order impacts	Higher order impacts		
Change in water quality: due to e.g. bank and channel erosion, contaminants from agricultural or urban and industrial areas	• high sediment concentrations • elevated N and P levels and resulting high algae concentrations	• high turbidity and reduced light penetration • reduced dissolved oxygen levels	• clogging of fish gills • decreased photo synthesis	• fish mortality • decreased primary production
	• elevated pesticide and herbicide levels • elevated levels of organic and chemical pollutants incl. hydrocarbons	• fish and other aquatic species mortality • reduced growth of native species • invasion of exotic species		
	• increased levels of pathogens	• impacts on human health		
	• floating debris	• esthetical impacts		
Physical disturbances				
• **High flow velocities**	• loss of riparian vegetation	• loss of habitat area • loss of habitat connectivity • direct loss of species	• reduced river bank stability	
• **Deposition of (coarse) sediments**	• coverage of flora and fauna	• loss of habitat area • loss of habitat connectivity • direct loss of species		
• **Prolonged inundation**	• mortality of plants	• reduced oxygen levels	• mortality of fish and other aquatic organisms	
• **High water levels, water flow**	• spread of exotic (invasive) plant species • escape of exotic fish from ponds			

7.3 Assessment of environmental risks of flooding

Assessment of the impacts of flooding on ecosystem condition and human health requires the availability of detailed baseline data (data on the situation before the flooding) and inventories of the situation after the flooding. This information is not available at this stage of the FMMP-C2 project. Comparison with control areas not affected by the flood is sometimes a possibility, but generally the only means of assessing the impact of flooding on ecosystems will be through qualitative assessments by individuals familiar with the system under investigation. This requires extensive fieldwork, before and after the flood. This is clearly outside the scope of the project.

A complicating factor is that changes in biodiversity and ecosystem functioning are long-term processes. Most changes are very gradual and take place over a number of years. Besides, they

are generally induced by a variety of factors, of which flooding is but one. Human interference with the ecosystem is commonly a much more important disturbing factor than flood related disturbances.

The only indicators of negative impacts of flooding on ecology that can probably be used are the more directly visible impacts like the area of vegetation dieback after a major flood, the occurrence of fish kills, the coverage of natural vegetation with sediment deposits and changes in the width and continuity of riparian vegetation as a result of 'stripping' by the flood.

Information on water quality conditions during flooding (as compared to low flow conditions) could give an indication on the potential negative impacts of poor water quality. Important parameters are nutrient (N and P) concentrations, dissolved oxygen (BOD) levels, pesticide/herbicide concentrations, levels of toxic chemicals like mercury (used in gold mining), pathogen levels and the total suspended solids concentration. This kind of information is not present.

Table 7.2 Indicators for assessing of negative impacts of flooding on ecosystems

Impact	Indicator	Source of information	Unit
Loss of biodiversity	• area of vegetation dieback during/after flooding for different types of natural vegetation	vegetation maps, combined with information from aerial photographs or satellite images, field observations	km^2/vegetation type
Fish kills	• number of fish kills reported during the flood season as compared to the low flow season	Ministries/Departments of Fisheries in the various countries?	# per season, location
Loss of riverbank vegetation	• length of stripped riverbank • width of stripped riverbank		• km • m
Overall impact of poor water quality on	• N and P concentrations • BOD levels • pesticide/herbicide concentrations • concentration of toxic pollutants • pathogen levels • total suspended solids both for low flows and flood events	Ministries/Departments of the Environment in the various countries	mg/l

7.4 Environmental risks of flooding in the focal areas

Because detailed information on potential sources of pollution and environmental conditions in the focal area is not available at this stage of the project, a simple approach has been followed: a qualitative assessment of the environmental/health risk of flooding was made on the basis of information gathered during the household surveys and focal group discussions.

7.4.1 Right Bank Bassac, Cambodia

From the focal group discussions it became clear that main environmental problem related to flooding is the deterioration of the water quality, mainly in years with a 'bad' flood, that is a flood that starts early and lasts long. The water is reported to be stagnant for a long period in

such years and to develop a bad smell and colour. Since a large proportion (over 30%) of the population is dependent on surface water as a source for domestic use, frequent occurrence of skin diseases, rashes and diarrhoea is reported. During 'good' flood years, the water keeps flowing and stays clear, and there are no health problems.

In the Koh Andet District, where the survey was carried out, there are no water treatment facilities and no sewerage systems. Less than 10% of the households have their own toilet/latrine and most of the people defecate in the fields. During a flood these human wastes, together with animal wastes, affect the water quality, as does the decay of flooded plans and crop residues and 'freshly added' human and animal wastes.

No industrial enterprises are located in the District, but there are 4 hard ware shops and 28 garages/repair shops and 83 food processing enterprises. Flooding of the garages/repair shops may result in pollution with hydrocarbons.

Fertiliser and pesticide use in the district is relatively low, even more so in the wet season than in the dry season. The risk of pollution of the flood water with fertilisers/ pesticides is therefore assumed to be low.

During prolonged flooding, perennial trees and fruit trees are reported to become damaged.

7.4.2 Left Bank Mekong, Cambodia

The situation in the Focal Area on the left bank of the Mekong River is very much comparable with the situation on the right bank of the Bassac. The focal groups reported very comparably on environmental risks: also in this region, the Kampong Trabek District, the main environmental problem related to flooding is the deterioration of the water quality in years with a 'bad' flood, starting early and lasting long. The water develops a bad smell and colour. A large proportion (some 25%) of the population is dependent on surface water for domestic use. As a consequence health problems occur frequently in the flood season. Illnesses reported are: skin diseases, rashes, diarrhoea, cholera, typhoid, and dengue fever. During 'good' flood years there are no health problems.

Less than 8% of the households in the Kampong Trabek have their own toilet/latrine and people defecate in the fields. During a flood these human wastes, together with animal wastes affect the water quality, as does the decay of flooded plants and crop residues and 'freshly added' human and animal wastes.

No industrial enterprises are located in the District, but there are 61 garages/repair shops and 37 food processing enterprises. Hydrocarbon pollution may result from flooding of garages/workshops.

Also in this Focal Area fertiliser and pesticide use is low and the risk of pollution of the flood water with fertilisers /pesticides is therefore considered to be low.

Damage to vegetation, fruit trees and other perennial trees, is reported to occur during prolonged flooding.

7.4.3 Bank Protection Kratie, Cambodia

In the Kratie Focal Area no focal group discussions were held, whereas the information collected during the household surveys, carried out in 6 communes (Sambok, Thma Krae, Krakor, Kratie, Roka Kandal and Bos Laev) in the Kratie District, only provided limited information.

A field visit to the area learned that the bank erosion of the Mekong River in the Kratie area does not pose any environmental risks. On the banks directly along the river no industrial enterprises are located and there no storage facilities containing potentially polluting materials are under threat.

Flooding in the Kratie area has a completely different character than flooding in the Cambodian Delta. Flood duration is short, about one week and waters are not stagnant. Industrial development in the area is limited and any pollutant that might end up in the floodwaters will be diluted to harmless concentrations due to the sheer magnitude of the flood volume.

7.4.4 Bank Protection Bokeo, Lao PDR

In the Bokeo Focal Area there is only a bank erosion problem, flooding is not an issue. There are garages/workshops (34), gas filling stations (4) and 3 ice production factories located in the 2 affected districts, Ton Pheung and Houayxay. Non of these enterprises is located on the banks directly along the river, nor are storage facilities containing potentially polluting materials.

Since the river discharges in flood period are very high, any pollutant that might end up in the floodwaters will be diluted to harmless concentrations.

7.4.5 Sebangfai Flood Protection, Lao PDR

Participants in the Focal Group discussions in the Nongbok District in the Xe Bangfaii Focal Area did not specifically mention poor water quality as the main environmental risk of flooding, as did people in the Cambodian Delta. However, health problems, like eye sores, dysentery, and dengue fever, malaria and skin diseases, emerging after the flooding, when people start to work on the contaminated fields were specifically mentioned. This contamination with pathogens is related to the spread of human and animal wastes during the flood, when sanitary conditions are very poor. During the flood, poor water quality is not a problem, since people have enough stock of fresh rain water for household use. This is related to the fact that floods in the Xe Bangfai area do not last very long, 30 to 45 days at most.

No industrial enterprises are located in the District, but there are 26 garages/repair shops and 4 registered fuel stations. Flooding of the garages/repair shops and fuel stations could result in pollution with hydrocarbons.

Fertiliser use in the district is limited, and pesticide use is reported to be almost zero. Stocks of agrochemicals are brought to save places before the flood arrives and for the period 1996 to 2006 no flood damages to fertiliser stocks have been reported. The risk of pollution of the flood water with fertilisers/ pesticides is therefore assumed to be low.

Overflowing of fish ponds is reported to occur frequently. This potentially results in the spread of exotic fish species over the flood plain and river system.

7.4.6 West bank Bassac (Long Xuyen Quadrangle), Vietnam

Household surveys in the Chau Phu District of the An Giang Province indicate that the water quality may become poor during flooding, more so during normal and small floods than during big floods. Again this is related to poor sanitation conditions in the area: human and animal wastes pollute the flood water. Although a large proportion of the population depends on river and canal water during the flood (70% in the Dao Huu Canh Commune and 32% in the Vinh Thanh Trung Commune) health impacts of the pollution are limited. This is to be attributed to the fact that Public Health Preventive Centres provide medicines, water filters and water treatment chemicals. Public places like kindergartens, schools and markets are disinfected

(sprayed) after the flood recedes. Nevertheless, diarrhoea and dengue are reported to occur frequently. The poor part of the population is hit harder due to lack of awareness and money to pay for adequate provisions.

No info is available on garages, workshops, etc. in the area that could form potential sources of pollution. It is reported that businesses in the area have all raised foundations above the year 2000 flood level. The risk of spreading of pollutants with the flood water is therefore considered limited.

7.4.7 Left Bank Mekong (Plain of Reeds), Vietnam

The situation on the Left Bank of the Mekong is very much comparable with the situation on the Right Bank of the Bassac. Household surveys in four communes in the Tan Hong District of the Dong Thap Province indicate that the environmental risks of flooding are limited. Also in this area, poor water quality is the main problem, resulting in incidence of diseases. Mentioned are: intestinal, skin and respiration problems. Between 70 and 15% of the population in the four communes depend on river and canal water during the flood season. Medicines, water filters and purification chemicals (Cloramin B) are provided by health workers, and spraying is applied to disinfect public places and residential areas after the flood.

All industries, shops and other businesses in the area are located on raised areas, above the year 2000 flood level. Household stocks are stored on higher floors before the flood arrives. Consequently, the environmental risk of pollutants being spread by the flood water is considered limited.

CHAPTER 8

SOCIAL DIMENSIONS OF FLOODING IN FOCAL AREAS

8 SOCIAL DIMENSIONS OF FLOODING IN FOCAL AREAS

8.1 Introduction

The annual floods in the Lower Mekong Basin (LMB) affect households, social groups and communities in different ways. In part, this is a function of the timing, depth, duration and other characteristics of the flood events. Other, very important aspects of how people are able to deal with floods are the social, demographic, economic and livelihood characteristics of the flooded-affected people and communities themselves, as well as factors such as the facilities, services and institutional support that are available to them. These characteristics serve to define the social dimensions of flooding in terms of the strengths (resilience) and weaknesses (vulnerability) of individuals, households, social groups and communities.

In the focal areas identified for the FMMP-C2, a programme of social surveys and focus groups (FG) was conducted involving district authorities, samples of households and businesses and other stakeholders. The purpose of the programme was, among others, to gather information relevant to the understanding of the social dimensions of flooding. This information has been used to provide a preliminary assessment of how households and communities in the focal areas are resilient – or vulnerable – to the impacts of annual floods. This includes discussions of how people perceive good and bad floods, the range of traditional coping measures and other strategies that people use to reduce flood-related risks and the level of flood preparedness and capacity to deal with flood emergencies and recovery.

The social surveys and focus group discussions were conducted in portions of the 5 focal areas including (i) Sebangfai in Khammuone Province, Lao PDR, (ii) Right Bank Bassac in the provinces of Takeo and Kandal, Cambodia, (iii) Left Bank Mekong in Prey Veng Province, Cambodia, (iv) Left Bank Mekong (Plain of Reeds), Dong Thap Province, Vietnam and (v) Right Bank Bassac (Long Xuyen Quadrangle), An Giang Province, Vietnam. In each focal area, work was carried out in 1-2 districts; in each district, 2 communes or village clusters were selected as the target areas, see also Table 1.1. The selection of these target areas was made in consultation with local authorities, with the objective of choosing areas that represented different flood conditions, e.g., deep-flooded areas versus shallow-flooded areas, areas along natural riverbank levees versus the main floodplain area, etc.

8.2 Lao PDR: Xe Bangfai Focal Area, Khammouane Province

The Sebangfai focal area encompasses Nongbok district which is located in the southwestern corner of Khammoane Province. The district is situated on the right bank of the Xe Bangfai River between the Mekong River (to the west) and Route 13S (to the east). It is affected annually by combined floods that are the result of the flat topography, high flows and poor conveyance capacity in the Xe Bangfai River and high water levels in the Mekong River that back up into the tributary. A normal flood starts in mid-to-late July and lasts 15 to 30 days. There is usually one peak up to 1.5 m; waters rise over 5-7 days and then take about 30 days to recede. Participants in focus groups indicated that more serious flooding such as occurred in 1999-2002 and 2004-2005 started later towards the middle to end of August and lasted to the end of September. The Nam Theun 2 project may increase flood levels in the Xe Bangfai about 20 cm.

The area has been selected as a focal area for the FMMP-C2 because it exemplifies the conditions of combined flooding. The objectives for its selection as a demonstration project would relate to providing greater protection for the wet season rice crop in terms of controlling the depth and duration of flooding. This could lead to further initiatives to expand development of the area. The district is divided into 10 village clusters with a total of 72 villages. The social survey was conducted in two areas of the district, in villages along (i) the Xe Bangfai River and (ii) the Mekong River.

8.2.1 What constitute good and bad floods?

Throughout communities in Nongbok, there is no "good" flood. The annual floods that normally occur in August are a cause of losses for people living in the district. The differences between years such as 1999-2002 and 2004-2005 is that the extent of damages in August is up to 60-65% compared with a maximum of 10-15% in what are considered to be normal years.

There is little or no flood protection in the district. There are proposals to construct up to 47 km of rural roads that will also act as flood embankments; and, to rehabilitate or construct water gates on a number of local streams. According to focus group participants the proposed embankments need to be 1-3 m to be effective. In the absence of other measures, villagers attempt to slow or stop floodwaters by embanking lower areas with sandbags although this generally is not effective because the water flows fast and rises quickly. The district authorities have categorized villages in terms whether they are "heavy flood" or "lesser flood" villages[9].

8.2.2 Benefits and costs of flooding

FG participants identified a wide range of damages or losses that are generally associated with floods. The potential benefits are small in the estimation of local people

Flood Benefits and Damages Sebangfai Focal Area, Lao PDR	
Benefits	**Damages**
▪ The flood fertilizes the soil. However, farmers use the same amount of fertilizer regardless of the flood, e.g., 6 bags per hectare. ▪ Increased fish catch during flood can provide additional income for households that block channels to keep water in their paddy and/or own a boat. However, the income generation is low because of oversupply and low prices.	**Agriculture** ▪ Rice plants dead ▪ All crops dead, except trees **Transport / accessibility** ▪ Difficult to travel ▪ Road been damaged **Health** ▪ Increase in post-flood illness / disease ▪ Lack of drinking/cooking water when no rains ▪ Eye infections ▪ Difficult to go to toilet **Animal** ▪ Difficult for animals to live ▪ Shortage of grazing area for animals ▪ Poultry washed away ▪ Fish in the ponds go out **Safety** ▪ It takes time, it is difficult and no place to store their farm implements and other related tools ▪ Difficult to remove equipments like rice mills, and hand tractors and other related machines **Environment** ▪ Mekong bank was eroded make villagers lose their lands on river bank ▪ Erosion in paddies, roads, and house yards

[9] Heavy flood villages include: Sorboe, Namphou, Nonglom, Daongsangam, Hatxaifong, Phak Itou, Natai, Samnadee, Sadeuneua, Sadeutai, Phonsao E, Thamuang, Dane Pakse, Dongkasin, Hatxiengdy. Lesser flood villages are Donekhio Kang, Donekhio Tai, Muangkhai, Nongsaphang Thoong, Navangnoi, Navangthong, Navangneua pakderd, Laona, pongkiew, Bungsanetha, Danesavang, Donekhioneua, Namanpa, Nongpalad, Xiengvangtha, Xiengvangneua.

Flood Benefits and Damages Sebangfai Focal Area, Lao PDR	
Benefits	**Damages**
	▪ Difficult to collect firewood for those who have no boats **Property** ▪ Temple walls of Nonglom village were damaged ▪ Houses need cleaning up, repairing, mending the eroded areas ▪ Flood damaged schools and village dispensaries (floors, windows and doors and furniture)
Source: Focus Group Discussions, Lao PDR	

8.2.3 Community characteristics

Nearly everyone living in Nongbok belongs to Tai-speaking ethnic groups (96%), with only a small proportion of minority ethnic groups. Nongbok is not a designated priority poor district as identified in the poverty reduction strategies of the Government of Lao (GoL).

Community Characteristics Sebangfai Focal Area, Lao PDR			
Indicator		*Unit*	*District*
Population		No.	41,103
Number of HH		No.	7,593
Ethnicity			
- Tai-Kadai	Lao	%	71.4
	Phoutai	%	24.9
- Mon-Khmer	Mangkang	%	2.9
	King	%	0.7
Poor HH		%	0.1
Popn growth, 2001-2006		%	2.4
Source: District Flood Vulnerability Database, Lao PDR			

The ethnic and poverty conditions reduce the social vulnerability of these communities for the following reasons:

(i) These communities are culturally and linguistically homogenous. This contributes to effective social and community networks that are an important asset in dealing with flooding planning, response and recovery on an individual, household and community basis.

Everyone in the village is brothers and sisters, aunts and uncles or very close friends. So, during the flood they help each other out as a gift or a loan without interest (Nongbok focus groups).

(ii) The low levels of poverty mean that, in general, households in Nongbok are less vulnerable to harm caused by flooding and other natural disasters. People live in substantial housing, have livelihoods, assets and incomes that meet (or exceed) basic household needs, have better levels of health and education and other characteristics that enable them to protect themselves from flood damage and/or to recover more easily following flooding.

8.2.4 Household characteristics

Households in Nongbok have, on average, 5.4 persons. The majority (95%) are headed by men who slightly outnumber women in the district population. However, more than one-third of the population (35%) is under the age of 15 years. This high proportion of children in combination with elderly people living in the district results in an age dependency ratio of 0.71. This means that every working-age person in the district must produce enough to support his or her own needs plus 70% of the needs of another, dependent person.

Household Characteristics **Sebangfai Focal Area, Lao PDR**			
Indicator		*Unit*	*District*
HH size (aver.)		Pers.	5.4
HH head	Male	%	95.0
	Female	%	5.0
Male/female ratio		ratio	1.02
Children < 15 years		%	35.5
Dependency ratio		ratio	0.71
Source: District Flood Vulnerability Database, Lao PDR			

The implications for social vulnerability include:

(i) The large proportion of children in Nongbok tends to increase vulnerability to the impacts of flooding. Children are often at risk of physical injury and drowning during floods. They may be more susceptible to becoming sick, for instance, if there is no safe drinking water or proper sanitation during floods. If flooding damages schools, children's education will be disrupted. Moreover, the high dependency ratio places extra burdens on parents and other adults to provide for children's needs for food, shelter, etc.

8.2.5 Land uses and tenure

Land Uses, **Xe Bangfai Focal Area, Lao PDR**		
Indicator	*Unit*	*District*
District area	ha	31,300
Rice land – irrigated	%	33.7
Rice land – rainfed	%	7.3
Upland crop land	%	5.5
Plantation land	%	0.3
Rural residential (gardens)	%	1.6
Urban land	%	0.4
Lakes, ponds & wetlands	%	8.7
Forest - dry Dipterocarpus	%	30.0
Forest - non-productive	%	11.3
Communal	%	1.2
Source: District Flood Vulnerability Database, Lao PDR		

Almost the entire territory of Nongbok district is land that contributes to the rural livelihoods of people living in the district. Cultivated land encompasses more than 45% of the district area and includes irrigated paddy (34% total), rainfed paddy (7%) and other land such as upland crops land and residential gardens (6-7%). In addition, people rely on riverbanks, wetlands and forests to grow and/or harvest food crops, as well as for other productive uses such as building materials, medicines, etc.; together, these resources account for nearly 40% of the district area.

Legal title to agricultural land in Lao PDR generally takes the form of a land certificate issued by local authorities. In Nongbok district, the ratio of land certificates to households is 0.95, meaning that nearly all households have secure tenure to their productive land. Landless households account for 1.7% of all people in the district. All households in the district also have a land certificate for their residential land. The issues of social vulnerability to the impacts of flooding include:

(i) The reliance of livelihoods on land and natural resources increases the direct and indirect costs of flooding. Household expenditures for food and other basic needs will increase if people are unable to cultivate vegetables in riverbank gardens or harvest forest or wetlands products they normally use for different purposes.

(ii) Secure land tenure as well as house ownership (see section below) provide households with collateral that will facilitate their ability to obtain loans and other assistance to rehabilitate property damaged during a flood or to meet other households needs (health care, new agricultural inputs, etc.).

(iii) People without productive land are at risk during a flood because, in most instances, they work as agricultural labour on other people's land. They lose this source of income if land is inundated for extended periods and/or the rice crop is damaged or destroyed. As they are generally poor, they have few alternative resources to meet basic or flood-induced needs (e.g., health care). In Nongbok, the needs of the small number of landless people may be effectively met through the strong family and social networks that exist.

8.2.6 Housing, structures and other assets

Structures **Xe Bangfai Focal Area, Lao PDR**		
Indicator	*Unit*	*District*
Main structures – total	No.	9,030
Residential - % total	%	88.4
Permanent	%	20.0
Semi-permanent	%	70.0
Temporary	%	10.0
HH owns structure	%	100.0
Commercial - % total	%	10.6
Permanent	%	20.6
Semi-permanent	%	79.4
HH/business owns structure	%	100.0
Industrial - % total	%	0.2
Semi-permanent	%	100.0
Institution - % total	%	0.9
Permanent	%	40.5
Temporary	%	59.5
Source: District Flood Vulnerability Database, Lao PDR		

Residential and separate commercial structures account for, respectively, 88% and 11% of the main structures in the district; however, many business activities are accommodated in spaces that are attached directly to residential structures. These types of structures are generally owned by their occupants. Industrial and institutional structures make up about 1% of the total.

Permanent structures made from brick and/or concrete account for 20% of these structures; 70% are semi-permanent construction, generally wood; and, the remainder are constructed of thatch, bamboo and other temporary materials. Based on data provided by surveyed households, permanent and semi-permanent house structures tend to have similar areas and value.

Housing Area & Value Se Ban Fai Focal Area, Lao PDR		**% HH**	**Area**	**Value**
			m^2	Kip million
Average			67	40.1
By house type	Permanent	84.3	66	39.8
	Semi-permanent	15.7	70	42.2
Source: Household surveys, Lao PDR				

Flood risks are a major factor in the sitting and design of housing in the focal area. In raised safe areas, people will construct one-story brick houses. However, in most areas, the traditional coping mechanisms include:

(i) Houses are raised 2.5-3 m on concrete poles to protect them against annual floods. The concrete poles have replaced wood poles that were traditionally used as they are more resistant to water logging.

(ii) Retail shops, repair garages/workshops and other commercial structures are generally not raised. However, the foundation will be made stronger to withstand potential damage from flood waters.

(iii) Within commercial structures, people frequently make provisions for temporary storage of inventory and equipment above the normal flood level that may occur within the structure. For commercial activities located in structures adjacent or attached to houses, the inventory and equipment will often be moved and stored within the raised house.

(iv) Other industries such as rice mills will often be located on higher ground within the community to provide protection during floods.

There are also numerous small agricultural structures such as rice huts and animal shelters (the number is nearly equal to the number of main structures). These are all temporary structures.

In terms of household assets, people in Nongbok rely on motorbikes as their principal means of transport; less than 1% of district households own a car or truck. Although the district is bounded by the Xe Bangfai and Mekong rivers, only 2% of households own small boats (without motors); an even small proportion (0.5%) own larger, motorized boats. More than a third of households own a hand tractor, but very few if any households own other types of productive equipment such as mechanized tractors, water pumps, diesel generators, rice mills.

The implications for assessing the vulnerability of households to flood damages are as follows:

(i) The traditional house form reduces the risks of flood damages to people's housing. In most years in Nongbok, there are no flood-affected houses; even in the serious floods in 2001 and 2005, there were on 2-3 damaged houses.

(ii) The establishment of safe areas and/or the sitting of non-residential structures on higher ground help to minimize flood damages.

(iii) However, the low proportion of households that own small or larger boats will be reflected in the lack of access that many people have during floods to health care and other services outside their immediate village. The lack of boats may also constrain local emergency response activities.

8.2.7 Economic activities

Rice cultivation and other types of agriculture are the dominant economic activities in Nongbok: more than 90% of households are involved to some degree in these activities. Nonetheless, district data indicate that less than two-thirds of economically active people (63.5%) are engaged primarily in agriculture. Nearly one-quarter (24.9%) of working people travel across the Mekong River to work as hired labour in Thailand, particularly in factories.

Occupations, Economically Active Population Xe Bangfai Focal Area, Lao PDR

Indicator	*Unit*	*District*
Number of persons 18-60 yrs.	No.	24,098
Agriculture	%	63.5
Fishery	%	1.5
Agricultural labour	%	3.7
Construction labour	%	0.9
Other labour – Thailand	%	24.9
Business owner	%	1.9
Employee – private sector	%	0.8
Employee – government	%	2.8

Source: District Flood Vulnerability Database, Lao PDR

(i) Vulnerability to economic losses due to flooding is directly related to the proportion of people engaged in agricultural activities.

(ii) The incidence of working people who migrate to Thailand reflects better job prospects and wages that are available to people living in Nongbok, as well as possible constraints on economic activities in the district (e.g., lack of agricultural land, non-farm employment). The higher wages contribute to the low poverty levels in the district. At the same time, however, the absence of younger family members during a flood event may increase household vulnerability. In addition, a greater burden is place on women when adult men are absent from the household.

8.2.8 Rural livelihoods

The dominant livelihoods in Nongbok district comprise the following: Men and women work together to cultivate the principal rice crop during the wet season (June-November). This crop relies primarily on rainfall; in some areas, supplemental irrigation is provided by a diversity of

small-scale irrigation systems. A total of 10,500 ha are planted with a yield of 4.3 tons/ha. A second, smaller rice crop is grown during the dry season using the irrigation systems: 1,500 ha are planted that have a yield of 6.2 tons/ha.

Agricultural Production & Income Xe Bangfai Focal Area, Lao PDR		*Paddy Area*	*Prod. Sold*	*Annual Income*
		ha	*%*	*Kip million*
Overall	Average	2.2	39.6	20.1
By house type	Permanent	2.3	38.1	18.3
	Semi-permanent	1.5	47.3	29.7
Source: Household surveys, Lao PDR				

Each household has, on average, 2.2 ha of rice land. People living in semi-permanent structures have an average of 1.5 ha per household; that is, they have about 30% less productive land than households in permanent structures.

In Nongbok, less than half of the rice crop is sold, on average. Rice is the staple food for all households; due to the relatively low yields in the district, more than half of the rice crop is required to meet basic household consumption needs. However, sale of surplus rice in Thai markets is an important source of income for households in this district.

Upland crops and tree plantations represent a small proportion of agricultural activities in the district. Women cultivate riverbank gardens to grow a diversity of vegetables that are used for household consumption and to generate cash income. Crops such as tobacco, corn, onion, garlic and beans are grown where rice cannot be grown. The choice and volume of these crops is determined by market demands in Lao PDR and in Thailand.

Natural and man-made fish ponds are stocked in the late spring and early summer for harvests 9-10 months later. The yields vary from 0.5 ton/ha for 6,000 ha of natural ponds and 1.2 ton/ha for 3,000 ha of man-made ponds. Many households raise different types of livestock. A household may own a few buffalo and/or cows that are used as draught animals and provide a financial security net for the family; chickens are widely raised for household consumption purposes. Pigs are the most common animal that is raised for sale.

During the flood season, people's activities focus on the following: planting and cultivating the wet season rice crop; fishing and fish cultivation; maintaining fences, dykes and ditches; preparing (and repairing) tools for the upcoming harvest; and, thatching mats used in house construction. The traditional coping mechanisms to protect livelihoods include:

(i) Prior to the onset of floods, people set aside at least a month's supply of rice, prepare water containers to collect rainwater and collect firewood and other materials used as fuels for cooking.

(ii) Protect livestock by moving them to higher ground and collecting grass and rice straw to feed them during the period that they are unable to graze.

(iii) Protect fish ponds by using plastic screens to surround the pond and prevent fish from getting out.

The implications for an assessment of vulnerability to flood impacts include the following:

(i) In Nongbok, there is a significant slow-down in agricultural activities during the flood season. People who work as agricultural labour will generally have little or no income during this period.

(ii) As mentioned previously, while there is an abundance of fish including in paddy fields, most people fish primarily to supplement household diets. The low rate of boat ownership and the low prices for fresh fish limit the opportunities to generate significant cash income from these activities.

(iii) However, according to FG participants, there are few if any problems with food shortages during most floods: *Rice and fish are the main food for people during the flood. Here everyone has rice and everyone catches fish*.

(iv) Individuals and traders with access to boats will buy food in market towns and resell it to neighbours and others who cannot access markets.

(v) The groups that are identified as vulnerable during floods include: elderly people; and, people without boats who are unable to fish or collect firewood.

8.2.9 Access to electricity, water and sanitation

Most households in the district (95%) are connected to the public electricity grid. The proportion of households without electricity is 2%. Among over 500 registered businesses in the district, however, only 21% are connected to the electricity grid.

There is one public, piped water supply system in the district town of Nongbok. According to district authorities, about 14% of households in the district are connected. Over 500 businesses are also connected or 58% of the 970 registered and unregistered businesses in the district. Outside of the district town, the primary source of drinking water is public drilled wells and/or standpipes (3 villages); public and private wells, local rivers and streams and/or rainwater collection (72 villages); and, purchased water (30 villages). During floods, people rely on rainwater, purchased water and boiled river/stream water for drinking and cooking; they use flood water for washing and bathing.

There is no wastewater collection or treatment system in the district. Just over half of the households (52%) have latrines; in most instances, these will be water-sealed latrines. The remaining households have no sanitation facilities. The implications for the assessment of social vulnerability to flooding include the following:

(i) Due to inadequate supplies of safe drinking water and, particularly, poor sanitation conditions (defecation in the open and in paddy fields), there is a high risk of diarrhoea and dysentery.

(ii) Bathing and washing clothes in flood waters increases the incidence of skin rashes and infections due to contamination of the water.

8.2.10 Access to health care

Floods in Nongbok are associated with a variety of health problems: diarrhoea and dysentery; malaria and dengue fever; colds; and, skin and eye infections. Health risks also arise because people return to work in the fields and other waterlogged areas as soon as the waters recede, while there are still decayed materials lying around. They may slip and fall on slippery roads, dykes and banks of ponds and rivers.

In Nongbok district, the health care facilities include: 1 district hospital with 15 beds, 2 clinics and 10 dispensaries. The 2 clinics provide services for the 72 villages in the district, with a ratio of 3,797 households per clinic. There is one dispensary for each village cluster, or a district-wide ratio of 759 households per dispensary. Due to the lack of adequate medical facilities and the difficulties of travel during the flood season, many households rely on traditional herbal medicines to treat diarrhoea, dysentery and the various types of skin and eye infections. The implications for social vulnerability due to flooding include:

(i) The inadequate (and often ill-equipped) health care facilities are a major source of people's vulnerability when they are injured and/or become ill during or following the flood.

(ii) Due to the lack of adequate health care and/or the need to travel to obtain health care, there is a higher risk of extraordinary health care costs that strain the resources of households, particularly poor households.

8.2.11 Flood preparedness, emergency response and recovery

In 2007, the District Disaster Management Committee (DDMC) for Nongbok prepared a flood preparedness programme with assistance from the MRC-ADPC-ECHO III project. This programme includes (i) investments such as the upgrading of roads/dykes and water gates (mentioned above); (ii) non-structural measures such as raising public awareness, establish village revolving funds, integrating disaster risk reduction into the school curriculum, land use planning, preparing flood risk maps and early warning systems; and (iii) identifying a budget plan with agency responsibilities for implementation of the programme.

Traditional methods of flood warning include markings on riverside trees, other markers on river banks and water levels at houses and other structures. These have been associated with staged actions such as relocating animals, removing possessions to upper levels of structures, stocking rice and water for one month, relocating children and elderly people and, finally, tying the house to nearby trees. The strengths of this system were that it was easy for people to learn and remember, and it could indicate rather precisely when different actions should be taken. However, when a tree is cut or a portion of the riverbank is eroded, important markers are lost. In Nongbok, different strategies have been used to respond to floods although the success has not been high according to FG participants:

(i) In 1997 and 1999, the district provided bags for people to fill with sand and dirt to construct temporary embankments against floodwaters. The success was that there was a high level of participation and cooperation, but the floodwaters were too fast/high.

(ii) The Office of Social Welfare is responsible for emergency response. The planning is done without consultation of people living in the area although they participate as much as possible in flood protection practice/drills. However, in a bad flood the waters rise too fast and too high.

There are been no formal flood recovery plans in the district (according to FG participants). The chief of each village cluster and village administration committees prepare and implement ad hoc plans with a small amount of assistance from the Office of Social Welfare. There is, however, a high level of participation and contribution of labour by villagers for recovery activities such as clean and repairing damaged houses, shops and businesses, community buildings and their equipment (schools, clinics, etc.) and damaged land.

8.3 Cambodia: Right Bank Bassac focal area, Takeo and Kandal Provinces

The Right Bank Bassac focal area encompasses portions of the provinces of Takeo and Kandal, extending along the west bank of the Bassac River from south of the town of TaKhmao to the Cambodia-Vietnam border. The area is bounded by Route 2 to the west.

This focal area is essentially flat, with elevations ranging from 1-10 masl. The flood season lasts from July to October. As water rises in the Bassac, it overtops the natural levees that line the river; colmatage canals direct water to a vast floodplain behind the levees. Overland flows into the floodplain also come from the Stung Prek Thnot in the northern portion of the focal area. The floodplain includes a shallow-flooding area located immediately behind the Bassac levees above the 5-m contour line; and, a deep-flooded area that extends in a NW-SE direction towards the Vietnam border.

The overall objective for alternative structural measures being considered for the focal area is to delay the onset of flooding in shallow-flooded areas so that farmers can plant an early rice crop as well as the recession crop. More specifically, the demonstration project is intended to: (i) reduce peak flows and extreme deep flooding by providing additional flood conveyance; (ii) create a small flood-free area; (iii) improve water supply for dry season agriculture, reducing the frequency of early- and mid-season drought damage; (iv) reduce flash flooding and related damages in the western portion of the focal area; and, (v) improve inland water navigation and road transport modes.

The social surveys in the Right Bank Bassac focal area were carried out in the main part of the focal area in Koh Andet district in Takeo Province; and, upstream on the western bank of the Bassac in Koh Thom district in Kandal Province. In addition to collecting data from district authorities, surveys and focus groups were conducted with households, businesses and other stakeholders in the communes of Rominh and Pech Sar (Koh Andet) and Prek Thmey and Leuk Dek (Koh Thom) [10].

8.3.1 What constitutes good and bad floods

In the focal area, lowland areas account for 50% and 30%, respectively, of the territory of the communes of Rominh and Pech Sar (Koh Andet). In Prek Thmey, the natural levees along the river are higher than the floodplain to the west. In these areas, a normal flood has a depth that ranges from 0.5 m (Prek Thmey) to 1 m (Rominh). Leuk Dek is a predominantly lowland area where the depth of a normal flood is, on average, 4 m.

In 2003, the Government constructed the Pech Sar dyke to provide protection for the 4 districts in the southern portion of Takeo Province (Koh Andet, Treang, Kirivong and Borei Cholsar). This

[10] Leuk Dek commune is not within the West Bassac focal area but was selected by local district authorities for inclusion in the social survey; it is located in a deeply-flooded area between the Bassac and Mekong rivers. In the discussion of the West Bassac focal area, attention is paid to identifying how the conditions and issues in this commune differ from those in the areas to the west of the Bassac River.

is the only flood protection measure reported in the focal area in communes included in the social survey.

The following summarizes the views of FG participants on what constitutes good and bad floods and the benefits and damages related to floods.

Flood Characteristics Right Bank Bassac Focal Area, Cambodia	
Good Floods / Flood Benefits	**Bad Floods / Flood Damages**
▪ During a good flood, water rises slowly at a normal pace to provide water for the rice crop and to control weeds. ▪ A good flood recedes quickly so that it does not rot the rice in the field. ▪ There are no strong winds, lightning strikes or waves that would make using boats and fishing dangerous. ▪ The flood brings fertile land and alluvial soils to rice fields, increasing yields by 25-33%. ▪ The flood increases fish production. ▪ Vegetables, perennial and fruit trees are not damaged.	▪ Flood waters rise rapidly and remain for a long time. The rice crops is damaged or lost. To lesser extent, there can be loss of vegetables. ▪ Fish cages damaged and fish escape from flooded natural ponds during bad floods. ▪ There are strong winds and waves that make navigation dangerous; people are at risk of drowning or being hit by lightning. ▪ Paths and roads are damaged limited accessibility; people cannot travel to markets ▪ Small stores, outbuildings and houses of temporary materials are damaged/ destroyed. ▪ Water quality deteriorates and becomes smelly (particularly in upland areas); drinking water is unsafe and health risks increase; washing/bathing in flood waters causes skin rashes. ▪ Children are unable to attend school for up to 3 months due to damaged schools and roads.
In Koh Andet, the level of damage depending on date of onset of a normal flood of 0.7-1 m: ▪ Mid-June: 60-80% ▪ Mid-July: 40-50% ▪ Mid-August: 20-30% ▪ Mid-September: 10% ▪ Mid-October: 0% ▪ Mid-November: 10%	In Koh Andet, a bad flood that exceeds 1.5 m will result in complete loss of rice crop regardless of the date of onset of the flood.
In Prek Thmey (Koh Thom), the level of damage depending on date of onset of a normal flood of 0.5 m: ▪ Mid-June: 100% ▪ Mid-July: 10% ▪ Mid-August: 0% ▪ Mid-September: 80% ▪ Mid-October: 100% ▪ Mid-November: 100%	In Prek Thmey (Koh Thom), the level of damage depending on date of onset of a flood of 1.5+ m: ▪ Mid-June: 100% ▪ Mid-July: 90% ▪ Mid-August: 70% ▪ Mid-September: 90% ▪ Mid-October: 100% ▪ Mid-November: 100%
Source: Focus Group Discussions, Cambodia	

8.3.2 Community characteristics

Over 50,000 people live in Koh Andet in six communes. The largest concentration of people is in the commune of Rominh. The lowest population is found in the commune of Prey Yuthka adjacent to the Vietnam border and in a deep-flood area; and, it is evenly distributed among the other communes. The population is nearly entirely Khmer (98%); a small number of Cham also live in the district.

Community Characteristics Right Bank Bassac Focal Area, Cambodia			
Indicator	*Unit*	*Koh Andet*	*Koh Thom*
Population	No.	50,716	150,517
Number of HH	No.	9,975	27,250
Ethnicity			
Khmer	%	98.3	87.4
Cham	%	1.7	2.8
Vietnamese	%	0.0	11.2
Poor population	%	22.6	30.0
Popn growth, 2001-2006	%	1.6	1.3
Source: District Flood Vulnerability Baseline Database, Cambodia			

The population of the 4 communes in Koh Thom district represents about 45% of the total district population, or approximately 68,000 people; the population density in Prek Sdey and Sampov Loun is lower than the other communes, indicating a more rural area. As in Takeo, the majority of the population is Khmer although there is a community of Vietnamese (11% of the population), many of whom are fishers living along the shores of the Bassac River.

While the population in the focal area is largely socially and culturally homogeneous, there are high proportions of people who live below the poverty line[11], including 23% in Koh Andet and 30% in Koh Thom. According to the 1998 census, the distribution of poor households was relatively equal across the communes (measured as proportion of the population). From the perspective of vulnerability to flood impacts:

(i) The social and cultural homogeneity of the population increases resilience to flooding in that it supports social and community networks.

(ii) Poverty is a key indicator of vulnerability to the impacts of flooding. Poor people tend to live in housing of inferior quality located in more vulnerable areas which means they may experience greater damages and losses due to flooding. Poor people have lower cash incomes and rely more on loans that they may have difficulty to repay; they are more at risk of having to sell produce at lower prices (not able to store until prices are better) or to sell off land and other assets to pay for extra expenses due to floods.

8.3.3 Household characteristics

Households in the focal area have, on average, 5-5.5 persons. The majority of households (86-87%) are headed by men, although 13-14% are headed by women. Women slightly outnumber men in the population. Therefore, although the proportion of female-headed households is well below the national average (25%), there may be situations in the district where women become *de facto* heads of households when their husbands out-migrate for long periods looking for work. The proportion of children under that age of 15 years is extremely high, ranging from 38% in Koh Thom to 44% in Koh Andet. As a consequence, there are high dependency ratios in the focal area where each working adult works to provide for one, dependent person as well as his own needs.

[11] Defined as 2,100 calories per adult equivalent per day

Household Characteristics Right Bank Bassac Focal Area, Cambodia				
Indicator		*Unit*	*Koh Andet*	*Koh Thom*
HH size (average)		Pers.	5.1	5.5
HH head	Male	%	86.1	87.0
	Female	%	13.9	13.0
Male/female ratio			0.95	0.96
Children < 17 years		%	43.5	38.0
Dependency ratio		ratio	0.99	0.91
Source: District Flood Vulnerability Baseline Database, Cambodia				

(i) Poverty tends to be higher among female-headed households, making them more vulnerable to the adverse impacts of flooding. For example, there may be a higher risk among female-headed households of distress sales of land or other assets to pay for food, medical care or house rebuilding after a flood.

(ii) The large proportion of children in the focal area tends to increase vulnerability to the impacts of flooding. Children are often at risk of physical injury and drowning during floods. They may be more susceptible to becoming sick, for instance, if there is no safe drinking water or proper sanitation during floods. If flooding damages schools, children's education will be disrupted. Moreover, the high dependency ratio places extra burdens on parents and other adults to provide for children's needs for food, shelter, etc.

8.3.4 Land uses and tenure

In Koh Andet, the principal portion of the focal area, nearly the entire land area is allocated to paddy cultivation (98%); about 2% is residential land where people live. In Koh Thom, on the other hand, there is a greater diversity of land uses. Nearly half of the district is flooded forest although this is located between the Bassac and Mekong rivers outside of the focal area. The four communes on the west bank of the Bassac include an area of higher land immediately behind the embankments that line the river; this area has been intensively developed for cash cropping to take advantage of the low flood risk and the proximity to markets in Phnom Penh. The remainder of these communes is in the floodplain where rice is the dominant land use.

In Cambodia, an ongoing project to implement systematic land titling has not yet extended to the jurisdictions within the Right Bank Bassac focal area. Therefore, tenure for agricultural land is based on other forms of documentation. The ratio of legal documents to agricultural households is about 0.66 in Koh Andet while it is only 0.33 in Koh Thom. Koh Andet district authorities report no landless households. In Koh Thom, just over 4% of household do not have agricultural land; many of these are ethnic Vietnamese who work as fishers. With regard to residential land, nearly all Koh Thom households have secure tenure; the data for Koh Andet indicate a low proportion of households with legal documents for their residential land. In terms of social vulnerability to flooding, the following are the risks in this focal area:

Land Uses Right Bank Bassac Focal Area, Cambodia			
Indicator	*Unit*	*Koh Andet*	*Koh Thom*
District area	ha	24,749	47,860
Rice land (dry season)	%	43.8	27.1
Rice land (wet season)	%	54.0	4.6
Orchard land	%	0.0	15.0
Residential	%	2.3	3.1
Commercial/industrial	%	n/a	n/a
Institutional	%	n/a	n/a
Forest (flooded)	%	n/a	50.2
Communal	%	n/a	n/a
Source: District Flood Vulnerability Baseline Database, Cambodia			

(i) The reliance of livelihoods on agricultural land increases the direct and indirect costs of flooding, particularly in Koh Andet. Household expenditures for food and other basic needs will increase if people are unable to cultivate rice or vegetables in riverbank gardens; incomes decrease from the loss of cash crops.

(ii) The lack of secure land tenure is a major risk factor for many households in Cambodia. They lack collateral to obtain loans to rehabilitate property damaged during a flood, finance agricultural inputs or meet other household needs (e.g., health care).

(iii) People without productive land are at risk during a flood because, in most instances, they work as agricultural labour on other people's land. They lose this source of income if land is inundated for extended periods and/or the rice crop is damaged or destroyed. As they are generally poor, they have few alternative resources to meet basic or flood-induced needs (e.g., health care).

8.3.5 Housing and other structures

Housing constitutes nearly all of the main structures in the focal area (97-99%). Commercial and institutional structures account for the remainder. There are no industrial structures. All households and/or businesses own their structures.

Housing and Other Structures Right Bank Bassac Focal Area, Cambodia			
Indicator	*Unit*	*Koh Andet*	*Koh Thom*
Structures – total	No.	9,794	25,103
Residential - % total	%	97.2	99.3
permanent	%	0.3	1.0
semi-permanent	%	80.6	79.0
temporary	%	19.1	20.1
Commercial - % total	%	2.6	0.1
permanent	%	0.0	14.3
semi-permanent	%	100.0	85.7
Institution - % total	%	0.27	0.6
permanent	%	57.7	0.0
semi-permanent	%	15.4	100.0
temporary	%	26.9	0.0
Source: District Flood Vulnerability Baseline Database, Cambodia			

In Koh Andet, more than half of the institutional structures are of permanent construction. However, in general, most structures in the focal area are semi-permanent construction. This includes 80% of residential structures such as the traditional wood structure raised on stilts.

More than 70% of the large number of small agricultural structures (e.g., animal shelters) throughout the district are temporary structures; the remaining are semi-permanent construction.

Housing Area & Value Right Bank Bassac Focal Area, Cambodia		*Koh Andet*			*Koh Thom*		
		% HH	*Area*	*Value*	*% HH*	*Area*	*Value*
			m2	*Riel million*		*m2*	*Riel million*
Overall	Average		53	3.8		57	7.0
By house type	Semi-Permanent	59.8	51	5.5	83.3	56	8.0
	Temporary	40.2	56	1.4	16.7	61	1.6
Source: Households surveys, Cambodia							

Among households surveyed in the focal area, the average size of housing is similar in the two districts.

However, the over-all value of housing in Koh Thom is nearly twice that of housing in Koh Andet. While temporary housing structures have similar values in the two districts, semi-permanent structures in Koh Thom have a higher value. The ratio of value per square metre for Koh Thom compared to Koh Andet is 1.3.

In general, people living in this focal area do not relocate during floods to safe areas. However, they employ some traditional coping measures to protect their houses and other property against flood damage:

(i) Households build on higher ground if it is available and away from rivers, streams and other water courses. If higher ground is not available, they will often raise the level of house sites with earth or rubble.

(ii) The traditional house is wood frame built on stilts. The stilts are wood or concrete columns, the latter being naturally water resistant. Prior to floods, households will increase the strength of house struts and bracing timbers.

The implications for assessing the vulnerability of households to flood damages are as follows:

(i) The sitting of houses and traditional construction techniques reduce the risks of flood damages to housing for most people. Poor people, however, tend to live in housing that is temporary structures built on the ground. They are highly vulnerable to having their structures damaged or swept away during floods.

(ii) Small, temporary agricultural buildings are highly vulnerable to damage or loss, depriving people of places to store rice or the use of kitchens or latrines.

8.3.6 Household assets

In Koh Thom compared with Koh Andet, more households own one or more means of transport, including a car or truck. More households also own a small and/or large boat, reflecting the greater importance of capture fishery and river transport for a greater proportion of the Koh Thom population. In both districts, the majority of farmers rely on traditional ploughs drawn by animals to prepare their paddy fields. In Koh Andet, fewer than 10% of households own a hand tractor and fewer than 1% have a four-wheel tractor; the proportions are much smaller in Koh Thom. A small proportion of households in Koh Andet (12%) own a water pump. However, very few households own other productive equipment such as rice mills.

Household Assets
Right Bank Bassac Focal Area, Cambodia

Indicator	*Unit*	*Koh Andet*	*Koh Thom*
Number of HH	No.	9,975	27,250
Bicycle (1 or more)	%	51.6	76.7
Motorbike (1 or more)	%	19.2	28.7
Car /truck	%	0.6	2.3
Small boat (without engine)	%	14.6	26.6
Large boat (with engine)	%	3.5	21.9
Mechanized tractor	%	0.7	0.4
Hand tractor	%	6.4	0.9
Cart	%	31.9	7.6
Diesel generator	%	0.1	0.1
Water pump	%	11.7	n/a
Rice mill	%	2.2	0.5
Other machinery	%	0.4	0.1
Source: District Flood Vulnerability Baseline Database, Cambodia			

The implications for people's vulnerability during floods include:

(i) The ownership of boats, in particular in Koh Thom, increases the options of households for alternative transport during floods (to get to markets, clinics, etc.). It also provides them with the means to increase fishing activities. The community benefits from the availability of craft to respond to emergencies.

8.3.7 Economic activities

Overall in the focal area, between 79% and 85% of economically active people work in the agricultural sector. In Koh Andet, however, these people are rice farmers while in Koh Thom are people engaged primarily in growing cash crops and people who are fishers, as well as rice farmers.

At the district level, the more urban character of Koh Thom is reflected in the higher proportions of people employed in the public and private sectors as well as trade and other services. However, the four communes in the focal area are more rural in character and, therefore, non-agricultural activities are more likely to be similar to those in Koh Andet. The implications in an assessment of social vulnerability to flooding are:

(i) Vulnerability to economic losses due to flooding is directly related to the high proportion of people engaged in agricultural activities, particularly in Koh Andet.

(ii) Businesses and shops are often located along roads that are generally constructed along dykes. This would tend to minimize disruption of these economic activities during normal floods.

Economic Activities
Right Bank Bassac Focal Area, Cambodia

Indicator	*Unit*	*Koh Andet*	*Koh Thom*
Economically active popn.	No.	11,138	31,167
Proportion 18-60 years	%	43.8	39.6
Rice farming	%	85.0	52.0
Fishery	%	0.1	7.9
Other agriculture	%	0.1	19.7
Employment-government	%	4.6	3.5
Employment-private	%	5.8	9.1
Trading & other services	%	4.3	7.8

Source: District Flood Vulnerability Baseline Database, Cambodia

8.3.8 Rural livelihoods

Agricultural production and rural livelihoods are significantly different in the two districts surveyed in the Right Bank Bassac focal area. The principal reasons for the differences include the topography and flood risks as well as the proximity to major urban areas. Different varieties of rice, the principal crop, are planted at different times in the upland and lowland portions of the floodplain in the focal area. Most farmers have plots in different areas.

(i) At the beginning of the wet season (May), a “heavy”/late variety of rice is planted in upland areas (above 5-m contour); strong, tall stalks remain above floodwater levels.

(ii) During the wet season, lowland areas are not cultivated. For example, there is no wet season rice in Leuk Dek commune or the lowland areas of other communes in the focal area.

(iii) At the end of the wet season (November), a dry-season recession rice crop is planted in lowland areas (3-5 masl). In Takeo, swamps in remote portions of lowland areas are being reclaimed to expand the area of recession rice crop.

Farmers employ various strategies to reduce risks to their rice crops due to abnormal floods and/or drought such as adapting sowing and transplanting dates to rain conditions and planting additional fast-maturing crops if conditions are favourable during the wet season. However, according to FG participants, many farmers in this focal area have stopped cultivating wet season rice, relying more on dry season crops: since the late 1990's in surveyed communes in Koh Andet, 30-40% of farmers have switched from producing wet and dry season crops to producing only dry season rice.

The partially-protected areas immediately adjacent to the Bassac River have a lower risk of serious floods; they also benefit from floods that deposit silt and cleanse the soils, improving the soil capacity of these areas. Good access to water and road transport networks and, particularly in the case of Koh Thom, proximity to urban markets has led to increased intensification and diversification of cash cropping in these areas. These crops have higher yields per area and higher market prices compared with rice.

The role of fishing activities in livelihoods varies across the focal area, based on information provided by FG participants. Whereas fishing is primarily to supplement household diets in Koh Andet, fishing plays an important role in the livelihoods of people in Koh Thom particularly minority Cham and Vietnamese communities. In fact, in Leuk Dek fishing is the sole source of income for many families during the flood season.

Fishing Activities Right Bank Bassac Focal Area, Cambodia		*Main Income Source*	*Household Consumption*
Pech Sar (Koh Andet)	▪ 2-month season	▪ 1% population ▪ 5-7 kg per day	▪ 30% population ▪ 1 kg per day
Rominh (Koh Andet)		▪ 20% population ▪ 7-10 kg per day	▪ 60% population ▪ 2 kg per day
Prek Thmey (Koh Thom)	▪ 7-month season	▪ 30% population (Cham & Vietnamese) ▪ 20 kg per day	▪ 5% population ▪ 1 kg per day
Leuk Dek (Koh Thom)	▪ 3-month season	▪ 80% population (Cham & Vietnamese) ▪ 7-10 kg per day	▪ 20% population ▪ 2 kg per day
Source: Focus group discussions, Cambodia			

Raising livestock is a more important aspect of rural livelihoods in Koh Andet compared with Koh Thom. Approximately 70% of households in Koh Andet raise cows and pigs. Each household has, on average, 3 pigs that are grown both to meet household consumption needs and to generate cash income from sales. In Koh Thom, less than 50% of households raise these animals. They also tend to have fewer animals per household. Nonetheless, throughout the focal area the importance of livestock means that many households will move their animals to higher ground to protect them from floodwaters.

Households in Koh Andet have paddy areas that are, on average, 60% greater than the area belonging to people in Koh Thom. Regardless of the area of paddy owned and the cropping patterns, the yields are similar in the two districts: the wet season crop produces 2.1-2.4 tons/ha while the recession crop yields 3.3-3.8 tons/ha. Due to the low yield levels, at least 50% of the crop is used to meet basic household consumption needs. Nonetheless, according to FG participants, many households experience rice shortages of 1-2 months in a normal flood; the duration of shortages may increase to 4-6 months in years with higher-than-normal flooding.

Agricultural Production / Income Right Bank Bassac Focal Area, Cambodia		Koh Andet			Koh Thom		
		Paddy Area	*Prod. Sold*	*Annual Income*	*Paddy Area*	*Prod. Sold*	*Annual Income*
		ha	*%*	*Riel million*	*ha*	*%*	*Riel million*
Overall	Average	2.4	45.2	4.5	1.5	48.1	5.9
By house type	Semi-Permanent	2.7	50.0	5.7	1.5	51.5	6.7
	Temporary	1.8	38.0	2.7	1.2	31.0	2.1
Source: Household surveys, Cambodia							

Based on data collected from surveyed households in the focal area, the average household income from all sources is 30% higher in the 4 communes in Koh Thom compared with Koh Andet. Moreover, in Koh Thom, the income ratio for people living in semi-permanent housing to those living in temporary housing is 3.2, compared with 2.7 for the same groups in Koh Andet. The higher income levels in Koh Thom reflect, among other factors, the value of cash cropping that is relatively more important than in Koh Andet, as well as greater opportunities for non-agricultural economic activities offered by access to transportation networks and urban centres.

The livelihoods of people living in the Right Bank Bassac focal area are highly vulnerable to the impacts of floods. Some of the key issues raised by FG participants include:

(i) In bad flood years, the wet season crop may be damaged or lost. Moreover, the planting of the recession crop may be delayed. Low yields are further reduced and there is increased risk of food shortages.

(ii) Households often borrow from family, friends and NGOs to have enough money to buy food. They also borrow to purchase inputs for their rice crops. Therefore, much of the crop is sold while still in the field or at harvest (when prices are low) because the proceeds are required to repay these loans.

(iii) The opportunities for fishing become critical, for example, in areas such as Leuk Dek commune where there is little or no wet season rice crop. Poor households that do not own a boat are particularly vulnerable. All fishers are vulnerable if, during a bad flood, there are high winds and waves that make fishing dangerous or not possible.

(iv) Due to the lack of food and money, poor people in particular increasing rely on “free” sources of food and income such as fishing, catching crabs and snails, collection of wild vegetables. This may be possible during a normal flood season if people have access to boats or other means to access natural resource areas, but it becomes difficult or not possible during bad flood seasons.

(v) Some households faced with food shortages will reduce the number of meals from three to two per day; women are more likely to go without food in order to feed their husbands and children. This has adverse consequences for the general health of women as well as their vulnerability to disease.

(vi) Distress sales of land and animals often occurs when households lose rice crops and require money for food, medical or other expenses. A common cause of people

becoming landless is the sale of land to pay for medical expenses. People will often sell animals prior to a flood (at significantly reduced prices) if they are worried they cannot protect their animals, find grass to feed them or pay for animal feed during the flood.

(vii) Many households must rely increasingly on selling their labour and other non-agricultural activities to supplement their incomes. This includes men and women who migrate, for example, to Phnom Penh to work at MOTORDOP drivers or food sellers. In some parts of the focal area, families are permanently migrating to other parts of the country because they cannot sustain their livelihoods.

(viii) The most vulnerable groups include a) women who head households because they lack male labour, b) landless people who rely on working as agricultural labour, c) poor households and d) households headed by elderly and disabled people who do not have young people in their households to help support them.

(ix) The cumulative impacts of flood losses are evident when there very bad floods (e.g., the 2000/2001 floods) or several above-normal floods within several years. Poor households in particular may have difficulty to recover from a single flood event – rebuilding housing, obtaining money to plant a new crop, repairing or replacing damaged assets, etc. A cycle of indebtedness is established with people repaying cash and in-kind loans often at high interest rates. As a result, they are more vulnerable in subsequent years even to the impacts of normal flooding.

8.3.9 Access to electricity, water and sanitation

In each of the two districts, there is one public system providing grid electricity and one public water supply system. In each district, similar proportions of households are connected to these systems: 4-4.5% of households in Koh Andet and 14-16% of households in Koh Thom. In general, these are the wealthier households and those that live in the district towns.

Power and Water Supply
Right Bank Bassac Focal Area, Cambodia

Indicator	*Unit*	*Koh Andet*	*Koh Thom*
Number of HH	No.	9,975	27,250
Public systems			
Grid electricity	% HH	4.4	16.1
Water supply	% HH	4.1	14.5
Electricity - other sources	% HH	61.0	73.1
No electricity	% HH	34.5	10.8

Source: District Flood Vulnerability Baseline Database, Cambodia

The majority of households obtain electricity from sources such as diesel generators or car batteries; water comes from a mixture of wells, rivers and rainwater collection. However, more than one-third of households in Koh Andet have no electricity, compared with 11% in Koh Thom. Many households do not have latrines; they defecate in fields and other open spaces. The implications for the assessment of social vulnerability to flooding include the following:

(i) Due to inadequate supplies of safe drinking water and, particularly, poor sanitation conditions (defecation in the open and in paddy fields), there is a high risk of diarrhoea and dysentery.

(ii) The lack of firewood (flooded forests, flooded roads that make forest areas inaccessible) means that people are often unable to boil water to make it safer to drink.

(iii) Bathing and washing clothes in flood waters increases the incidence of skin rashes and infections due to contamination of the water.

8.3.10 Access to health care

Access to Health Care Right Bank Bassac Focal Area, Cambodia			
Indicator	*Unit*	*Koh Andet*	*Koh Thom*
No. of HH	No.	9,975	27,250
No. of communes	No.	6	11
Hospital	No.	4	1
Number of beds	No.	36	80
HH per hospital bed	ratio	277	341
Health clinics	No.	5	11
HH per clinic	ratio	1,995	2,477
Dispensaries	No.	4	30
HH per clinic	ratio	2,494	908
Source: District Flood Vulnerability Baseline Database, Cambodia			

According to data provided by district health authorities, the health care facilities available to people living in the focal area are limited. Based on population, there is one hospital bed for every 275-340 households. On average, each clinic serves between 2,000 and 2,500 households; dispensaries serve from 900 to 2,500 households each.

People are vulnerable during floods for the following reasons:

(i) In the event of serious injuries or disease associated with floods, the health care facilities may not be sufficient to meet the needs of people living in the focal area.

(ii) In the absence of adequate health care facilities, they tend to rely on buying drugs from petty traders who do not have any medical knowledge, or going to traditional healers and monks for help and advice.

(iii) The impacts are greatest on children and women. Children are easily injured or get sick because they drink unsafe floodwaters. Women, as noted, are most likely to forego meals if the household is experiencing a food shortage, thus reducing their overall health status. They also are unable to obtain reproductive health services during flood periods.

(iv) Due to the lack of adequate health care and/or the need to travel to obtain health care, there is a higher risk of extraordinary health care costs that strain the resources of households, particularly poor households. This may lead to distress sales and increased landlessness.

8.3.11 Flood preparedness, emergency response and recovery

Throughout the focal area, there are no plans or strategies that have been prepared for flood warning or preparedness. Flood warnings consist of notices issued by provincial governments

through district authorities, commune councils and/or village chiefs. Radio and TV are also used to warn people about flood conditions.

Similarly, there are no plans/strategies for emergency response or flood recovery. Provincial governors, the Cambodian Red Cross and other NGOs provide some assistance, as well as local pagodas and monks. In general, communities have to rely on traditional methods of restoring and reconstructing rice fields, dykes and drainage channels. The key weaknesses pointed out by FG participants include:

(i) Lack of financial resources and technical expertise.

(ii) Lack of organized, coordinated responses during and after flood emergencies.

(iii) Lack of transparency and accountability in assistance programs.

(iv) Focus on short-term relief without sufficient attention to long-term, sustainable strategies to assist communities.

(v) Poor households are unable to participate or take appropriate actions to restore livelihoods and living conditions because they lack labour as well as funds.

8.4 Cambodia, Left Bank Mekong Focal Area, Prey Veng Province

The Left Bank Mekong focal area is located in Prey Veng Province. On the left bank of the Mekong River, it extends from Highway No. 1 to the Cambodia-Vietnam border; the eastern border is the Prek Kampong Chrey River. This focal area is essentially flat, with elevations ranging from 2-5 masl. Therefore, annually it is flooded usually by the end of July, with flood conditions last about 30 days. The movement of flood waters across this region is complex, but results in significant overland flooding emanating from two river branches: (i) the Prek Veal Robang located approximately 5 km east of the Mekong and (ii) the Prek Kampong Trabek located about 30 km farther east. Between the two rivers, the elevation rises above 5 m (asl), creating an area of shallow flooding. However, along the Cambodia-Vietnam border, low-lying areas join together to form another deep-flooded area.

In deep-flooded portions of the focal area, people generally cultivate a single, recession rice crop. In areas with both deep and shallow (or no) flood conditions, such as Kampong Trabek district, a large area of rainfed rice is planted at the beginning of the wet season. A second, smaller recession crop is planted in the areas close to the Prek Kampong Trabek.

The overall objectives for alternative structural measures being considered for the focal area are (i) to delay the onset of early flooding in deep-flooded areas so that farmers can plant an early rice crop as well as the recession crop; and, (ii) minimize the impacts of maximum floods in the deep-flood areas. In relation to this, the demonstration project is intended to provide better protection for people and property from flood damages, improve road and canal transport networks and provide supplemental irrigation to reduce the risks of drought in the region.

The social survey was conducted in two communes in Kampong Trabek district. The commune of Cham is located immediately adjacent to the Cambodia-Vietnam border and represents an area of deep flooding in the district. The commune of Kampong Trabek is located along the Prek Kampong Trabek; it combines areas of shallow flooding along the natural levees and deeper flooding conditions.

8.4.1 What constitute good and bad floods?

In recent years, there have been no major flood protection measures implemented in this focal area. Following the 2000 flood, about 50% of households in Cham spent, on average, Riel 400,000 per household (US$100) to raise the level of their house sites; wealthy families in Kampong Trabek spent as much as Riel 1,000,000 for similar activities. In 2005, CARE funded a programme to assist poor households in Kampong Trabek to establish safe areas near their houses. In both communes, local authorities and villagers collaborated to reserve and/or repair safety areas to be used by people and their animals in the event of flood. In both areas of the district, there is a general consensus about what constitute good and bad floods.

Flood Characteristics Left Bank Mekong Focal Area, Cambodia	
Good Flood / Flood Benefits	**Bad Flood / Flood Damages**
▪ The flood levels rise slowly starting in the middle of August or early September. ▪ The water level reaches 0.6 in Kampong Trabek and 0.8–1.0 m in Cham. The water level is suitable for the rice crop. ▪ The water level recedes quickly so that it does not damage or rot the rice. ▪ Flood waters deposit silt that increases productivity in subsequent years (25%). ▪ Floods increase fish production by providing habitat and nutrition; the bigger the flood, the bigger the catch. ▪ Floods are natural means of removing rats and other pests from fields. ▪ There are no strong winds or large waves so that people can safely fish, collect wild vegetables, cut grass to feed animals and carry out other activities without danger or difficulty. ▪ Fruit trees, other trees and perennials are not damaged. ▪ Water quality remains good and clear and there is no smell because water does not stagnate and water levels recede quickly.	Deep, long flood ▪ Flood waters rise early (e.g., mid-July), quickly and remain for 2 months or longer. For example, during the 2000 floods the water levels rose 1.5 - 2 m starting in July and remained for 3 months. ▪ The duration and depth of the flood leads to poor water quality (stench; skin diseases) and increased incidence of water-borne disease (diarrhoea and dysentery). ▪ The depth and duration of the flood reduces dry places for livestock and grazing fields. ▪ Strong winds / wave make it dangerous to travel by boat or go fishing; storms / lightning increase risks of death or injury for people. Lower-than-normal, fluctuating flood ▪ 2007 is cited as a bad flood because the water depth was not sufficient to bring fish, kill rats or prevent drought conditions in shallow-flood areas. ▪ The water level rose and fell several times causing delays for the dry season rice cultivation.
In Kampong Trabek, a normal flood of 0.6 m will incur the following damages depending on the date of onset: ▪ Mid-June: 100% ▪ Mid-July: 40% ▪ Mid-August: 20% ▪ Mid-September: 0% ▪ Mid-October: 0% ▪ Mid-November: 10% Late floods in October/November can also delay planting of the dry season crop.	In Kampong Trabek, a bed flood will incur the following damages depending on the date of onset: ▪ Mid-June: 100% ▪ Mid-July: 100% ▪ Mid-August: 20% ▪ Mid-September: 0% ▪ Mid-October: 10% ▪ Mid-November: 30% Late floods in October/November can also delay planting of the dry season crop.
In Cham, a normal flood of 0.8-1 m will incur the following damages depending on the date of onset: ▪ Mid-June: 100%	In Cham, a bad flood will incur the following damages depending on the date of onset: ▪ Mid-June: 100% ▪ Mid-July: 100%

Flood Characteristics Left Bank Mekong Focal Area, Cambodia	
Good Flood / Flood Benefits	**Bad Flood / Flood Damages**
▪ Mid-July: 30% ▪ Mid-August: 10% ▪ Mid-September: 0% ▪ Mid-October: 0% ▪ Mid-November: 50% Late floods in October/November can also delay planting of the dry season crop.	▪ Mid-August: 70% ▪ Mid-September: 50% ▪ Mid-October: 50% ▪ Mid-November: 100% Late floods in October/November can also delay planting of the dry season crop.
Source: Focus groups, Cambodia	

8.4.2 Community characteristics

More than 125,000 people live in Kampong Trabek district. The population density varies from 140 p/km^2 to 300 p/km^2 across the 13 communes; the target communes for social surveys have densities of about 250 p/km^2. Nearly everyone in the district is Khmer, although there are a few Cham and Vietnamese households.

Community Characteristics Left Bank Mekong Focal Area, Cambodia		
Indicator	*Unit*	*Kampong Trabek*
Population	No.	125,638
Number of HH	No.	26,332
Ethnicity		
Khmer	%	99.5
Cham	%	0.4
Vietnamese	%	0.1
Poor population	%	8.4
Popn growth, 2001-2006	%	1.8
Source: District Flood Vulnerability Baseline Database, Cambodia		

The poverty level in the district is low (8.4%), compared to regional levels (about 30%) and the levels in the Right Bank Bassac focal area (23-30%). According to 1998 census data, poor households are distributed more or less evenly across different communes. From the perspective of social vulnerability to flooding:

(i) The social and cultural homogeneity of the population increases resilience to flooding in that it supports social and community networks.

8.4.3 Household Characteristics

Households in the focal area have, on average, 4.8 persons. The majority of households (82%) are headed by men, although nearly 18% are headed by women. Women outnumber men in the population. Therefore, although the proportion of female-headed households is well below the national average (25%), there may be situations in the district where women become *de facto* heads of households when their husbands out-migrate for long periods looking for work. The proportion of children under the age of 15 years is extremely high at 40%. As a consequence, there is a high dependency ratio in the focal area where each working adult works to provide for one dependent person as well as his own needs.

Community Characteristics Left Bank Mekong Focal Area, Cambodia			
Indicator		*Unit*	*Kampong Trabek*
HH size (average)		Pers.	4.8
HH head	Male	%	82.3
	Female	%	17.7
Male/female ratio			0.90
Children < 17 years		%	40.3
Dependency ratio		ratio	0.88
Source: District Flood Vulnerability Baseline Database, Cambodia			

(i) Poverty tends to be higher among female-headed households, making them more vulnerable to the adverse impacts of flooding. For example, there may be a higher risk among female-headed households of distress sales of land or other assets to pay for food, medical care or house rebuilding after a flood.

(ii) The large proportion of children in the focal area tends to increase vulnerability to the impacts of flooding. Children are often at risk of physical injury and drowning during floods. They may be more susceptible to becoming sick, for instance, if there is no safe drinking water or proper sanitation during floods. If flooding damages schools, children's education will be disrupted. Moreover, the high dependency ratio places extra burdens on parents and other adults to provide for children's needs for food, shelter, etc.

8.4.4 Land uses and tenure

Nearly the entire area of Kampong Trabek district is allocated to agricultural uses, primarily rice paddy. A small portion of the district (0.5% of the area) is used for residential development. According to data provided by district authorities, there is a high rate of registered title to agricultural land although only about half of the district households have title or legal documents for residential land. The proportion of households without any agricultural land is nearly 5%.

Land Uses Left Bank Mekong Focal Area, Cambodia		
Indicator	*Unit*	*Kampong Trabek*
District area	ha	31,549
Rice land (dry season)	%	21.8
Rice land (wet season)	%	77.6
Orchard land	%	0.1
Residential	%	0.5
Source: District Flood Vulnerability Baseline Database, Cambodia		

In terms of social vulnerability to flooding, the following are the risks in this focal area:

(i) The reliance of livelihoods on agricultural land increases the direct and indirect costs of flooding. Household expenditures for food and other basic needs will increase if people are unable to cultivate rice or vegetables in riverbank gardens; incomes decrease from the loss of crop sales.

(ii) Secure tenure for agricultural land is a major asset, providing collateral to obtain loans to rehabilitate property damaged during a flood, finance agricultural inputs or meet other household needs (e.g., health care).

(iii) People without productive land are at risk during a flood because, in most instances, they work as agricultural labour on other people's land. They lose this source of income if land is inundated for extended periods and/or the rice crop is damaged or destroyed. As they are generally poor, they have few alternative resources to meet basic or flood-induced needs (e.g., health care).

8.4.5 Housing and other structures

Housing and Other Structures Left Bank Mekong Focal Area, Cambodia		
Indicator	*Unit*	*Kampong Trabek*
Structures – total	No.	24,180
Residential - % total	%	99.8
Permanent	%	0.4
semi-permanent	%	59.1
Temporary	%	40.5
Commercial - % total	%	0.1
semi-permanent	%	100.0
Institution - % total	%	0.1
semi-permanent	%	100.0
Source: District Flood Vulnerability Baseline Database, Cambodia		

Residential structures account for nearly all main structures in the district; commercial and institutional structures account each for 0.1%. Residential and commercial structures are owned by the households and/or businesses.

The majority of structures in the district are of semi-permanent construction. This includes 60% of residential structures and all commercial and institutional structures. A semi-permanent house is, generally, wood construction raised on wood stilts or concrete poles. However, 40% of houses are temporary structures, usually made of a combination of wood, bamboo and thatch and often not raised above the ground.

People living in the district own a large number of small agricultural and other buildings such as rice huts, animals shed, toilets and kitchens. More than 80% of these structures are temporary; the remaining ones are semi-permanent.

In Kampong Trabek, the average size of houses is similar for both semi-permanent and temporary construction. However, the value of the former is estimated by survey respondents to be 5-6 times higher than temporary structures.
During a normal flood, most people living in this focal area will not relocate to safe areas. However, they employ some traditional coping measures to protect their houses, commercial structures and other property against flood damage:

House Area & Value Left Bank Mekong Focal Area, Cambodia		% HH	Area m^2	Value Riel million
Overall	Average		49	6.0
By house type	Semi-Permanent	74.4	50	7.6
	Temporary	25.6	48	1.3
Source: Household surveys				

(i) Households build on higher ground if it is available and away from rivers, streams and other water courses. If higher ground is not available, they will often raise the level of house sites with earth or rubble.

(ii) The traditional house is wood frame built on stilts. The stilts are wood or concrete columns, the latter being naturally water resistant. Prior to floods, households will increase the strength of house struts and bracing timbers.

(iii) Shops and markets are generally located on higher ground in designated safe areas or, in Kampong Trabek, on the embankment of NR No. 1.

The implications for assessing the vulnerability of households and communities to flood damages are as follows:

(i) The sitting of shops, houses and traditional construction techniques reduce the risks of flood damages. Poor people, however, tend to live in housing that is temporary structures built on the ground. They are highly vulnerable to having their structures damaged or swept away during floods.

(ii) Small, temporary agricultural buildings are highly vulnerable to damage or loss, depriving people of places to store rice or the use of kitchens or latrines.

8.4.6 Household assets

More than two-thirds of households in the focal area rely on bicycles as their primary mode of transport. Just over 20% over motorbikes, but very few households have a car or truck. In addition, only a small proportion (3-4%) owns a boat, either a small, non-motorized boat or a larger boat. There is also a low ownership of other productive assets. The implications for people's vulnerability during floods include:

Household Assets Left Bank Mekong Focal Area, Cambodia		
Indicator	*Unit*	*Kampong Trabek*
Number of HH	No.	26,332
Bicycle (1 or more)	%	67.5
Motorbike (1 or more)	%	21.4
Car /truck	%	0.8
Small boat (w/o engine)	%	2.9
Large boat (w/ engine)	%	0.9
Hand tractor	%	3.7
Cart	%	8.8
Rice mill	%	1.8
Source: District Flood Vulnerability Baseline Database, Cambodia		

(i) The low rate of ownership of boats decreases the options of households for alternative transport during floods (to get to markets, clinics, etc.). It also limits fishing activities to places that people can access on foot.

(ii) The community is more vulnerable because there are not craft available to respond to emergencies.

8.4.7 Economic activities

The majority (79%) of economically active people in the focal area are engaged in rice farming. Most of the remainder (14%) are employees in private sector businesses.

The implications in an assessment of social vulnerability to flooding are:

Occupations/Economic Activities Left Bank Mekong Focal Area, Cambodia		
Indicator	*Unit*	*Kampong Trabek*
Econ. active (18-60 yrs)	No.	31,653
Rice farming	%	79.3
Fishery	%	0.3
Employee-government	%	2.8
Employee-private sector	%	14.0
Trading & other services	%	3.6
Source: District Flood Vulnerability Baseline Database, Cambodia		

(i) Vulnerability to economic losses due to flooding is directly related to the high proportion of people engaged in agricultural activities.

8.4.8 Rural Livelihoods

Rice cultivation is the basis of livelihoods in the focal area. The cropping patterns vary between shallow-flooded and deep-flooded areas, as reported by FG participants:

(i) In Kampong Trabek, a shallow-flooded area that combines large upland areas with lowland areas, farmers with upland paddy cultivate a late wet-season rice crop; the tall, strong stalks grow above and can withstand the floodwaters. In lowland areas, farmers plant a recession rice crop starting at the beginning of the dry season.

(ii) In Cham, a deep-flooded area, farmers with upland paddy plant early and ordinary varieties of wet-season rice. Farmers in lowland areas cultivate late wet-season and recession rice crops.

Nonetheless, throughout the focal area farmers are increasingly changing from planting wet season crops to cultivating only dry season rice. Raising livestock, particularly cows, is the second most important component of livelihoods in the focal area. Due to the value of these animals, people will move them to safe areas during floods; they will also try to stock cut grass and other feed to provide for the period during which grazing lands are flooded.

Fishing is a main income source only for the small proportion of Cham living in the focal area; in Cham communities, up to 90% of households rely on the income from catching fish and making and selling Prahoc (fish paste). During the flood season, however, more households depend on fishing in paddy fields and streams to supplement household consumption needs.

The average area of paddy land in the focal area is 1.6 ha per household. In general, the paddy area owned by people in this focal area and particularly those living in temporary housing structures is below the level of 2 ha per household that most FG participants consider necessary to be self-sufficient. The average yields are also low: 1.2 ton/ha for wet season crops and 2.3 ton/ha for dry season crops.

Agricultural Production / Income Left Bank Mekong Focal Area, Cambodia		*Paddy Area*	*Prod. Sold*	*Annual Income*
		ha	*%*	*Riel million*
Overall	Average	1.6	59.5	5.3
By house type	Semi-Permanent	1.8	63.1	5.9
	Temporary	0.9	48.9	3.4
Source: Household Surveys				

Households in the focal area balance their needs for rice to feed their families with the sale of rice. In a normal flood year, some households will have rice shortages; for example, in Cham it is estimated that 40% of households do not have sufficient rice for up to 2 months per year. In a bad flood year, however, the proportion of affected households can rise to 90% and the duration of rice shortages to 6-8 months.

On average, 60% of the crop is sold while still in the field or at harvest to repay loans that were taken out to purchase agricultural inputs for the crop, or to buy food and pay medical expenses. Poorer households living in temporary structures, on average, are able to sell less than half of their crop. This generates less cash income for these households and increases their risk of a continuing cycle of indebtedness. This is reflected in the average household income (from all sources); poor households have incomes that are 30% below the average.

The livelihoods of people living in the Left Bank Mekong focal area are highly vulnerable to the impacts of floods. Some of the key issues raised by FG participants include:

(i) In bad flood years, the wet season crop may be damaged or lost. Moreover, the planting of the recession crop may be delayed. Low yields are further reduced and there is increased risk of food shortages.

(ii) Households often borrow from family, friends and NGOs to have enough money to buy food. They also borrow to purchase inputs for their rice crops. Therefore, much of the

crop is sold while still in the field or at harvest (when prices are low) because the proceeds are required to repay these loans.

(iii) The opportunities for fishing become critical, for example, in areas such as Kampong Trabek where there is little or no wet season rice crop. Poor households that do not own a boat are particularly vulnerable. All fishers are vulnerable if, during a bad flood, there are high winds and waves that make fishing dangerous or not possible.

(iv) Due to the lack of food and money, poor people in particular increasing rely on "free" sources of food and income such as fishing, catching crabs and snails, collection of wild vegetables, etc. This may be possible during a normal flood season if people have access to boats or other means to access natural resource areas, but it becomes difficult or not possible during bad flood seasons.

(v) Some households faced with food shortages will reduce the number of meals from three to two per day; women are more likely to go without food in order to feed their husbands and children. This has adverse consequences for the general health of women as well as their vulnerability to disease.

(vi) Distress sales of land and animals often occurs when households lose rice crops and require money for food, medical or other expenses. A common cause of people becoming landless is the sale of land to pay for medical expenses. People will often sell animals prior to a flood (at significantly reduced prices) if they are worried they cannot protect their animals, find grass to feed them or pay for animal feed during the flood.

(vii) Many households must rely increasingly on selling their labour and other non-agricultural activities to supplement their incomes. This includes men and women who migrate, for example, to Phnom Penh to work at Motodop drivers or food sellers. In some parts of the focal area, families are permanently migrating to other parts of the country because they cannot sustain their livelihoods.

(viii) The most vulnerable groups include a) female household heads with many children because they lack labour, b) households with chronically ill members (e.g., people living with HIV/AIDS), c) landless people who rely on working as agricultural labour, d) poor households and e) households headed by elderly and disabled people who do not have young people in their households to help support them.

(ix) The cumulative impacts of flood losses are evident when there very bad floods (e.g., the 2000/2001 floods) or several above-normal floods within several years. Poor households in particular may have difficulty to recover from a single flood event – rebuilding housing, obtaining money to plant a new crop, repairing or replacing damaged assets, etc. A cycle of indebtedness is established with people repaying cash and in-kind loans often at high interest rates. As a result, they are more vulnerable in subsequent years even to the impacts of normal flooding.

8.4.9 Access to electricity, water and sanitation

Approximately 4% of households in the focal area are connected to the public electricity grid. About 19% have no electricity. The remaining households generate electricity from diesel generators and car batteries, or rely on kerosene and other fuels for lighting.

There are no public water supply or wastewater systems in the focal area. Households rely on public and private wells, rivers and streams and rainwater collection to provide water for drinking, cooking and other household purposes. Some wealthier households (7.5% all households) have latrines; everyone else uses paddy fields and other natural areas for sanitation purposes. The implications for the assessment of social vulnerability to flooding include the following:

(i) There are significant changes in water quality reported during flood periods. Due to inadequate supplies of safe drinking water and, particularly, poor sanitation conditions (defecation in the open and in paddy fields), there is a high risk of diarrhoea and dysentery.

(ii) The lack of firewood (flooded forests, flooded roads that make forest areas inaccessible) means that people are often unable to boil water to make it safer to drink.

(iii) Bathing and washing clothes in flood waters increases the incidence of skin rashes and infections due to contamination of the water.

8.4.10 Access to health care

In Kampong Trabek district, there is one district hospital (80 beds, or 1 bed per 1,570 people). There are 11 health clinics serving 13 communes (1 clinic per 2,400 households); and, a total of 30 dispensaries (1 dispensary per 875 households). Health problems reported by FG participants during flood seasons include: skin diseases; typhoid (Riel 400,000 for treatment); dengue fever (Riel 3,000,000 for treatment); and, particularly among children, diarrhoea (Riel 150,000 for treatment). People are vulnerable during floods for the following reasons:

(i) In the event of serious injuries or disease associated with floods, the health care facilities are not sufficient to meet the needs of people living in the focal area.

(ii) In the absence of adequate health care facilities, they tend to rely on buying drugs from petty traders who do not have any medical knowledge, or going to traditional healers and monks for help and advice.

(iii) The impacts are greatest on children and women. Children are easily injured or get sick because they drink unsafe floodwaters. Women, as noted, are most likely to forego meals if the household is experiencing a food shortage, thus reducing their overall health status. They also are unable to obtain reproductive health services during flood periods.

(iv) Due to the lack of adequate health care and/or the need to travel to obtain health care, there is a higher risk of extraordinary health care costs that strain the resources of households, particularly poor households. This may lead to distress sales and increased landlessness.

8.4.11 Flood preparedness, emergency response and recovery

According to FG participants, there are no specific plans for flood warning/ preparedness, emergency response or recovery. Nonetheless, there are a number of initiatives that assist people and communities in the focal area.

The Provincial Government works with districts, commune councils and village chiefs to notify and warn people about flood levels; and, issue warnings on radio and TV. Commune councils, in particular, play an important role by advising village chiefs at least a month prior to the expected flood so that they can take steps such as evacuating people and animals to safe areas; commune councils also work with village chiefs to ensure accurate reporting of flood damages and relief requirements. Commune/Village Committees for Disaster Management have been established although they are not fully effective due to lack of financial and technical support.

The Provincial Government collabourates with (and relies heavily on) the Cambodian Red Cross (CRC), CARE and other NGOs to deal with the requirements of emergency response and flood recovery:

(i) The CRC fields volunteers in many communities to build capacity at the village level for activities such as flood warnings, evacuation, relief and rescue. During floods, the CRC targets poor households by providing food, health supplies and services, water and other basic necessities. CRC also works with village chiefs to assist households with new seed, rice and tents while they rebuild damaged structures.

(ii) CARE also targets poor households in the focal area. As part of emergency response, they provide motorized boats, water pumps, temporary wells and other agricultural materials.

(iii) CRC and CARE also provide funds for long-term rebuilding, for example, to raise and improve the construction of houses, establish safety areas and construct wells and latrines to improve water supply and sanitation conditions.

Various NGOs have developed small lending/micro-credit programs for agricultural production, although they often have very limited coverage. Notwithstanding these efforts, FG participants point out some weaknesses including: (i) a lack of transparency and accountability in terms of who benefits from initiatives and (ii) low participation by poor households because they lack labour and funds.

8.5 Vietnam, Left Bank Mekong focal area, Dong Thap province

In Vietnam, the Left Bank Mekong or Plain of Reeds (POR) focal area encompasses the wetlands of the upper Mekong floodplain including portions of the provinces of Dong Thap, Tien Giang and Long An. The Mekong River forms the western and southern boundaries of the area; the Vietnam-Cambodia border defines the northern boundary. To the east, the focal area extends to the Vam Co Tay River and the Cho Gao canal. The Plain of Reeds is referred to as the “closed” section of the upper floodplain because it is a deep-flooded area (floods up to a depth of 3 m) and drainage of floodwaters is slow and difficult.

The inundation of the Plain of Reeds comes from the Mekong River and overland flooding from Cambodia; the flood season generally lasts 3.5-5 months, with depths of 0.5-4 m. There are three flood periods: (i) the early flood (July to August) when overland flows from the Mekong flood paddy fields and deposit silt; (ii) the main flood which combines high water from the river and overland flooding from Cambodia; and, (iii) the receding flood period (late October to December) when overland floods from Cambodia diminish. There are generally two peaks in the

flood season: a first peak in August and a second, higher peak in late September or early October.

Rice cultivation is the major economic activity in the Plain of Reeds; farmers generally cultivate two crops per year. Due to the high risk of flooding, the Government is investing in a major programme to relocate people to designated areas where the elevation of ground has been raised. A demonstration project in the focal area would have as its primary objective expanding the opportunities for a third rice crop through combined flood control, drainage and irrigation.

The social surveys were conducted in two districts (4 communes) in Dong Thap Province. Tan Hong district is located adjacent to the Vietnam-Cambodia border; Tam Nong is located immediately south of Tan Hong district. Within each district, surveys and focus groups discussions were conducted in two communes. The following summarizes the flood conditions in these communes.

Commune Flood Characteristics
Left Bank Mekong Focal Area, Vietnam

District	*Commune*	*Flood Depth (cm)*	*Flood Duration*
Tan Hong	Tan Cong Chi	30-60	Aug-Nov
	Thong Binh	60-100	Aug-Dec
Tam Nong	Phu Thanh A	60-150	Aug-Dec
	Phu Cuong	60->150	Aug-Dec

Source: Vietnam National Report Appendices

8.5.1 Flood protection measures

A number of flood protection measures have been taken in the target communes and districts in the focal area, as summarized below.

Flood Protection Measures
Left Bank Mekong Focal Area, Vietnam

District	*Commune / Measures*
Tan Hong	Thong Binh Commune ▪ Flood protection embankments (1 m) to protect 1,745 ha against flooding in August; will protect up to 4 m water level at Tan Chau. ▪ Flood protection embankments to protect 205 ha in Choi Moi hamlet (55% total) ▪ Flood-free areas for 1,405 HH in deep-flooded areas (45% total) ▪ Raised 3 rural roads → If flood reaches 2000 levels, only 30% HH affected
	Tan Cong Chi Commune ▪ Flood protection embankments (1-2 m) to protect rice against August flooding; will protect up to 4.6 m water level at Tan Chau ▪ Flood protection embankments (elevation 5.9 m) to protect 1,500 ha of 3-crop areas ▪ 3 flood-free areas for 1,897 HH from deep-flooded areas ▪ Raised rural roads above 2000 flood levels

Flood Protection Measures Left Bank Mekong Focal Area, Vietnam	
District	*Commune / Measures*
Tam Nong	Phu Cuong Commune ▪ Flood protection embankments (1.2 m above paddy) to protect 4,581 ha against flooding in August ▪ 3 flood-free areas for 520 HH from deep-flooded areas ▪ Raise roads above 2000 flood levels
	Phu Thanh A Commune ▪ 21.5 km flood protection embankment to protect 1,324 ha against flooding in August; will protect up to 4.5 m at Tan Chau ▪ 1 flood-free area for 142 HH from deep-flooded areas ▪ Raised roads above 2000 flood levels and surface with concrete
Source: Focus Group Discussions, Vietnam	

8.5.2 What constitutes good and bad floods?

Throughout the focal area, FG participants classify a good flood as one that brings the normal flood levels that are conducive to the growth of the SA rice crop, as well as more fish. A bad flood is one that comes too soon, for example, before August, one that results in higher-than-normal water levels and/or lasts longer than normal. The benefits and damages associated with good and bad floods are similar across the focal area. The following table summarizes and the degree of damage depending on the date of onset of the flood.

Flood Characteristics Left Bank Mekong Focal Area, Vietnam			
Dist.	*Commune*	*Flood Benefits*	*Flood Damages*
All	All	▪ Floods provide fertility and sediment for rice fields ▪ Lower costs for rice production and higher yields following big flood years: costs lower by 10-25%; yield up by 5-15%. ▪ Floodwaters clean toxic matter and disease germs from soils ▪ Floods increase fish levels: ▪ People benefit from catching fish to supplement diet/make money; benefit greater in big flood year ▪ Natural fish used to feed fish in cages, nets in paddy ▪ Water quality better in big flood	▪ Damage to SA rice crop if flood is high and/or early ▪ Reduction 50% in business activities ▪ Inundation of houses and structures ▪ Increased risk of intestinal and other diseases/personal safety ▪ Poor households are most vulnerable: limited funds to take protection measures

Flood Characteristics Left Bank Mekong Focal Area, Vietnam			
Level of Flood Damages			
Tan Hong	Thong Binh	NORMAL flood: damages depending on date of flood: ▪ 0% regardless of date of onset due to existing flood protection measures	BIG flood: damages depending on date of flood: ▪ Mid-June: 50% ▪ Mid-July: 100% ▪ Mid-August – Mid-October: 0%
	Tan Cong Chi		BIG flood: damages depending on date of flood: ▪ Mid-June: 100% ▪ Mid-July: 40% ▪ Mid-August – Mid-October: 0%
Tam Nong	Phu Cuong		BIG flood: damages depending on date of flood: ▪ Mid-June: 100% ▪ Mid-July: 30-40% ▪ Mid-August – Mid-October: 0%
	Phu Thanh A		BIG flood: damages depending on date of flood: ▪ Mid-June: 100% Mid-July – Mid-October: 0%
Source: Focus Group Discussions, Vietnam			

8.5.3 Community Characteristics

The characteristics of communities in the two districts surveyed in this focal area are similar in terms of total population, number of households and proportion of households that live below the poverty line. Although data are not available on the ethnic composition of Tan Hong, it can be assumed that the majority of people are Kinh Vietnamese; the proportion of ethnic Khmer may be higher than in Tam Nong due to the close proximity to Cambodia. The ethnic and poverty conditions reduce the social vulnerability of these communities for the following reasons:

Community Characteristics Left Bank Mekong Focal Area, Vietnam				
Indicator		*Unit*	*Tam Nong*	*Tan Hong*
Population		No.	99,047	86,137
Number of HH		No.	22,937	21,246
Ethnicity	Kinh	%	99.9	n/a
	Khmer	%	0.02	n/a
	Hoa	%	0.02	n/a
Poor HH		%	14.2	15.0
Popn growth, 2001-2006		%	0.8	2.1
Source: Flood Vulnerability Database, Vietnam				

(i) These communities are culturally and linguistically homogenous. This contributes to effective social and community networks that are an important asset in dealing with flooding planning, response and recovery on an individual, household and community basis.

(ii) The relatively low levels of poverty mean that, in general, households are less vulnerable to harm caused by flooding and other natural disasters. People live in substantial

housing, have livelihoods, assets and incomes that meet (or exceed) basic household needs, have better levels of health and education and other characteristics that enable them to protect themselves from flood damage and/or to recover more easily following flooding.

8.5.4 Household Characteristics

Although the available data are incomplete, it is likely that household characteristics are similar in both districts. The household size is relatively small (about 4 person) and women head one-quarter or more of the households. However, the proportion of children is low and, therefore, there are low dependency ratios. The consequences regarding vulnerability to flooding include:

Household Characteristics
Left Bank Mekong Focal Area, Vietnam

Indicator		*Unit*	*Tam Nong*	*Tan Hong*
HH size (average)		Pers.	4.32	4.05
HH head	Male	%	n/a	71.4
	Female	%	n/a	28.6
Male/female ratio			0.95	0.93
Children < 15 years		%	23.3	n/a
Dependency ratio			0.66	n/a

Source: Flood Vulnerability Database, Vietnam

(i) The proportion of female-headed households is similar to the national average, and tends to indicate a higher risk of poverty compared with male-headed households. In addition, if there is a shortage of adult males in these households, women will be more vulnerable because they lack labour.

(ii) The low proportion of children and low dependency ratios will decrease vulnerability of households. Children are frequently most at risk, for example, drowning in floodwaters or becoming sick from drinking and/or exposure to contaminated water.

8.5.5 Land Use and Tenure

The largest land use in each district in the focal area is irrigated rice land. Irrigated paddy and other productive land account for nearly 90% of the areas of these districts. Tan Hong has more developed areas and less commune reserve land compared with Tam Nong.

Land Uses
Left Bank Mekong Focal Area, Vietnam

Indicator	*Unit*	*Tam Nong*	*Tan Hong*
Rice land (irrigated)	%	68.8	84.5
Crop land	%	0.3	0.3
Plantation land	%	1.5	0.9
Aquaculture	%	-	0.6
Rural residential (garden)	%	1.4	3.4
Urban residential	%	0.1	0.3
Commercial/industrial	%	0.03	0.1
Institutional	%	0.1	0.1
Forest	%	16.2	0.4

Land Uses Left Bank Mekong Focal Area, Vietnam			
Indicator	*Unit*	*Tam Nong*	*Tan Hong*
Military land	%	-	4.3
Religious / cemetery	%	-	0.1
Commune reserve land	%	11.7	5.2
Source: Flood Vulnerability Database, Vietnam			

In Vietnam, in general, there is widespread implementation of the system of land use rights certificates (LURC) for productive and residential land. Nonetheless, according to data provided by district authorities, only 65% of households in Tam Nong and 82% in Tan Hong have LURC for their agricultural land. The proportion of households with LURC for residential land is higher, at 95-99%. The implications for social vulnerability to flooding include:

(i) The reliance of livelihoods on agricultural land increases the direct and indirect costs of flooding. Household expenditures for food and other basic needs will increase if people are unable to cultivate rice paddy or vegetables in riverbank gardens; incomes decrease from the loss of crop sales.

(ii) The lack of secure tenure for agricultural land is a source of vulnerability in that flood-affected households have limited collateral to obtain loans to rehabilitate property damaged during a flood, finance agricultural inputs or meet other household needs (e.g., health care).

(iii) People without productive land are at risk during a flood because, in most instances, they work as agricultural labour on other people's land. They lose this source of income if land is inundated for extended periods and/or the rice crop is damaged or destroyed. As they are generally poor, they have few alternative resources to meet basic or flood-induced needs (e.g., health care).

8.5.6 Houses and other structures

The range of data from Tan Hong is limited; however, the characteristics of housing and other structures may be assumed to be similar to those in Tam Nong. The majority of structure types are housing (80%) and shops and other commercial structures (17%). Industrial and institutional structures make of the remainder. Households tend to own their residential structures.

Residential structures include a mixture of structure types. The majority (over 60%) are temporary structures constructed primarily of bamboo, Nipa palm and/or thatch. A further 25-30% is semi-permanent structures that are generally wood and less than 10% are made of brick and/or concrete. On the other hand, other types of buildings are primarily permanent structures, including shops (60%), industrial buildings (90%) and institutional buildings (70%). The remaining structures are semi-permanent construction.

Housing/Structure Characteristics Left Bank Mekong Focal Area, Vietnam			
Indicator	*Unit*	*Tam Nong*	*Tan Hong*
Residential - % total	%	80.0	n/a
permanent	%	8.4	4.7
semi-permanent	%	28.1	65.0
temporary	%	63.5	30.3
Commercial - % total	%	17.1	n/a
permanent	%	60.0	n/a
semi-permanent	%	40.0	n/a
Industrial - % total	%	2.1	n/a
permanent	%	90.0	n/a
semi-permanent	%	10.0	n/a
Institution - % total	%	0.8	n/a
permanent	%	70.0	n/a
semi-permanent	%	30.0	n/a
Source: Flood Vulnerability Database, Vietnam			

The average area and value of housing varies significantly, depending on the type of construction. A permanent structure is 2-3 times larger than a temporary structure and up to twice as large as semi-permanent structures. Wealthier households that live in permanent houses have structures that are worth about VND 1.5 million per square metre. This compares with semi-permanent structures (VND 0.8 million per square metre) and temporary structures (VND 0,3 million per square metre).

Common strategies to ensure the location and design of their housing, shops and other structures are flood resistant include:

Housing Area & Value Left Bank Mekong Focal Area, Vietnam		*Tam Nong*			*Tan Hong*		
		% HH	*Area* m^2	*Value* VND million	*% HH*	*Area* M^2	*Value* VND million
Overall	Average		81	81.2		75	69.5
By house type	Permanent	22.1	139	204.3	22.2	90	136.7
	Semi-Permanent	57.4	70	58.2	59.3	76	60.6
	Temporary	20.6	50	13.2	18.5	54	17.3
Source: Household surveys							

(i) Increasingly in the focal area, households are relocating to government-developed flood-free areas.

(ii) If people remain on or close to their agricultural land, they are likely to raise the lower level of their houses 50-70 cm above the 2000 flood levels to reduce the risk in future big floods. They may do this by placing the house on stilts or a raised foundation.

(iii) People are also investing in strengthening and bracing their houses to make them more resistant to floodwaters.

(iv) Within the house, people will move their possessions to a higher level to protect them in the event of a flood.

(v) Shop owners will employ similar methods, such as raising the foundation of the shop structure and making sure that it is possible to shift inventory and equipment to high levels within the structures.

The implications for the vulnerability of households and businesses to flooding include:

(i) Due to major flood protection initiatives undertaken by the Government including the construction of flood-free areas and the measures that individual households have taken since the 2000 floods, there is an increased and relatively high level of resilience among households and communities. That is, there is a low risk of major damage to housing and other structures.

8.5.7 Household assets

In Vietnam, every household has at least one bicycle; today, however, it is more indicative of transport options to consider that 70-80% of the households in the focal area also have at least one motorbike. Ownership levels for a car or truck remain very low.

It is interesting to note the high proportion of households that have some type of boat. In Tan Hong, in the deep-flooded area near the Cambodian border, half of the households have a small boat; nearly 20% have a large, motorized boat that could be used on inland waterways. Tam Nong is adjacent to the Mekong River and people living in the district have better access to roads. This may explain the predominance of large boats as well as the lower overall boat ownership rate.

Although rice cultivation in the focal area is not highly mechanized (low ownership of tractors), a large proportion of households own a water pump that is used to pump water into and out of paddy fields. Some households also own an array of other equipment that would be useful for the 2-3 rice crops that are planted in the region. The implications for the resilience of households and communities during floods include:

Household Assets
Left Bank Mekong Focal Area, Vietnam

Indicator	*Unit*	*Tam Nong*	*Tan Hong*
Number of HH	No.	22,937	21,246
Motorbike (1 or more)	%	78.5	70.1
Car /truck	%	n/a	0.5
Small boat (without engine)	%	8.6	49.4
Large boat (with engine)	%	23.2	18.8
Mechanized tractor	%	1.4	n/a
Hand tractor	%	1.9	n/a
Water pump	%	43.6	n/a
Rice cutting & threshing	%	0.8	n/a
Rice drying	%	0.4	n/a
Rice planting	%	6.7	n/a

Source: Flood Vulnerability Database, Vietnam

(i) A higher ownership rate of boats increases the opportunities for households to fish to meet household needs and generate income. It also means that the community as a whole has these resources to use to undertake emergency rescues, reach isolated people and other activities during the flood season.

8.5.8 Economic activities

The majority of economically active people are self-employed in rice cultivation and other agricultural activities. In Tam Nong, in particular, there are households that fish in the Mekong River and other waterways. Most other people work in trade and services that account for about 15% of working people.

The implications for the vulnerability of people to flood events include:

Occupations/Sectoral Activities Left Bank Mekong Focal Area, Vietnam			
Indicator	*Unit*	*Tam Nong*	*Tan Hong*
Agriculture	%	83.5	73.1
Fishery	%	2.0	0.4
Industry	%	3.0	8.9
Services	%	11.5	17.6
Source: Flood Vulnerability Database, Vietnam			

(i) Vulnerability to economic losses is directly related to the high proportion of people engaged in agricultural activities.

(ii) People who work in trade and services may also be at risk of temporary or long-term unemployment if floods damage business structures. However, in this focal area, this risk is low due to the measures taken to protect structures.

8.5.9 Rural livelihoods

Rural livelihoods are based on the cultivation of rice. Farmers plant two crops: the Summer-Autumn (SA) crop that is harvested in July before the normal flood occurs; and, the Winter-Spring (WS) crop, a recession crop that is planted when floodwaters recede. In general, farmers do not plant rice or other crops during the flood season. The exception is small areas of Autumn-Winter (AW) rice that are planted in late June in flood-free areas that have been protected by the construction of embankments.

Throughout the focal area, the average holding of rice paddy is about 2.5 ha. However, households that live in permanent houses tend to have holdings that are 2-3 times larger than those belonging to households living in temporary structures. The yields are high in Vietnam: for the WS crop, the yields are 6.5-6.7 tons/ha; for the SA crop, the yields are 4.6-5.1 tons/ha. As a consequence, households in the focal area are able to sell nearly all their rice crop (an average of 88-90%).

Agricultural Production & Income Left Bank Mekong Focal Area, Vietnam		*Tam Nong*			*Tan Hong*		
		Paddy Area	*Prod. Sold*	*Annual Income*	*Paddy Area*	*Prod. Sold*	*Annual Income*
		ha	*%*	*VND million*	*ha*	*%*	*VND million*
Overall	Average	2.4	88.6	81.8	2.5	90.0	71.2
By house type	Permanent	3.7	94.8	143.5	3.0	92.8	118.9
	Semi-Permanent	2.4	88.8	72.3	2.6	91.3	66.0
	Temporary	1.2	81.5	42.4	1.3	82.3	30.5
Source: Household Surveys, Vietnam							

A range of vegetables and other crops are grown throughout the year in gardens located adjacent to houses and in other locations. In Tam Nong, there is small-scale aquaculture: about 650 ha of fish pond have an annual yield of 43 tons/ha. There is also some cultivation of shrimp and fish cages. Tan Hong district has some aquaculture but the area is one-third that of Tam Nong and the yield is one-half. Most households raise a range of small animals such as chickens, ducks and pigs; some households also have cows and buffalo. The smaller animals are used to meet household consumption needs and to generate income from sales. The strategies that farmers use to ensure their rice crops include, among others:

(i) Farmers use short-term rice varieties and plant the SA crop as early as possible. For example, FG participants in Phu Cuong Commune (Tam Nong) indicated that farmers observe a strict schedule to plant this crop by 15 April at the latest to increase the probability that it can be harvested before the flood arrives.

(ii) Farmers will also pump water out of their fields to enable them to sow the rice according to meet the schedules for planting.

Other strategies related to flood conditions in the focal area include:

(iii) Animals, in particular the larger, more valuable animals, are moved to higher ground prior to the flood.

(iv) Fish and shrimp ponds are protected by embankments and/or netting to minimize the loss of fish due to flooding of the ponds.

(v) People do not have tree plantations due to the risk of flood damage.

(vi) People ensure that they store sufficient rice from the SA crop to last through the flood season (i.e., up to 6 months). Poorer households may not have sufficient rice, but they rely on catching fish in paddy and streams as a source of food/protein during the flood season. As a result, there are very few problems with food shortages in the focal area.

Although rice cultivation is the primary occupation, many households have other non-agricultural income sources. Wealthier households that are able to build permanent structures for their houses, for example, have total incomes from all sources that are 3-4 times greater than those of poor households living in temporary structures. The implications for the vulnerability of households to floods include:

(i) There is a high degree of resilience at the household and community levels with respect to the impacts of flooding on rural livelihoods. Due to government investments since the 2000 flood, there is a much lower level of flood risk, even in a major flood.

(ii) In addition, households have systematically adapted their agricultural and cropping patterns to reduce the risk of damage or loss of their rice crops.

8.5.10 Access to electricity, water and sanitation

Throughout the focal area, there is a high level of access to grid electricity, particularly in districts such as Tam Nong where nearly everyone is connected to the public electricity system. In Tan Hong, a more remote area, there are still approximately 20% of the households that do not have electricity.

There are over 30 public piped water systems and several private piped systems in the surveyed districts. In Tam Nong, the level of coverage for connected households is approximately 30%; in the more remote area of Tan Hong, the coverage is about 20%. Other households rely on private wells and rainwater collection.

Poor households and others that do not have access to these sources generally take water from rivers, streams and canals; many filter and/or boil water to provide safer drinking water. Prior to the flood season, health care workers distribute Cloramin B to be used for treating water sources.

Each surveyed district has a small sewered wastewater system in the district town. The proportion of connected households is about 4%. Throughout the focal area 40% or more of households have their own latrines. The implications for people's vulnerability during floods include:

Access to Services
Left Bank Mekong Focal Area, Vietnam

Indicator	*Unit*	*Tam Nong*	*Tan Hong*
Number HH	No.	22,937	21,246
Electricity			
HH - public grid	%	98.9	81.0
HH - no electricity	%	0.0	18.8
Water and sanitation			
Public piped systems	No.	34	37
HH connected	%	28.3	19.3
Private piped systems	No.	2	0
HH connected	%	2.2	-
Non-piped water supply			
Private wells (HH)	%	n/a	13.2
Rainwater (HH)	%	n/a	35.3
Sewered WW systems	No.	1	1
HH connected	%	4.4	3.8
Private latrines – HH	%	40.0	68.0

Source: Flood Vulnerability Database, Vietnam

(i) The higher the proportion of households that have access to safe drinking water and adequate sanitation, the lower the risk of illness and disease. Notwithstanding, in this focal area, FG participants have indicated that there is increased incidence of diarrhoea and dysentery during the flood period that is the result of contaminated water and inadequate sanitation.

(ii) The creation of flood-free areas for people to live will reduce the vulnerability of people to a common flood-related health problem, that is, skin and eye infections caused by washing clothes and bathing in contaminated flood waters.

8.5.11 Access to health care

In general, there is at least one hospital and one health clinic in each district in the focal area. A number of dispensaries are easily accessible to most households.

Access to Health Care Left Bank Mekong Focal Area, Vietnam			
Indicator	*Unit*	*Tam Nong*	*Tan Hong*
Popn./hospital bed	ratio	1,321	1,231
HH/clinic	ratio	1,911	1,771
HH/dispensary	ratio	675	494
Source: Flood Vulnerability Database, Vietnam			

Most health care facilities in the focal area have boats that enable them to participate in rescue activities and to reach people who are unable to access clinics or dispensaries. Health care workers also carry out activities to disinfect and spray around schools, markets, offices, hospitals and residential areas to control problems stemming from polluted water, mosquito breeding areas, etc. The implications for people's social vulnerability during floods are:

(i) The number, distribution and resources of health care facilities are important assets during floods when people may have special needs to obtain health services and medications. This tends to increase the resilience of households and communities to deal with the health impacts of flooding.

8.5.12 Flood warning, emergency response and recovery

In Vietnam, there is a well-organized system of flood warning, preparedness, emergency response and recovery that is coordinated from through the national, regional and provincial levels to districts and communes.

(i) The National Committee for Flood and Natural Disaster Management and Mitigation has developed a system of flood warnings. In the focal area, water levels at Tan Chau are used to establish different levels of alert. Information on alerts is disseminated through TV. District and commune authorities are involved in activities such as organizing hamlet meetings in May to raise awareness and preparedness for the upcoming flood; and, to monitor households in lowland areas, advise them about how to strengthen their houses and assess whether they need to be relocated. Flood preparedness includes establishing assistance units in critical areas such as production protection units, health care units.

(ii) Communes with assistance from districts draft, prepare budgets for and implement emergency response plans when there are major floods; people living in the commune are informed about the plans and invited to offer comments. The scope of emergency response activities include moving inundated households, establishing safe areas for children (safety kindergartens) and carrying out emergency rescue operations.

(iii) Communes with assistance from districts formulate and carry out recovery plans; people living in the commune are informed about the plans and are invited to offer comments. Contingency funds for flood and natural disaster mitigation are used to assist flood-affected people and households, e.g., food and technical assistance to rebuild; clean up and disinfect damaged areas; and, rebuild/rehabilitate public infrastructure and services.

(iv) Associated with these activities, the Government has a programme to construct flood-free areas and to assist households to relocate permanently to these areas.

The strengths of this system are that the roles and responsibilities at different levels are generally clearly defined. FG participants commented on the degree of organization and capacities of commune officials and the support they receive from district officials. In general, the systems work well although, across the board, there were comments about limited financial resources and, in some instances, the lack of flood rescue equipment and tools.

8.6 Vietnam, Right Bank Bassac focal area, An Giang province

The Right Bank Bassac or Long Xuyen Quadrangle (LXQ) focal area encompasses portions of the provinces of An Giang and Kien Giang. It extends along the right (west) bank of the Bassac River from the Vietnam-Cambodia border. The southern and western border is QL 80 that connects Long Xuyen to Rach Gia and, parallel to the Gulf of Thailand, Rach Gia to Ha Tien.

The Right Bank Bassac focal area is referred to as an "open" section of the Mekong floodplain because it gently slopes from the Bassac River towards the Gulf of Thailand. Floodwaters come from across the Vietnam-Cambodia border (75% of volume) and the Bassac River (25%). Within the focal area, there are 3 principal zones with different flood conditions: (i) north of the Mac Can Dung canal, the depth of flood is 2.5-3.5 m and it lasts for 3-4 months; (ii) between the Mac Can Dung canal and the Ba The-Cho Moi road, floodwaters reach 2-3 m for a period of 3-4 months; and, (iii) in the remainder of the focal area (largely in Kien Giang), the depth of floods is 1-2 m and the duration 2-3 months.

Rice cultivation is the major economic activity in the LXQ; farmers generally cultivate two crops per year. Due to the high risk of flooding, the Government is investing in a major programme to relocate people to designated areas where the elevation of ground has been raised. A demonstration project in the focal area would have as its primary objective expanding the opportunities for a third rice crop through combined flood control, drainage and irrigation.

The social surveys were conducted in two communes in Chau Phu district; this district is located adjacent to the Vietnam-Cambodia border in the deep-flooded portion of the focal area. The selection of communes was based on the following criteria: (i) Vinh Thanh Trung is close to the district town in a densely populated area that includes the natural levees along the Bassac River as well as adjacent floodplain; and, (ii) Dao Huu Canh is a remote commune just north of the Mac Can Dung canal in the most deeply flooded portion of the district.

8.6.1 Flood protection measures

Along the Vietnam-Cambodia border, rubber dams at Tha La-Tra Su block the early flood waters that flow from Cambodia in July and August in order to protect the Summer-Autumn (SA) rice crop in the LXQ. In addition, a number of flood protection measures have been taken in the target communes, as summarized below.

Flood Protection Measures Right Bank Bassac Focal Area, Vietnam	
Commune	*Measures*
Vinh Thanh Trung	▪ Dredging floodway ▪ Improving embankments for year-round protection of crop areas and temporary shelter for people/animals ▪ Improving flood protection embankments to protect against flooding in August ▪ Flood-free areas constructed in deep-flooded areas ▪ Raise rural roads above 2000 flood levels
Dao Huu Canh	▪ Flood protection embankments to protect against flooding in August ▪ Flood-free areas constructed in deep-flooded areas ▪ Raise rural roads above 2000 flood levels
Source: Focus Group Discussions, Vietnam	

8.6.2 What constitutes good and bad floods?

Throughout the focal area, FG participants classify a good flood as one that brings the normal flood levels that are conducive to the growth of the SA rice crop, as well as more fish. A bad flood is one that comes too soon (before August), one that results in higher-than-normal water levels and/or lasts longer than normal.

The benefits and damages associated with good and bad floods are similar across the focal area. The following table summarizes flood benefits and the degree of flood damage depending on the date of onset of the flood.

Flood Characteristics Right Bank Bassac Focal Area, Vietnam		
Commune	*Flood Benefits*	*Flood Damages*
All	▪ Floods provide fertility and sediment for rice fields ▪ Lower costs for rice production and higher yields following big flood years: costs lower by 20-30%; yield up by 5-10%. ▪ Floodwaters clean toxic matter, acidity and disease germs from soils ▪ Floods increase fish levels: ▪ Commercial fisheries benefit from increased yield and extended fishing season ▪ HH benefit from catching fish to supplement diet/make money; benefit greater in big flood year ▪ Some people benefit from planting floating vegetables and lotus ▪ Water quality better in big flood ▪ Benefits are most significant in relation to moderate/big floods	▪ Damage to SA rice crop and other crops if flood is high and/or early ▪ Reduction 50% in business activities ▪ Inundation of houses and structures ▪ Increased risk of intestinal and other diseases/personal safety ▪ Poor households are most vulnerable: limited funds to take protection measures

Flood Characteristics **Right Bank Bassac Focal Area, Vietnam**		
Flood Levels		
Vinh Thanh Trung	NORMAL flood: damages depending on date of flood: ▪ 0% regardless of date of onset due to existing flood protection measures	BIG flood: damages depending on date of flood: ▪ Mid-June: 100% ▪ Mid-July: 30% ▪ Mid-August – Mid-October: 0%
Dao Huu Canh		BIG flood: damages depending on date of flood: ▪ Mid-June: 100% ▪ Mid-July: 40% ▪ Mid-August – Mid-October: 0%
Source: Flood Vulnerability Database, Vietnam		

8.6.3 Community Characteristics

The northern portion of the focal area is densely population. The majority of people are Kinh, with small communities of other ethnic groups. There are relatively few households living below the poverty line. The ethnic and poverty conditions reduce the social vulnerability of these communities for the following reasons:

Community Characteristics **Right Bank Bassac Focal Area, Vietnam**			
Indicator		*Unit*	*Chau Phu*
Population		No.	250,567
Number of HH		No.	54,490
Ethnicity	Kinh	%	99.1
	Khmer	%	0.3
	Hoa	%	0.2
	Cham	%	0.4
Poor HH		%	9.0
Popn growth, 2001-2006		%	0.9
Source: Flood Vulnerability Database, Vietnam			

(i) These communities are culturally and linguistically homogenous. This contributes to effective social and community networks that are an important asset in dealing with flooding planning, response and recovery on an individual, household and community basis.

(ii) The relatively low levels of poverty mean that, in general, households are less vulnerable to harm caused by flooding and other natural disasters. People live in substantial housing, have livelihoods, assets and incomes that meet (or exceed) basic household needs, have better levels of health and education and other characteristics that enable them to protect themselves from flood damage and/or to recover more easily following flooding.

8.6.4 Household Characteristics

The household size is relatively small (4.6 persons) and the proportion of households headed by women is low (15%). Although one-third of the population is children under the age of 15 years, the dependency ratio is low. The consequences regarding vulnerability to flooding include:

Household Characteristics LXQ Focal Area, Vietnam			
Indicator		*Unit*	*Chau Phu*
HH size (average)		Pers.	4.60
HH head	Male	%	85.0
	Female	%	15.0
Male/female ratio			0.96
Children < 15 years		%	32.8
Dependency ratio			0.62
Source: Flood Vulnerability Database, Vietnam			

(i) The low proportion of children and low dependency ratios will decrease vulnerability of households. Children are frequently most at risk, for example, drowning in floodwaters or becoming sick from drinking and/or exposure to contaminated water.

8.6.5 Land Use and Tenure

The largest land use in the district is irrigated rice land. Irrigated paddy and other productive land account for more than 90% of the total area. Other developed land uses account for less than 5% of the territory.

In Vietnam, in general, there is widespread implementation of the system of land use rights certificates (LURC) for productive and residential land. Nonetheless, according to data provided by district authorities, only 75% of households in the district have LURC for their agricultural land. The proportion of households with LURC for residential land is even lower, at about 50%. The implications for social vulnerability to flooding include:

Land Uses Right Bank Bassac Focal Area, Vietnam		
Indicator	*Unit*	*Chau Phu*
Rice land (irrigated)	%	89.0
Crop & plantation land	%	2.6
Rural residential (garden)	%	2.5
Urban residential	%	0.1
Commercial/industrial	%	0.2
Institutional	%	0.1
Commune reserve land	%	5.5

(i) The reliance of livelihoods on agricultural land increases the direct and indirect costs of flooding. Household expenditures for food and other basic needs will increase if people are unable to cultivate rice or vegetables in riverbank gardens; incomes decrease from the loss of crop sales.

(ii) The lack of secure tenure for agricultural land is a source of vulnerability in that flood-affected households have limited collateral to obtain loans to rehabilitate property damaged during a flood, finance agricultural inputs or meet other household needs (e.g., health care). People without productive land are at risk during a flood because, in most instances, they work as agricultural labour on other people's land. As they are generally poor, they have few alternative resources to meet basic or flood-induced needs.

8.6.6 Houses and other structures

The majority of structure types are housing (86%) and shops and other commercial structures (13%). Industrial and institutional structures make of the remainder. Households tend to own their residential structures.

Residential structures include a mixture of structure types. Approximately half (49%) are temporary structures constructed primarily of bamboo, Nipa palm and/or thatch. A further 44% are semi-permanent structures that are generally wood and less than 10% are made of brick and/or concrete. Most other types of buildings are semi-permanent structures, including shops (80%), industrial buildings (90%) and institutional buildings (60%). Most of the remaining structures are permanent construction.

The average area and value of housing varies significantly, depending on the type of construction. A permanent structure is nearly 3 times larger than a temporary structure and 1.5 times as large as semi-permanent structures. Wealthier households that live in permanent houses have structures that are worth about VND 1.3 million per square metre. This compares with semi-permanent structures (VND 0.8 million per square metre) and temporary structures (VND 0.4 million per square metre). Common strategies to ensure the location and design of their housing, shops and other structures are flood resistant include:

Housing and Other Structures Right Bank Bassac Focal Area, Vietnam		
Indicator	*Unit*	*Chau Phu*
Residential - % total	%	85.9
permanent	%	6.8
semi-permanent	%	44.1
temporary	%	49.1
Commercial - % total	%	12.7
permanent	%	9.1
semi-permanent	%	80.9
temporary	%	10.0
Industrial - % total	%	1.3
permanent	%	9.8
semi-permanent	%	90.2
Institution - % total	%	0.05
permanent	%	40.0
semi-permanent	%	60.0
Source: Flood Vulnerability Database, Vietnam		

Housing Area & Value Right Bank Bassac Focal Area, Vietnam		*Area*	*Value*
		m2	*VND million*
Overall	Average	87	85.3
By house type	Permanent	128	163.9
	Semi-Permanent	80	66.9
	Temporary	49	22.0
Source: Household Surveys, Vietnam			

(i) Increasingly in the focal area, households are relocating to government-developed flood-free areas. Similarly, business owners are relocating their shops and other businesses to these areas.

(ii) If people remain on or close to their agricultural land, they are likely to raise the lower level of their houses above the 2000 flood levels to reduce the risk in future big floods. They may do this by placing the house on stilts or a raised foundation.

(iii) People are also investing in strengthening and bracing their houses to make them more resistant to floodwaters.

(iv) Within the house, people will move their possessions to a higher level to protect them in the event of a flood.

(v) Shop owners will employ similar methods, such as raising the foundation of the shop structure and making sure that it is possible to shift inventory and equipment to high levels within the structures.

The implications for the vulnerability of households and businesses to flooding include:

(i) Due to major flood protection initiatives undertaken by the Government including the construction of flood-free areas and the measures that individual households have taken since the 2000 floods, there is an increased and relatively high level of resilience among households and communities. That is, there is a low risk of major damage to housing and other structures.

8.6.7 Household assets

In Vietnam, every household has at least one bicycle; in addition, more than 50% of the households in the focal area also have at least one motorbike. Ownership levels for a car or truck remain very low.

It is interesting to note that more than one-quarter of households have some type of boat. Although rice cultivation in the focal area is not highly mechanized (low ownership of tractors), more than 10% of households own a water pump that is used to pump water in and out of paddy fields. Some households also own an array of other equipment that would be useful for the 2-3 rice crops that are planted in the region. The implications for the resilience of households and communities during floods include:

Household Assets Right Bank Bassac Focal Area, Vietnam		
Indicator	*Unit*	*Chau Phu*
Motorbike (1 or more)	%	54.0
Car /truck	%	0.1
Small boat (without engine)	%	27.5
Large boat (with engine)	%	1.6
Mechanized tractor	%	1.3
Cart	%	1.7
Water pump	%	11.2
Other agricultural equipment	%	3.7
Source: Flood Vulnerability Database, Vietnam		

(i) A higher ownership rate of boats increases the opportunities for households to fish to meet household needs and generate income. It also means that the community as a whole has these resources to use to undertake emergency rescues, reach isolated people and other activities during the flood season.

8.6.8 Economic activities

Three-quarters of economically active people are self-employed in rice cultivation and other agricultural activities. Most other people work in trade and services that account for about 19% of working people. There are small sectors engaged in fishery and industrial activities. The implications for the vulnerability of people to flood events include:

Occupations / Economic Activities Right Bank Bassac Focal Area, Vietnam

Indicator	*Unit*	*Chau Phu*
Agriculture	%	75.8
Fishery	%	2.7
Industry	%	2.9
Services	%	18.6

Source: Flood Vulnerability Database, Vietnam

(i) Vulnerability to economic losses is directly related to the high proportion of people engaged in agricultural activities.

(ii) People who work in trade and services may also be at risk of temporary or long-term unemployment if floods damage business structures. However, in this focal area, this risk is low due to the measures taken to protect structures.

8.6.9 Rural livelihoods

Rural livelihoods are based on the cultivation of rice. Farmers plant two crops: the Summer-Autumn (SA) crop that is harvested in July before the normal flood occurs; and, the Winter-Spring (WS) crop, a recession crop that is planted when floodwaters recede. In general, farmers do not plant rice or other crops during the flood season. The exception is small areas of Autumn-Winter (AW) rice that are planted in late June in flood-free areas that have been protected by the construction of embankments.

The average holding of paddy land in the focal area is 2.1 ha. However, households that live in permanent houses tend to have holdings that are 2-3 times larger than those belonging to households living in temporary structures. The yields are high in Vietnam: for the WS crop, the yields are 7.3 tons/ha; for the SA and AW crops, the yields are 5.4 tons/ha. As a consequence, households in the focal area are able to sell nearly all their rice crop (an average of 87%).

Agricultural Production & Income Right Bank Bassac Focal Area, Vietnam		*Paddy Area*	*Prod. Sold*	*Annual Income*
		ha	*%*	*VND million*
Overall	Average	2.1	87.4	170.4
By hsg type	Permanent	2.6	87.0	381.9
	Semi-Permanent	2.1	90.8	92.7
	Temporary	1.1	82.0	50.1
Source: Household Surveys, Vietnam				

A range of vegetables and other crops are grown throughout the year in gardens located adjacent to houses and in other locations. There is small-scale, but highly productive aquaculture: about 275 ha of fish pond have an annual yield of 210 tons/ha. There is also some cultivation of shrimp and fish in cages. Most households raise a range of small animals such as chickens, ducks and pigs; some households also have cows and buffalo. The smaller animals are used to meet household consumption needs and to generate income from sales. The strategies that farmers use to ensure their rice crops include, among others:

(i) Farmers use short-term rice varieties and plant the SA crop as early as possible. For example, FG participants in Dao Huu Canh indicated that farmers observe a strict schedule to plant this crop 15 April at the latest to increase the probability that it can be harvested before the flood arrives; in Vinh Thanh Trung, the critical date is the end of May.

(ii) Farmers will also pump water out of their fields to enable them to sow the rice according to meet the schedules for planting.

Other strategies related to flood conditions in the focal area include:

(iii) Some people take advantage of flooded conditions to grow floating vegetables such as morning glory.

(iv) Animals, in particular the larger, more valuable animals, are moved to higher ground prior to the flood.

(v) Fish and shrimp ponds are protected by embankments and/or netting to minimize the loss of fish due to flooding of the ponds.

(vi) Due to the risks of flood damage, people do not have tree plantations except melaleuca that can withstand standing water.

(vii) People ensure that they store sufficient rice from the SA crop to last through the flood season (i.e., up to 6 months). Poorer households may not have sufficient rice, but they rely on catching fish in paddy fields and streams as a source of food/protein during the flood season. As a result, there are very few problems with food shortages in the focal area.

Although rice cultivation is the primary occupation, many households have other non-agricultural income sources. Wealthier households that are able to build permanent structures

for their houses, for example, have total incomes from all sources that are, on average, more than 7 times greater than those of poor households living in temporary structures. The implications for the vulnerability of households to floods include:

(i) There is a high degree of resilience at the household and community levels with respect to the impacts of flooding on rural livelihoods. Due to government investments since the 2000 flood, there is a much lower level of damage risk even in a major flood.

(ii) In addition, households have systematically adapted their agricultural and cropping patterns to reduce the risk of damage or loss of their rice crops.

8.6.10 Access to electricity, water and sanitation

Over 90% of households are connected to the public electricity grid. The remaining households rely of generators or car batteries to generate small amounts of electricity; or, they use kerosene or other fuels for lighting. There are 26 public piped water supply systems in the district to which almost half of all households are connected. A small number of households are connected to a private system. The remaining households get their water from private wells and rainwater collection.

Poor households and others that do not have access to these sources generally take water from rivers, streams and canals; many filter and/or boil water to provide safer drinking water. Prior to the flood season, health care workers distribute Cloramin B to be used for treating water sources.

Access to Services Right Bank Bassac Focal Area, Vietnam		
Indicator	*Unit*	*Chau Phu*
Public electricity grid: HH connected	%	92.5
Public piped water supply systems	No.	26
HH connected	%	47.4
Private piped water supply systems	No.	1
HH connected	%	0.9
Sewered WW systems	No.	1
HH connected	%	3.7
Public latrines – villages	No.	3
Private latrines – HH	%	39.2
Source: Flood Vulnerability Database, Vietnam		

There is one sewered wastewater system in the district town. The proportion of connected households is about 4%. Throughout the focal area 40% or more of households have their own latrines. Nonetheless, FG participants indicate that there is increased incidence of diarrhoea and dysentery during the flood period that is the result of contaminated water and inadequate sanitation. The implications for people's vulnerability during floods include:

(i) The higher the proportion of households that have access to safe drinking water and adequate sanitation, the lower the risk of illness and disease. Notwithstanding, in this focal area, FG participants have indicated that there is increased incidence of diarrhoea and dysentery during the flood period that is the result of contaminated water and inadequate sanitation.

(ii) The creation of flood-free areas for people to live will reduce the vulnerability of people to a common flood-related health problem, that is, skin and eye infections caused by washing clothes and bathing in contaminated flood waters.

8.6.11 Access to health care

There is one hospital in the district and one health clinic in each of the communes. A number of dispensaries are easily accessible to most households. Most health care facilities in the focal area have boats that enable them to participate in rescue activities and to reach people who are unable to access clinics or dispensaries. Health care workers also carry out activities to disinfect and spray around schools, markets, offices, hospitals and residential areas to control problems stemming from polluted water, mosquito breeding areas, etc. The implications for people's social vulnerability during floods are:

Access to Health Care Right Bank Bassac Focal Area, Vietnam		
Indicator	*Unit*	*Chau Phu*
Popn./hospital bed	ratio	3,105
HH/clinic	ratio	4,192
HH/dispensary	ratio	545
Source: Flood Vulnerability Database, Vietnam		

(i) The number, distribution and resources of health care facilities are important assets during floods when people may have special needs to obtain health services and medications. This tends to increase the resilience of households and communities to deal with the health impacts of flooding.

8.6.12 Flood warning, emergency response and recovery

In Vietnam, there is a well-organized system of flood warning, preparedness, emergency response and recovery that is coordinated from through the national, regional and provincial levels down to districts and communes.

(i) The National Committee for Flood and Natural Disaster Management and Mitigation has developed a system of flood warnings. In the focal area, water levels at Tan Chau are used to establish different levels of alert. Information on alerts is disseminated through TV. District and commune authorities are involved in activities such as organizing hamlet meetings in May to raise awareness and preparedness for the upcoming flood; and, to monitor households in lowland areas, advise them about how to strengthen their houses and assess whether they need to be relocated. Flood preparedness also includes establishing assistance units in critical areas such as production protection units, health care units.

(ii) Communes with assistance from districts draft, prepare budgets for and implement emergency response plans when there are major floods; people living in the commune are informed about the plans and invited to offer comments. The scope of emergency response activities include moving inundated households, establishing safe areas for children (safety kindergartens) and carrying out emergency rescue operations.

(iii) Communes with assistance from districts formulate and carry out recovery plans; people living in the commune are informed about the plans and are invited to offer comments. Contingency funds for flood and natural disaster mitigation are used to assist flood-affected people and households, e.g., food and technical assistance to rebuild; clean up and disinfect damaged areas; and, rebuild/rehabilitate public infrastructure and services.

(iv) Associated with these activities, the Government has a programme to construct flood-free areas and to assist households to relocate permanently to these areas.

The strengths of this system are that the roles and responsibilities at different levels are generally clearly defined. FG participants commented on the degree of organization and capacities of commune officials and the support they receive from district officials. In general, the systems work well although, across the board, there were comments about limited financial resources and, in some instances, the lack of flood rescue equipment and tools.

8.7 Thailand, Nam Mae Kok focal area, Chieng Rai province

The Nam Mae Kok River in Thailand has a high yearly variation in flood peaks and incidentally severe floods occur. It has been selected by the TNMC as focal area for Integrated Flood Risk Management. The area concerns the Nam Mae Kok from Chiang Rai to its confluence with the Mekong.

The Nam Mae Kok basin covers an area of 10,730 km2. The length of the river from source to mouth is 360 km. Flood prone areas in the Nam Mae Kok basin are mainly (i) Valley of Nam Mae Fang; (ii) Chiang Rai Province; and (iii) Mouth of Nam Mae Kok. In Chiang Rai Province flooding takes place near the city of Chiang Rai, located at the confluence of the Nam Mae Kok and Nam Mae Lao. The city is flood prone when the rivers convey large discharges. The last major flood of 2006 came from the Nam Mae Lao and a small creek named Nam Mae Korn. Details are presented in Hydrological hazard.

Two districts in the focal area in Chiang Rai province were selected by the Thai Authorities for social economic survey and data collection under the FMMP-C2. They are Mueang Chiang Rai and Chieng Saen. See Map

The social surveys were conducted in the two districts: 6 villages in 3 sub-district/communes of Mueang Chiang Rai district; and 6 villages in 2 communes of Chieng Saen district. See the Table 8.1 below:

Table 8.1 Sample of Socio-economic Survey

District	Sub-district	Village	Household	Business
Mueang CR	Rob Wieng	Doi Kao Kaoy	24	4
		Mae Korn	19	4
		Mae Lao Noi	21	
	San Sai	Mae Korn	25	1
	Ta Sai	Mae Lao Noi	25	4
		San Kamint	20	
Sub-total			**134**	**13**

District	Sub-district	Village	Household	Business
Chieng Saen	Ban Saw	Koa Pha Kam	15	3
		San Sai Kong Ngan	15	4
		Sob Kok	15	4
	Yonok	Doi Jun	13	4
		San Tat	22	2
		San Ton Pao	10	4
Sub-total			**90**	**21**
TOTAL			**224**	**34**

Source: Socio-economic survey, Thailand

8.7.1 Flood protection measures

A number of flood protection measures have been taken in the target communes and districts in the focal area, as summarized below.

Flood Protection Measures Nam Mae Kok Focal Area, Thailand	
District	*Commune / Measures*
Mueang Chiang Rai	3 FGDs at Ban Tha Sai, Ban Doi Khao Khwai, and Ban Mae Korn ▪ Flood protection measures are temporary dike embankments made from soil along 2 sides of Mae Lao River in Ban Tha Sai sub-district. ▪ Other measures were building a house on poles and improving cannels/river bank.
Chieng Saen	2 FGDs at Yonok and Ban Sop Kok communities ▪ The area is dominated by agricultural land without any flood protection. ▪ The houses are on the hills and hard being affected by the flood.
Source: Focus Group Discussions, Thailand	

8.7.2 What constitutes good and bad floods?

Throughout the focal area, FG participants classify a good flood as one that brings the normal flood levels and occurs in a short duration that are conducive to the growth of the rice crop, as well as more fish. A bad flood is one having high flooding depth and occurring long duration. The benefits and damages associated with good and bad floods are similar across the focal area. The following table summarizes and the degree of damage depending on the date of onset of the flood.

Flood Characteristics Nam Mae Kok Focal Area, Thailand			
Dist.	*Commune*	*Flood Benefits*	*Flood Damages*
All	All	▪ Floods provide fertility and sediment for rice fields ▪ Lower costs for rice production in fertilizers application by 7% and almost no change in pesticides application. ▪ Floods increase fish levels: ▪ People benefit from catching fish to supplement diet/make money; benefit greater in big flood year ▪	▪ Damage to rice crop if flood is high ▪ Difficulty in travelling to work and school
Timing of Flood Damages			
Mueang Chiang Rai	All	▪ Normal flood	▪ Mid September-Mid October
	All	▪ Big flood	▪ Mid August-Mid October
Chieng Saen	All	▪ Normal flood	▪ Mid August-Mid September
	All	▪ Big flood	▪
Source: Focus Group Discussions, Thailand			

8.7.3 Community Characteristics

The characteristics of communities in the two districts surveyed in this focal area are similar in terms of population composition by age groups and by sex. Male is more than female in age group (1-14) especially in Chieng Saen district. However, the situation is reversed in other two age groups (15-60) and (more than 60).

Community Characteristics, Nam Mae Kok Focal Area, Thailand					
Age group	Sex	Maung CR	Chieng Saen	Maung CR	Chieng Saen
		(#person)	(#person)	(% of total)	(% of total)
1-14	Male	6,958	4,137	9%	10%
	Female	6,439	1,034	8%	2%
15-60	Male	28,030	15,263	36%	37%
	Female	28,667	17,557	37%	42%
60+	Male	3,305	1,591	4%	4%
	Female	3,419	1,955	4%	5%
TOTAL		76,818	41,537	100%	100%

Source: Flood Vulnerability Database, Thailand

Total population of Maung Chiang Rai was about 77,000 person almost double of population in Chieng Saen district. Population growth rate from 2001-2006 was 1.76% and 1.90% per year in Mueang Chiang Rai and Chieng Saen district respectively. Ethnic composition in the two selected districts are the same as 83% -Thai, 9% - Mountaineer, 1% - Chinese and 7% - others.

The residential area is located on a hill and/or high ground place, therefore flooding risk for the communities is low, especially in Chieng Saen district where most villages are on the high land.

Community Characteristics Nam Mae Kok Focal Area, Thailand				
Indicator		*Unit*	*Mueang CR*	*Chieng Saen*
Population		No.	76,818	53,537
Number of HH		No.	18,870	10,685
Ethnicity	Thai	%	83%	83%
	Chinese	%	1%	1%
	Mountaineer	%	9%	9%
	Others	%	7%	7%
Poor HH		%	n/a	n/a
Population growth, 2001-2006		%	1.76%	1.90%
Source: Flood Vulnerability Database, Thailand				

8.7.4 Household Characteristics

Size of household was about 4 persons in Mueang Chiang Rai district and 5 persons in Chieng Saen district. Women head varies between 11-15% of the households. However, the proportion of children is low and, therefore, there are low dependency ratios. The consequences regarding vulnerability to flooding include:

Household Characteristics Nam Mae Kok Focal Area, Thailand				
Indicator		*Unit*	*Mueang CR*	*Chieng Saen*
HH size (average)		Pers.	4.07	5.01
HH head	Male	%	85%	89%
	Female	%	15%	11%
Male/female ratio			5.49	7.79
Children < 15 years		%	17.4%	9.7%
Dependency ratio			0.26	0.16
Source: Flood Vulnerability Database, Thailand				

(i) The proportion of female-headed households tends to indicate a higher risk of poverty compared with male-headed households. In addition, if there is a shortage of adult males in these households, women will be more vulnerable because they lack labour.

(ii) The low proportion of children and low dependency ratios will decrease vulnerability of households. Children are frequently most at risk, for example, drowning in floodwaters or becoming sick from drinking and/or exposure to contaminated water.

8.7.5 Land Use and Tenure

The largest land use in each district in the focal area is forest land (about 45% in Mueang Chiang Rai district and 54% in Chieng Saen district. irrigated rice land. Almost no irrigated rice land in Chieng Saen and small area of rice land irrigated in Mueang Chiang Rai district. Rain-fed rice land occupies 20% and 10% of the total land area in Mueang Chiang Rai and Chieng Saen.

Land Uses Nam Mae Kok Focal Area, Thailand			
Indicator	*Unit*	*Mueang CR*	*Chieng Saen*
Rice Land – Irrigated	%	2%	
Rice Land - Not irrigated or rain-fed	%	20%	10%
Crop Land	%	13%	9%
Plantation Land	%	10%	22%
Residential - Rural (including gardens)	%	3%	1%
Residential – Urban	%	3%	0.2%
Commercial / Industrial	%	0.22%	0.01%
Institution	%	1%	0.02%
Forest	%	45%	54%
Communal land	%	2%	4%
Source: Flood Vulnerability Database, Thailand			

The proportion of households depend in agricultural economic activities with implications for social vulnerability to flooding include:

(i) The reliance of livelihoods on agricultural land increases the direct and indirect costs of flooding. Household expenditures for food and other basic needs will increase if people are unable to cultivate paddy or vegetables in the fields/ gardens; incomes decrease from the loss of crop sales.

(ii) The lack of flood protection measures to crop cultivation and agricultural production during the flood season increase the flooding risk for agricultural households.

(iii) People in remote areas are the most vulnerable groups due to limited access to flooding information and prevention measures.

8.7.6 Houses and other structures

There is no information on houses and structures available at a district level, except the information collected in household and business sample survey.

Housing/Structure Characteristics Nam Mae Kok Focal Area, Thailand			
Indicator	*Unit*	*Mueang CR*	*Chieng Saen*
Residential - % total	%	n/a	n/a
permanent	%	n/a	n/a
semi-permanent	%	n/a	n/a
temporary	%	n/a	n/a
Commercial - % total	%	n/a	n/a
permanent	%	n/a	n/a
semi-permanent	%	n/a	n/a
Industrial - % total	%	n/a	n/a
permanent	%	n/a	n/a
semi-permanent	%	n/a	n/a

Housing/Structure Characteristics Nam Mae Kok Focal Area, Thailand			
Indicator	*Unit*	*Mueang CR*	*Chieng Saen*
Institution - % total	%	n/a	n/a
permanent	%	n/a	n/a
semi-permanent	%	n/a	n/a
Source: Flood Vulnerability Database, Thailand			

The average area and value of housing varies significantly among the two selected districts but construction cost was in-order of 5 thousand Bat per m2. The average hose area is 117m2 in Mueang Chiang Rai district which is bigger than those in Chieng saen district. Most of houses in the focal area is classified as permanent.

Housing Area & Value Nam Mae Kok Focal Area, Thailand		*Mueang CR*			*Chieng Saen*		
		% HH	*Area* m^2	*Value 1000 Bat*	*% HH*	*Area* M^2	*Value 1000 Bat*
Overall	Average		117	577		81	393
By house type	Permanent	92%	116	591	93%	81	401
	Semi-Permanent	7%	121	416	7%	82	273
	Temporary	1%	160	550	-	-	-
Source: Household surveys							

(i) In the focal area, households are located in village where ground level is high and the impact of flood is low.

(ii) In a low ground areas, people built their house on poles or on highly raised foundation for flood free to reduce the risk.

(iii) Shop owners will employ similar methods, such as raising the foundation of the shop structure and making sure that it is possible to shift inventory and equipment to high levels within the structures.

In-short, the implications for the vulnerability of households and businesses to flooding is low, comparing to lower Mekong Delta in Cambodia and Vietnam.

8.7.7 Household assets

There was no information available to the survey team from district statistic data.

Household Assets Nam Mae Kok Focal Area, Thailand			
Indicator	*Unit*	*Mueang CR*	*Chieng Saen*
Number of HH	No.	18,870	10,685
Motorbike (1 or more)	%	n/a	n/a
Car /truck	%	n/a	n/a
Small boat (without engine)	%	n/a	n/a
Large boat (with engine)	%	n/a	n/a
Mechanized tractor	%	n/a	n/a

Household Assets Nam Mae Kok Focal Area, Thailand			
Indicator	*Unit*	*Mueang CR*	*Chieng Saen*
Hand tractor	%	n/a	n/a
Water pump	%	n/a	n/a
Rice cutting & threshing	%	n/a	n/a
Rice drying	%	n/a	n/a
Rice planting	%	n/a	n/a
Source: Flood Vulnerability Database, Thailand			

8.7.8 Economic activities

There was no information available to the survey team from district statistic data.

Occupations/Sectoral Activities Nam Mae Kok Focal Area, Thailand			
Indicator	*Unit*	*Mueang CR*	*Chieng Saen*
Agriculture	%		
Fishery	%		
Industry	%		
Services	%		
Source: Flood Vulnerability Database, Thailand			

8.7.9 Rural livelihoods

Rural livelihoods are based on the cultivation of rice mainly rain-fed, except a small area (12% of rice land) in Mueang Chiang Rai is under irrigation. The rice cultivation area occupies 62% in Mueang Chiang Rai and 47% in Chieng Saen. The remaining land is cultivated upland crops (corn, pineapple, cassava, and vegetables).

Throughout the focal area, the average holding of rice paddy is about 2.2 ha in Mueang Chiang Rai district and 18.1ha in Chieng Saen district. The households that live in permanent and semi-permanent houses tend to have holdings that are 2-3 times larger than those belonging to households living in temporary structures. The average yields are high in Mueang Chiang Rai district (4.4 ton/ha) and much lower in Chieng Saen district (2.8 ton/ha). It is observed that their rice production sold to market is more than 80% of total production harvested, especially farmer in Mueang Chiang Rai district even sold more than 90%.

Production & Income Nam Mae Kok Focal Area, Thailand		*Mueang CR*			*Chieng Saen*		
		Paddy Area	*Prod. Sold*	*Annual Income*	*Paddy Area*	*Prod. Sold*	*Annual Income*
		ha	*%*	*VND million*	*ha*	*%*	*VND million*
Overall	Average	2.2	92%	n/a	18.1	84%	n/a
By house type	Permanent	2.1	92%	n/a	18.7	84%	n/a
	Semi-Permanent	3.5	90%	n/a	8.8	87%	n/a
	Temporary	0.8	95%	n/a			
Source: Household Surveys, Thailand							

A range of vegetables and other crops are grown throughout the year in gardens located adjacent to houses and in other locations on a high land

Although rice cultivation is the primary occupation, many households have other non-agricultural income sources from livestock and raising fish. The survey showed that 25% of household in Chieng Saen district whose fish pond affected by flood 2006.

8.7.10 Access to electricity, water and sanitation

There is limited data and information available in the focal area. In Mueang Chiang Rai district, there is a high level of access to grid electricity 97% of household and about 1% connecting to private electricity source. There are still approximately 2% of the households that do not have electricity.

There are 6 public piped water systems in Mueang Chiang Rai district covering 80% of households. There is no data available in Chieng Saen district.

Access to Services Nam Mae Kok Focal Area, Thailand			
Indicator	*Unit*	*Mueang CR*	*Chieng Saen*
Number HH	No.	18,870	10,685
Electricity			
HH - public grid	%	97%	n/a
HH - no electricity	%	2%	n/a
Water and sanitation			
Public piped systems	No.	6	n/a
HH connected	%	80%	n/a
Private piped systems	No.	n/a	n/a
HH connected	%	n/a	n/a
Non-piped water supply			
Private wells (HH)	%	n/a	n/a
Rainwater (HH)	%	n/a	n/a
Sewered WW systems	No.	2	n/a
HH connected	%	n/a	n/a
Private latrines – HH	%	n/a	n/a
Source: Flood Vulnerability Database, Thailand			

The higher the proportion of households that have access to safe drinking water and adequate sanitation, the lower the risk of illness and disease. Notwithstanding, in this focal area, FG participants have indicated that there is increased incidence of diarrhoea and dysentery during the flood period that is the result of contaminated water and inadequate sanitation.

8.7.11 Access to health care

In general, there is at least one hospital and one health clinic in each district in the focal area. A number of dispensaries are easily accessible to most households. There is significant different in a level of access to health care between Mueang Chiang Rai and Chieng Saen district. The limited health care services are observed in Chieng Saen district through high health care indicator.

Access to Health Care Nam Mae Kok Focal Area, Thailand			
Indicator	*Unit*	*Mueang CR*	*Chieng Saen*
Population/hospital bed	ratio	68	892
HH/clinic	ratio	173	822
HH/dispensary	ratio	185	2671
Source: Flood Vulnerability Database, Thailand			

The implications for people's social vulnerability during floods are:

(i) The number, distribution and resources of health care facilities are important assets during floods when people may have special needs to obtain health services and medications. This tends to increase the resilience of households and communities to deal with the health impacts of flooding, especially in Chieng Saen district.

8.7.12 Flood warning, emergency response and recovery

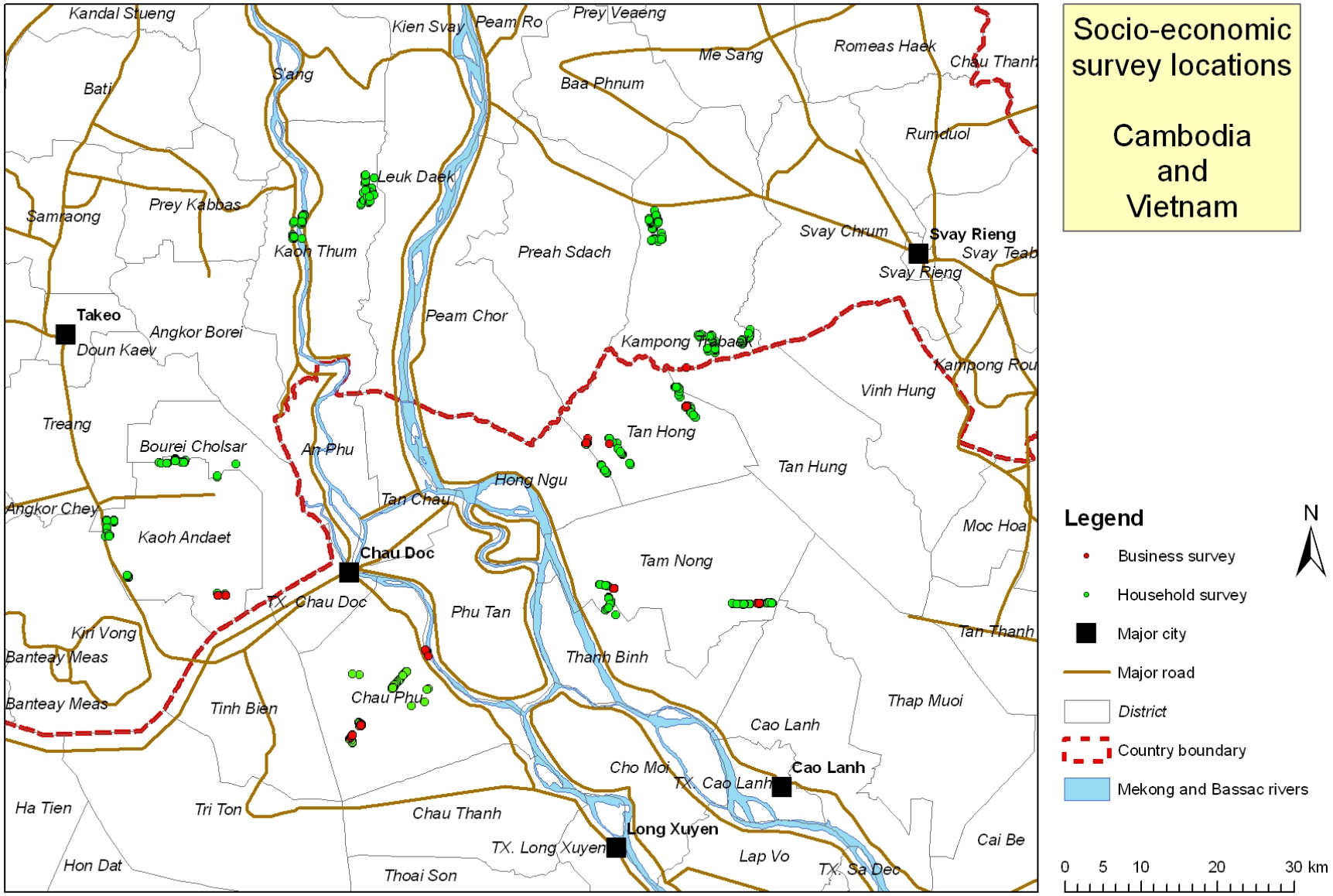
(i) Flood warning: There is public relation in villages through village air radio operated by head of villages/ local Administration authority. This activity will make announcement/warning when water level is increasing. Then, people in the communities can get information from this announcement directly and it covers all over area. The village air radio will make warning in advance 2 days before flooding. Thus, this system is the strength point. Moreover, the communities can get the weather forecasting from television and radio national net-work as well.

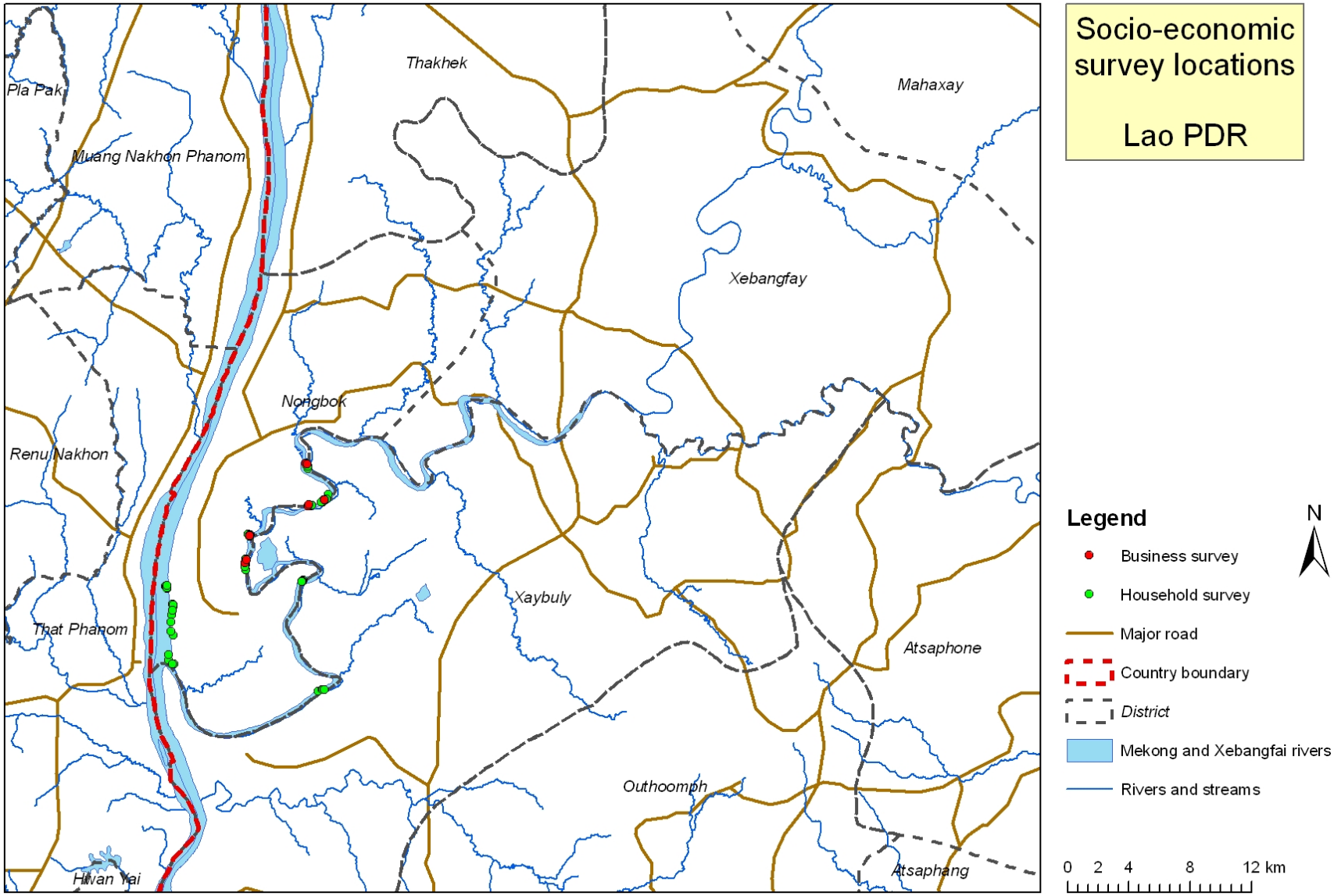
(ii) Emergency response to flooding: Amphoe (District) will provide information on emergency warning to sub-districts (villages) for making announcement. At provincial level, there are coordination among various relevant agencies (Royal Irrigation Department office in province, Office of Water Resources, DDPM, and other NGOs) to support/rescue local communities to eliminate the losses cause by flooding.

(iii) Recovery after flooding: There are no plans/strategies to recover after flooding. However, during flooding or after the events government pays for compensation. Such government supports have eliminated the harness and difficulties of communities suffering from flooding.

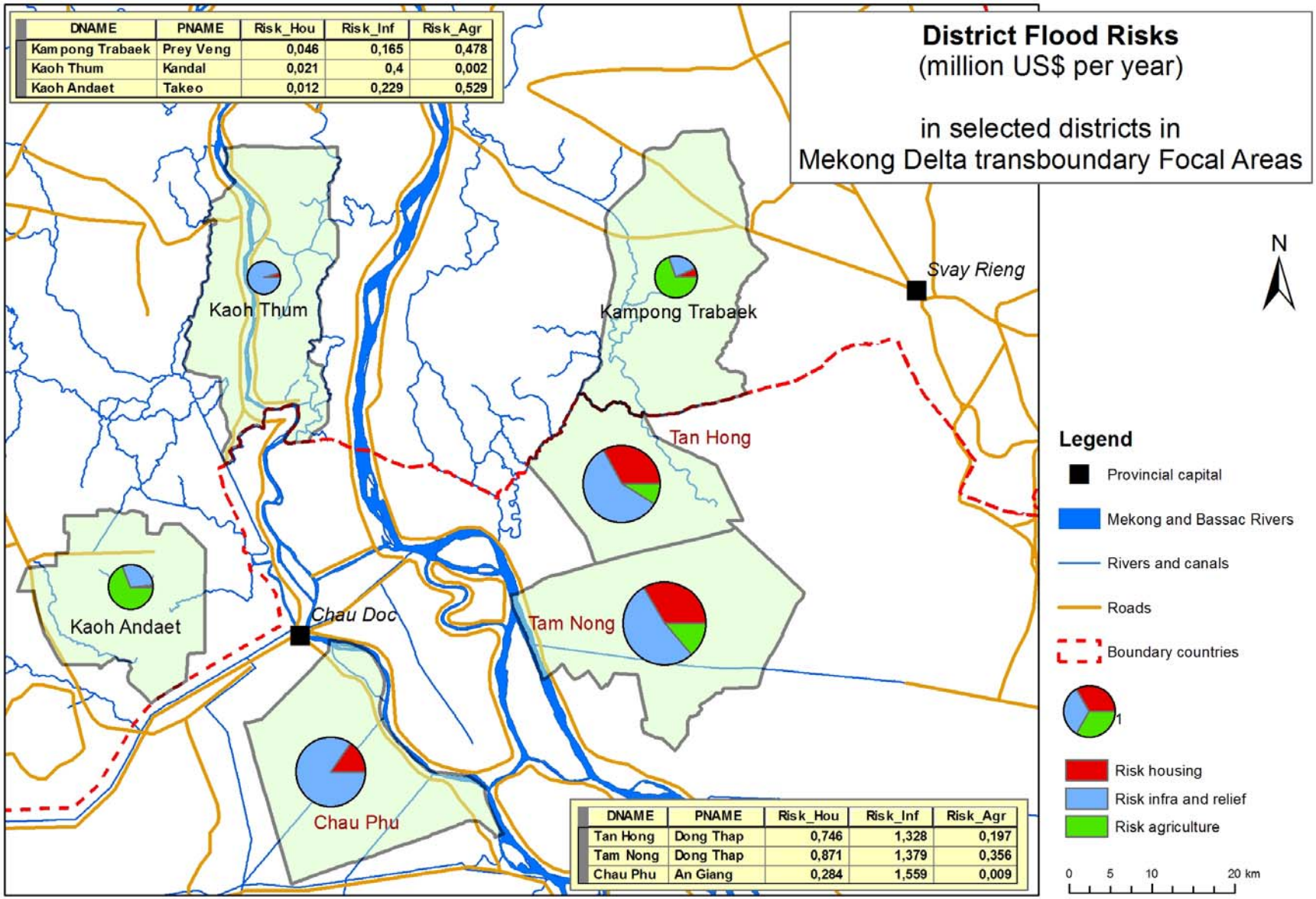
APPENDICES

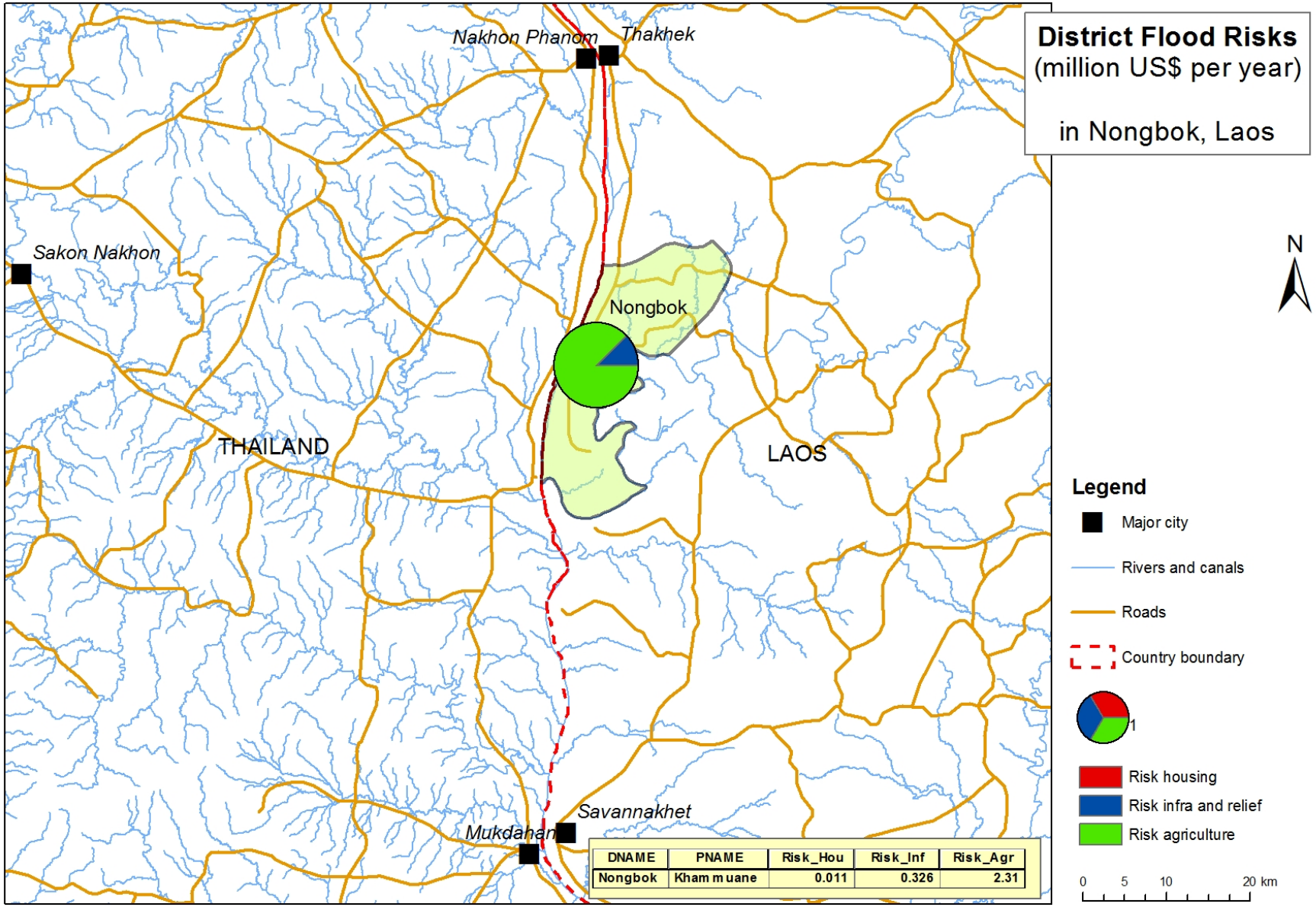
APPENDIX A HOUSEHOLD AND BUSINESS SURVEY LOCATIONS


Socio-economic survey locations
Cambodia and Vietnam
Legend
Business survey
Household survey
Major city
Major road
District
Country boundary
Mekong and Bassac rivers
N
0 5 10 20 30 km
Kandal Stueng
Kien Svay
Peam Ro
Prey Veaeng
Me Sang
Romeas Haek
Chau Thanh
S'ang
Bati
Baa Phnum
Rumduol
Leuk Daek
Prey Kabbas
Samraong
Kaoh Thum
Preah Sdach
Svay Chrum
Svay Rieng
Svay Teab
Takeo
Angkor Borei
Doun Kaev
Peam Chor
Kampong Trabaek
Kampong Rou
Vinh Hung
Treang
Bourei Cholsar
An Phu
Tan Hong
Tan Hung
Hong Ngu
Angkor Chey
Tan Chau
Moc Hoa
Kaoh Andaet
Chau Doc
Tam Nong
TX. Chau Doc
Phu Tan
Kiri Vong
Tan Thanh
Banteay Meas
Thanh Binh
Chau Phu
Thap Muoi
Tinh Bien
Cao Lanh
Cho Moi
TX. Cao Lanh
Ha Tien
Tri Ton
Chau Thanh
Long Xuyen
Cai Be
TX. Long Xuyen
Lap Vo
Hon Dat
Thoai Son
TX. Sa Dec


Socio-economic survey locations
Lao PDR
Thakhek
Mahaxay
Pla Pak
Muang Nakhon Phanom
Xebangfay
Nongbok
Renu Nakhon
Xaybuly
That Phanom
Atsaphone
Outhoomph
Hinan Yai
Atsaphang
Legend
Business survey
Household survey
Major road
Country boundary
District
Mekong and Xebangfai rivers
Rivers and streams
N
0 2 4 8 12 km

APPENDIX B FLOODING RISK MAPS


District Flood Risks
(million US$ per year)
in selected districts in
Mekong Delta transboundary Focal Areas
DNAME PNAME Risk_Hou Risk_Inf Risk_Agr
Kampong Trabaek Prey Veng 0,046 0,165 0,478
Kaoh Thum Kandal 0,021 0,4 0,002
Kaoh Andaet Takeo 0,012 0,229 0,529
Kaoh Thum
Kampong Trabaek
Svay Rieng
Tan Hong
Kaoh Andaet
Chau Doc
Tam Nong
Chau Phu
DNAME PNAME Risk_Hou Risk_Inf Risk_Agr
Tan Hong Dong Thap 0,746 1,328 0,197
Tam Nong Dong Thap 0,871 1,379 0,356
Chau Phu An Giang 0,284 1,559 0,009
N
Legend
Provincial capital
Mekong and Bassac Rivers
Rivers and canals
Roads
Boundary countries
1
Risk housing
Risk infra and relief
Risk agriculture
0 5 10 20 km


District Flood Risks
(million US$ per year)
in Nongbok, Laos
Nakhon Phanom
Thakhek
Sakon Nakhon
Nongbok
THAILAND
LAOS
Savannakhet
Mukdahan
N
Legend
Major city
Rivers and canals
Roads
Country boundary
1
Risk housing
Risk infra and relief
Risk agriculture
0 5 10 20 km
DNAME PNAME Risk_Hou Risk_Inf Risk_Agr
Nongbok Kham muane 0.011 0.326 2.31