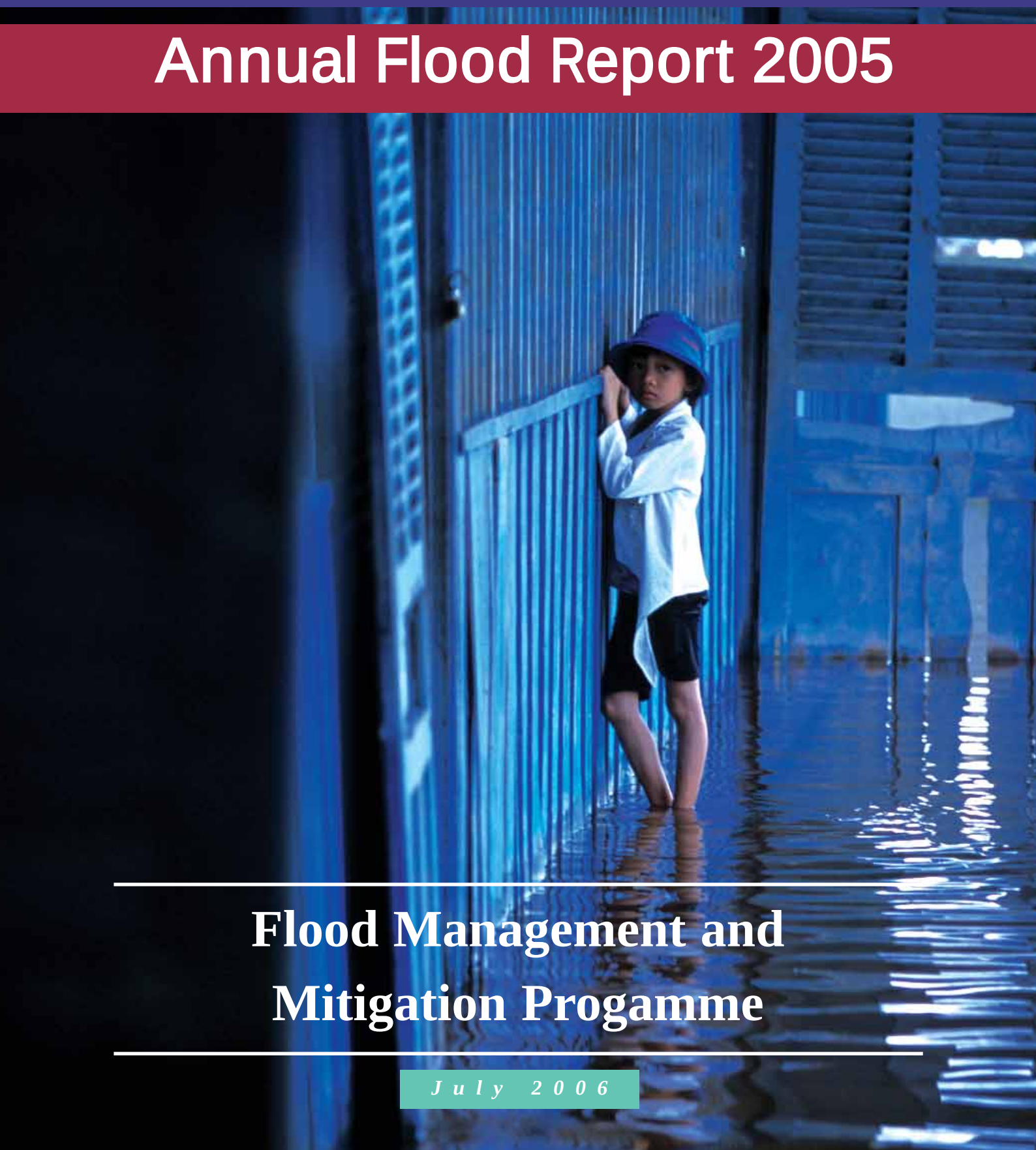
Mekong River Commission

Annual Flood Report 2005



Flood Management and Mitigation Progamme

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It is my pleasure to introduce the Mekong River Commission's 2005 Annual Flood Report of the Lower Mekong Basin produced by the MRC's Flood Management and Mitigation Programme.

This report is the first of its kind and contains data and first hand reports of the 2005 flood season as it affected inhabitants of the Lower Mekong Basin countries of Cambodia, Lao PDR, Thailand and Viet Nam.

The MRC has instigated this initiative because we realise how important it is to listen to the needs and the comments of the people of the basin. Their needs are our top priority. Our programmes are driven by these needs and we recognise that the comments and information gathered from those communities most affected by floods is essential if we are to provide solutions to the challenges facing the poorest people in our region. Our teams went into the field and worked with villagers, local authorities and those involved in flood management and mitigation at provincial levels. It is only by involving those at grass roots level that we can gain the real picture of how flood affects the people of our region, as often they are the ones who know the situation better than us. This type of fieldwork will enable the orientation of the FMMP to be based on a sound understanding of people's needs and problems.

The MRC's FMMP will update this report annually and will use data gathered to improve its flood management and mitigation activities. We think this will prove an invaluable tool in helping the MRC provide more accurate data for flood preparedness and also help our member countries in planning future land use.

As the population of the basin has grown, agriculture has intensified and land use has changed and this, in turn, has had an effect both on the flood patterns and the toll on humanity and the economy. Today the existing flood forecasting and warning systems in the Mekong River Basin are not yet adequate enough and there is a real and urgent need to improve the quality of flood information available. We need to develop professional solutions to the basin's needs. We need to create a highly efficient flood forecasting system, which must also include the ability to cope with flash floods and which will provide accurate, timely and easily understood data to all those people likely to be affected by floods.

Floods create a climate of insecurity and instability to socio-economic systems, making sustainable development, which builds on long-term planning and future-oriented investments, more difficult. Better flood preparedness will help to reduce people's susceptibility to floods by providing necessary data on flood hazards and flood occurrences as well as measures to cope with such natural hazards. It will contribute to stabilisation of socio-economic systems and allow for a long-term development perspective.

Taking into account that more than one-third of the predominantly rural population in Cambodia, Lao PDR and Viet Nam live below the poverty line such devastating floods have a great impact on the fragile social and economic systems. They pose a major threat to people's lives and property. Flood preparedness is an important precondition for poverty alleviation and sustainable development in the Mekong region.

However we must also take into account that for many of the basin's people the annual flood is also a source of livelihood and sustenance. Beneficial impacts of a normal flood include rejuvenation of wetlands as breeding grounds for aquatic plants, fish and animals (vital sources of income and food for the poor); enrichment of soil by river-borne sediments and nutrients beneficial to agriculture; and replenishment of reservoirs and groundwater as reserves against dry season water shortages.

We need to help these people who are living with floods to be ready when disaster strikes and to plan ahead when implementing land use changes or introducing barriers and infrastructure.

The MRC's FMMP is a good example of how MRC is gradually adopting integrated water resources management at basin level, It complements the integrated nature of MRC's work receiving valuable inputs from the other MRC programmes such as the Basin Development Plan, the Environment Programme, the Information and Knowledge Management Programme, Water Utilisation Programme and the Agriculture, Irrigation and Fisheries Programme.

This MRC Annual Flood Report 2005 is a step toward building up an improved knowledge base of floods and their occurrences to better enact the aim of the FMMP - to prevent, minimise and mitigate people's suffering and economic losses due to floods while preserving the environmental benefits of floods.

I am sure it will be essential reading for all those involved in flood management work in the Lower Mekong Basin.

Dr Olivier Cogels
Chief Executive Officer
Mekong River commission Secretariat

Annual Flood Report 2005

Contents

Acronyms

ACF	Action Contre la Faim
ARC	American Red Cross
BDP	Basin Development Programme
CSO	Civil Society Organisations
CA	Cooperative Agreement
CRC	Cambodian Red Cross
DiPECHO	Disaster Preparedness Programme of the European Community Humanitarian Office
LMB	Lower Mekong Basin
FMM	Flood Management and Mitigation
FMMP	Flood Management and Mitigation Programme
GIS	Geographical Information System
IO	International Organisations
MRC	Mekong River Commission
MRCS	Mekong River Commission Secretariat
NDMO	National Disaster Management Organisation
NCDM	National Committees for Disaster Management
NMC	National Mekong Committees
OFDA	Office of Foreign Disaster Assistance
PCDM	Provincial Committee Disaster Management
RCV	Red Cross Volunteer
RFMMC	Regional Flood Management and Mitigation Center
USAID	United States Agency for International Development
VMD	Vietnamese Mekong Delta

1. INTRODUCTION

The flooding of the Mekong River is a recurrent event. Every year the Lower Mekong Basin (LMB) experiences flooding, which has the potential to adversely affect economic and human activities, often claiming lives and causing damage to important infrastructure, human settlements and essential services. Whilst the regular flood cycle is seen as a source of livelihood, severe floods can have a devastating effect on the basin's efforts to improve economic development and reduce poverty. The negative effects of floods regularly counteract efforts for economic development and poverty reduction in various locations throughout the LMB, but, at the same time floods make an essential contribution to the wealth of biodiversity, abundance of fish and soil fertility.

Immediately following the severe flood of 2000, the Mekong River Commission Council instructed the Mekong River Commission Secretariat (MRCS) to prepare a Flood Management and Mitigation (FMM) Strategy using a highly participatory process of interaction with National Mekong Committees (NMC) and line agencies in the four riparian states, the donor community, International Organisations (IO) and Civil Society Organisations (CSO). The development objective of the MRC Flood Management and Mitigation Programme (FMMP) is: "to prevent, minimise or mitigate people's suffering and economic losses due to floods, while preserving the environmental benefits of floods". This objective is the key to a balanced approach to Flood Management and Mitigation (FMM) and reinforces the region's commitment to "living with floods".

This MRC Annual Flood Report 2005, the first flood report to be published at LMB level, was prepared as part of the MRC's Flood Management and Mitigation Programme (FMMP) at the RFMMC. This report is intended to be an account of the floods which occurred during 2005. It will serve as a source of information and as a reference document for the MRC Joint Committee and Council members and also for a wider audience, such as the agencies responsible for disaster management and mitigation in the MRC Members States, institutes involved in water resources planning, donor organisations, NGOs etc. As part of its programme activities the FMMP is scheduled to develop an Annual Flood Report from this year forward.

Over the past three years, each of the MRC's member countries has prepared an annual flood report to be presented during the Annual Mekong Flood Forum (the last forum was held in 2005). However often, while key information was provided, the usefulness of these reports was seriously limited by lack of standardisation and lack of consolidated overview and this has hindered a clear understanding of the flood events throughout the Lower Mekong Basin.

The preparation of this MRC Annual Flood Report 2005 is the result of a joint exercise which integrates the views of a wide range of stakeholders involved in or affected by floods in the Mekong River Basin. The key objective of this exercise is to attempt to make this report as coherent and as "standardised" as possible in order for the reader to get the most comprehensive picture of the flood issues, benefits and stakes.

In the future, a more comprehensive report should be developed step-by-step, by monitoring the flood events according to standardised procedures during the flood period. It will be important to organise data flow in such a way that the writing of the annual flood report should eventually be an easy exercise of consolidating all the various information collected. It may take time to establish those common monitoring procedures in the four countries, but building this system, step by step, and gradually obtaining a better knowledge of the actual flood issues and stakes in the Mekong River is an essential tool when designing flood management and mitigation strategies and investments.

This annual flood report 2005 is produced with funds from the Royal Netherlands Embassy in Hanoi, Vietnam, for component 1 of the Flood Management and Mitigation Programme of MRCS.

2. THE FLOOD IN THE LOWER MEKONG BASIN

2.1 Catchment geography

From its source, the Mekong stretches about 4,800 km to the South China Sea, draining a total catchment area of approximately 795,000 km^2 within the six countries of China, Myanmar, Lao PDR, Thailand, Cambodia and Viet Nam. The Mekong ranks 10th amongst the world's great rivers on the basis of mean annual flow at the mouth. The Greater Mekong can be divided into two parts: the Upper Basin in Tibet and China (where the river is called Lancang Jiang), and the Lower Mekong Basin from Yunnan downstream from China to the South China Sea.

The Mekong flows for almost 2,200 km from its source and decreases in altitude by nearly 4,500 m before it enters the Lower Basin where the borders of Thailand, Lao PDR, China and Burma come together in the Golden Triangle. Downstream from the Golden Triangle, the river flows for a further 2,600 km through Lao PDR, Thailand and Cambodia before entering the South China Sea via a complex delta system in Viet Nam. The Upper Basin makes up 24% of the total area and contributes 15% to 20% of the water that flows into the Mekong River. The catchment here is steep and narrow.

Major tributary systems develop in the Lower Mekong Basin. These systems can be separated into two groups: tributaries that contribute to the major wet season flow, and tributaries that drain low relief regions of lower rainfall. The first group are left bank tributaries that drain the high-rainfall areas of Lao PDR. The second group are those on the right bank, mainly the Mun and Chi Rivers that drain a large part of Northeast Thailand.

As the Mekong enters Cambodia over 95% of the flows have already joined the river. From here on downstream the terrain is flat and water levels rather than flow volumes determine the movement of water across the landscape. The seasonal cycle of changing water levels at Phnom Penh results in "flow reversal" of water into and out of the Great Lake via the Tonle Sap River. During the flood months, water flows up the Tonle Sap from the Mekong mainstream into the Lake. As the water level decreases in the mainstream in late September, water flows out of the Tonle Sap down into the Mekong mainstream. Nowhere else in the world is there a flow reversal this large.

The Great Lake on the Cambodian floodplain is the largest body of fresh water in Southeast Asia and forms one of the key features of the lowlands. The depth of the Great Lake increases from a dry season maximum of 3.6 m to more than 10 m, and the area of open water increases from approximately 2,500-3,000 km^2, up to 13,000 km^2. The seasonal storage of water in the Great Lake also acts as a huge natural regulator for water flows downstream of the Tonle Sap-Mekong confluence at Phnom Penh. This has some significant advantages in terms of the seasonal distribution of flows in the Vietnamese delta. As stored water flows out of the lake back to the mainstream during the dry season, the low flows in the Mekong are increased and are therefore higher downstream of Phnom Penh than they would be otherwise. The benefit is more water for irrigation and a reduction in saltwater intrusion in the delta.

The Mekong Delta begins in Phnom Penh, where the river divides into its two main distributaries, the Mekong and the Bassac. The Mekong then divides into six main channels and the Bassac into three to form the "Nine Dragons" of the outer delta in Viet Nam. The main delta is made up of a vast triangular plain which is lower than five metres above sea level, large areas of which are flooded every year. The movement of water within this complex channel network cannot be regarded as natural, due to the long history of modification. Levees were built hundreds of years ago along some of the main natural channels. Hydrology is not only dominated by the rivers but also by the tide, which has a large expansion in the dry season and which can slow down the drainage of the river during heavy flood periods, mainly downstream.

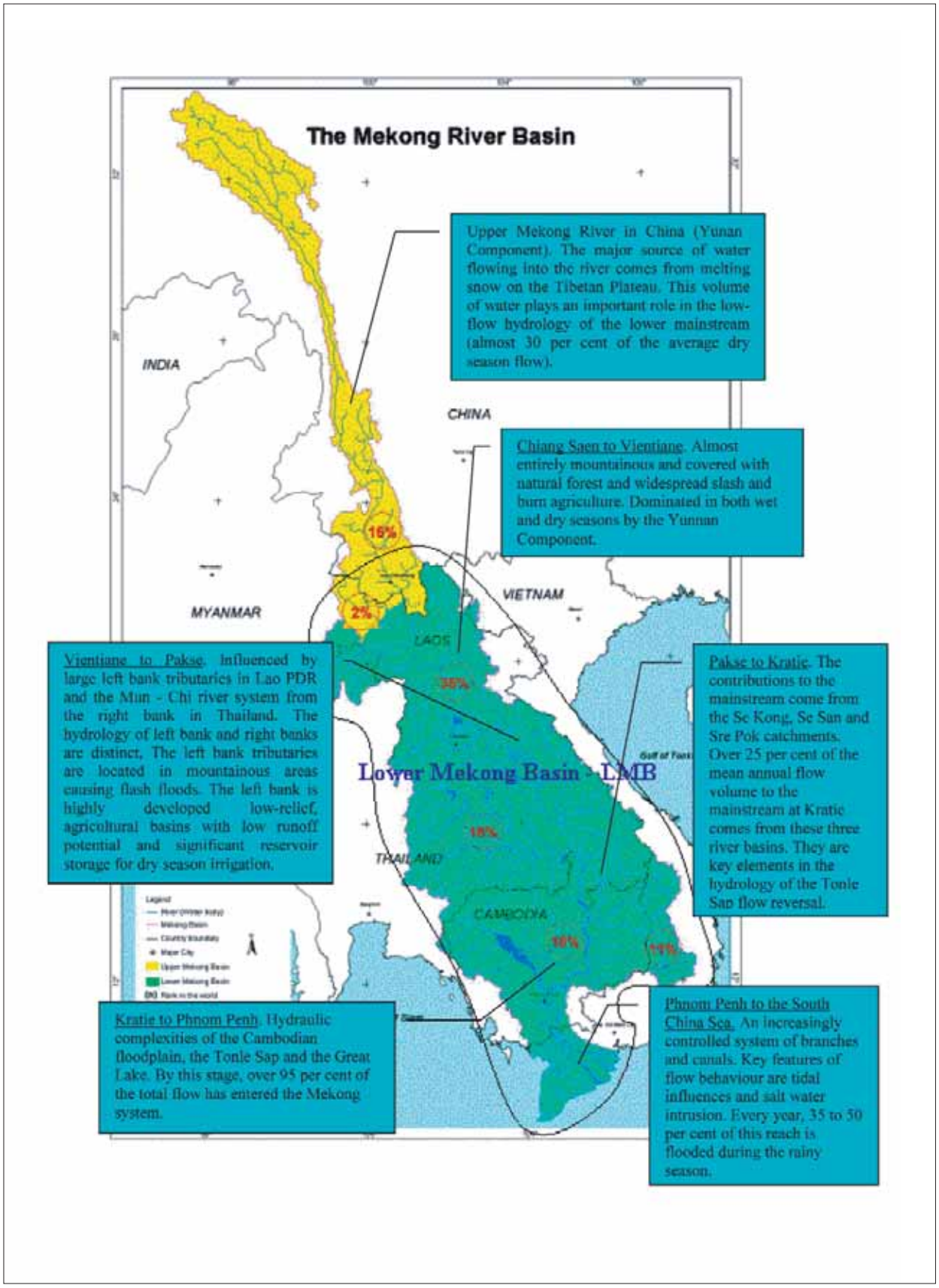


Figure 1: The Lower Mekong Basin

2.2 The climate

The climate of the Lower Mekong Basin is dominated by the Southwest Monsoon, which generates wet and dry seasons of more or less equal length. The flood period in the LMB corresponds to the Southwest monsoon season which usually lasts from May until late September or early October. There are usually heavy rainfalls during one or two days in most parts of the basin. Later in the season, tropical cyclones occur over much of the area so that August, September and even October (in the delta) are the wettest months of the year (see Figure 2).

The Lower Mekong Basin is divided into six sub regions for the comparison of annual and monthly rainfalls and changes in space and time. Annual average rainfalls over the Cambodian floodplain and the Mekong delta are equally low and less than 1,500 mm. Elsewhere the highest rainfall is expected in the Central Highlands and within the mainstream valley at Pakse. Rainfall is less important in the more temperate northern regions around Chiang Rai. July, August and September are generally the months of highest rainfall, although there is evidence of a shift later in the season in Cambodia and in the delta where more rain falls in September and October.

Tropical storms and cyclones have a strong effect on the climate of the basin. This effect shows up as a double peak in rainfall distribution over most of the Lower Mekong Basin during a wet period or season, and the concentration of maximum rainfalls during the last quarter of the year in Cambodia and Viet Nam. Tropical cyclones over central and southern Vietnam show that the occurrence of the cyclones is more frequent in the period September to November, causing higher rainfall during these months, which may generate flash floods in the tributaries.

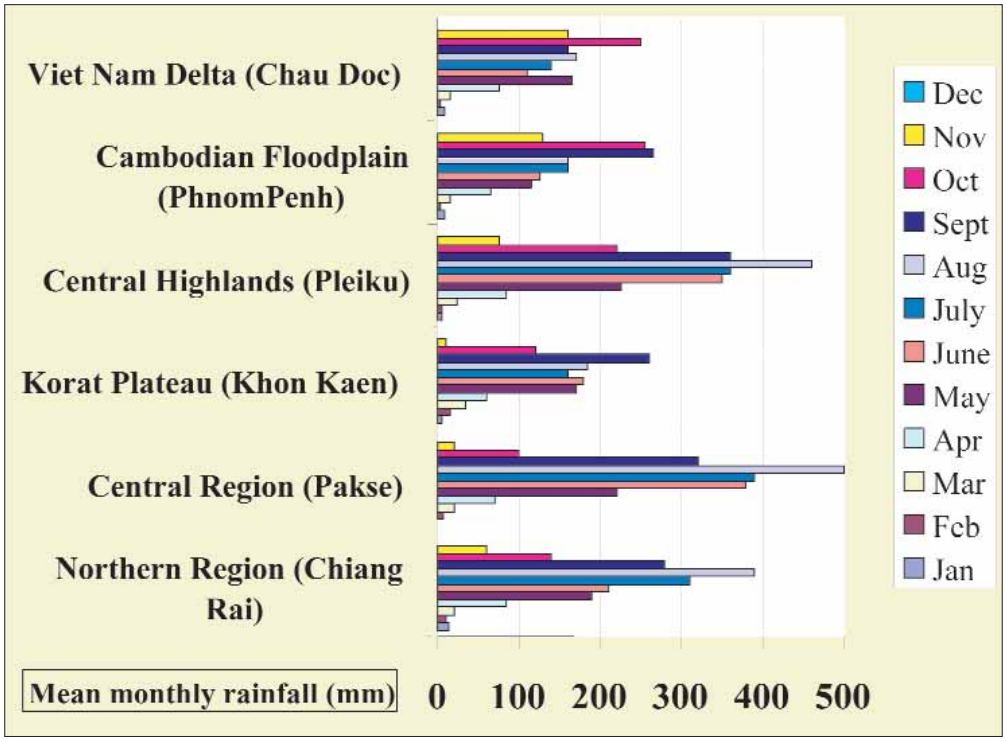


Figure 2: Rainfall pattern in the Lower Mekong Basin

The Southwest monsoon, combined with severe tropical storms, is the cause of flood disasters in the Lower Mekong Basin, particularly in Cambodia and the Mekong Delta and even sometimes in the upstream part up to Vientiane[1].

The seasonal range of mean temperatures in the lowlands and river valleys of the Lower Mekong Basin is not large. There are, however, significant changes, both season to season and from day to night at increasing altitudes and in the more temperate climates to the north. Mean summer temperatures during the period from March to October are similar within the lower basin from Phnom Penh, Cambodia to as far north as Luang Prabang, Lao PDR and Chiang Rai, Thailand. Annual rates of evapotranspiration range between one and two metres, with little variability from year to year, and combined with high relative humidity result in fairly constant annual values.

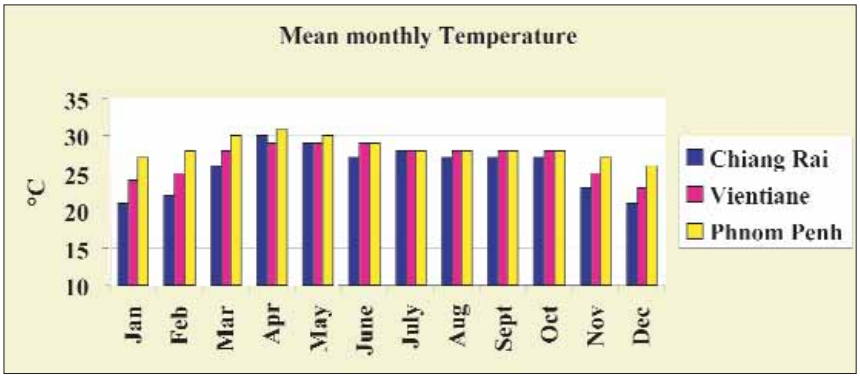


Figure 3: Mean monthly temperature in the Lower Mekong Basin

2.3 The population

Over 55 million people live in the Lower Mekong Basin. The percentage of territory and population within the basin varies considerably from one country to another. Cambodia and Lao PDR lie largely within the basin, but together constitute only 27% of the basin's population. The basin territory in Thailand is only 37% of the country but comprises 42% of the basin's population. In Viet Nam, the Mekong Delta and Central Highlands comprise only 20% of the country, but contribute 31% of the basin's population. Approximately 80% of the basin's population live in rural areas. Population density is very low at 87 people per km^2. However, if the limits of arable land are considered, net densities are significantly higher, particularly in Lao PDR (465/km^2) and Viet Nam (395/km^2 and up to 900/km^2 in some districts of the Mekong Delta).

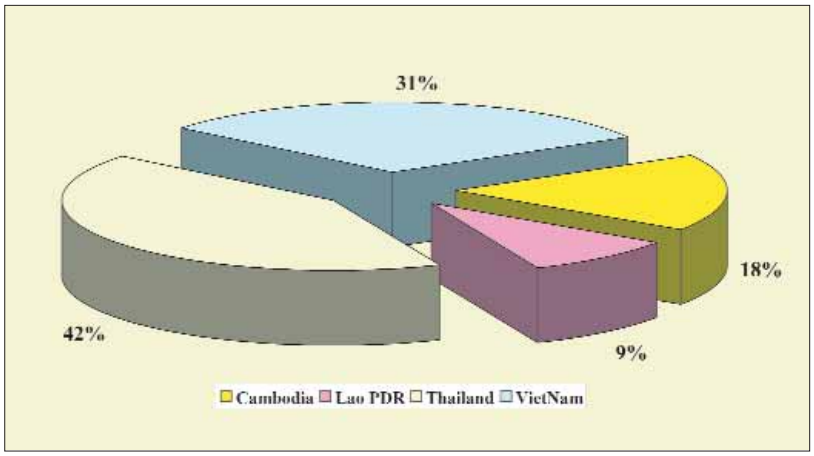


Figure 4: Percentage of population living in the Lower Mekong Basin

[1]In 1966, Typhoon Phyllis was responsible for the most extreme flood recorded at Vientiane since 1913

2.4 The socio-economy

In the past 15 years, economies within the LMB area have begun to change. Although the majority of people still earn their livelihoods from a combination of subsistence farming, supplemented by fishing and foraging from wetlands and forests, other sectors began to develop in the 1980s and 1990s .

Agriculture is the single most important economic activity in the LMB. Overall, an estimated 75% of the LMB population earn their livelihood from agriculture, in combination with other activities such as fisheries, livestock, and/or forestry. Agriculture in the LMB is divided into two main categories – subsistence and commercial.

Subsistence farmers typically grow enough rice for household consumption, sometimes with a small surplus to sell. Shifting cultivation, which involves clearing forested areas and farming plots on a rotational basis, is practiced extensively in upland areas in the Viet Nam Central Highlands, in northeast Cambodia, and in upland Lao PDR. An estimated 70% of the people who live in the LMB are subsistence farmers. They supplement the rice they grow with the wild fish they catch and plants and animals foraged from nearby forests and wetlands for use as food and medicines.

Production of rice and fish (in a natural environment or in fishponds) constitute the two basic activities for most inhabitants of the Mekong region. These activities are regulated according to flood and drought periods. Intensity of floods and droughts, and possible human mitigation, are key social and economic stakes.

In the lowlands, where soil and access to inputs and markets are all good, agriculture is becoming increasingly commercial and profitable now that all four LMB governments have adopted free market systems. For some years farmers in the Korat Plateau in Northeast Thailand, have practised commercial farming of single crops such as tobacco and sugarcane. In Viet Nam's Mekong Delta, commercialisation of rice farming has made the country the world's second highest exporter of rice. Although commercial agriculture is largely confined to lowland areas, lowland farmers have been encouraged to resettle in the Central Highlands in Viet Nam to grow cash crops such as coffee, tea and rubber. Irrigation and flood control infrastructure are increasing in the lowland areas of the basin to enable production of a second and even a third rice crop, dry season or perennial cash-crops, and to expand wet season production.

The Mekong's fishery is of huge importance to the people who live in the Lower Mekong Basin. Most of the 12 million rural households in the LMB fish as well as farm, and fish is the main source of animal protein in most people's diets. An estimated 40 million rural dwellers are involved in the fishery at least part-time or seasonally. In Cambodia more than 1.2 million people who live in fishing areas around the Tonle Sap Lake depend almost entirely on fishing for their livelihood. Annual fish yield for the Tonle Sap Great Lake in Cambodia is estimated at 230 kg per hectare, a figure much higher than that of other Asian floodplain fisheries, whose average is about 100 kg per hectare per year. The Mekong River has one of the most abundant fisheries in the world and is probably the

world's largest river fishery. The annual catch is an estimated 1.5 million tonnes, with another 500,000 tonnes raised in reservoirs and other forms of aquaculture.

The forestry sector covers commercial logging, private and commercial gathering of fuel wood, and the harvesting of non-timber forest products (NTFPs). Countries in the LMB consume most of the wood they produce, but there is significant flow between countries. Cambodia and Lao PDR produce a surplus and Thailand and Viet Nam import wood from these two countries. Non-timber forest products include wildlife, wild fruits, medicinal plants, resins, gums, precious woods, rattan and bamboo. Although not included in official forest valuations, NTFPs are important sources of income for millions of people, as well as sources of food and cash for farmers during poor harvest years.

Forests and wetlands play an essential role in the basin, not only for the biodiversity they support but also as flood regulators. Forest covering reduces runoff and wetlands increase water storage capacity. Any human contribution toward reducing the forest and wetlands areas can increase the peak of water level in the Mekong and its tributaries.

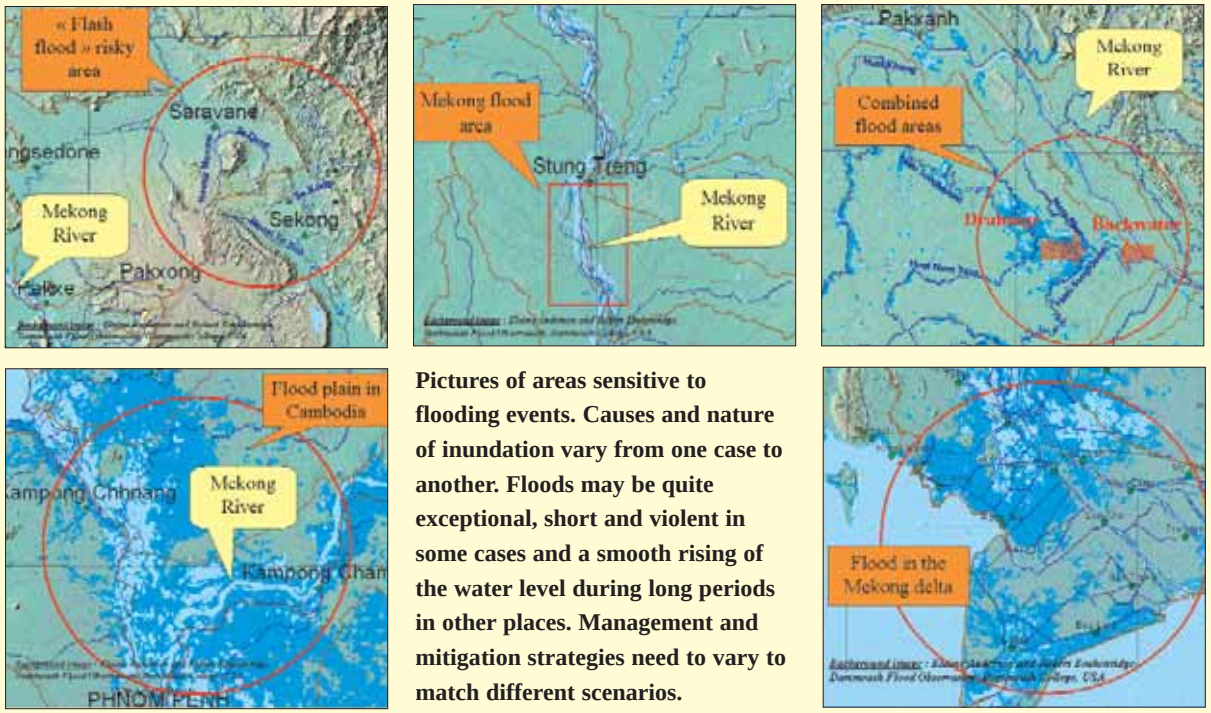
Wetlands constitute an essential resource in the LMB. Basin residents commonly harvest at least 20 species of aquatic plants for food, with surpluses sold in local markets. In seasonally flooded areas along the Songkhram River in Thailand and other tributaries in Lao PDR, Thailand and Cambodia, bamboo shoots are harvested for food and for income generation. Other commonly consumed wild plants include watercress, water chestnuts and aquatic ferns. Water ferns and water cabbages feed ducks, cows and pigs. Medicinal uses of aquatic plants include eliminating parasites, reducing fevers and reducing inflammation. A study of one lakeside community listed 35 species of wetland plants that were used for medicinal purposes.

Wetlands also provide an essential biological system for fish reproduction. The large floodplain areas in the Mekong Delta and around the Tonle Sap Great Lake in Cambodia are crucial nursery habitats. Deep pools and channels in the mainstream of the Mekong near Kratie in Cambodia, in the Nam Theun and Nam Hinboun Rivers in Lao PDR, and in the Se San River in Cambodia are important dry season refuges for fish, which re-colonise the floodplain when waters rise with the next rainy season. Many important commercial species swim hundreds of kilometres across borders from the Mekong Delta in Viet Nam, through Cambodia to Thailand or Lao PDR via the Mekong River mainstream; to Lao PDR via the Se Kong River; or, to the Central Highlands in Viet Nam via the Se San and Sre Pok Rivers. The species migrations are essential for the success of the Mekong's fishery. Although rivers and their associated floodplains encompass a range of different fish habitats, they are all ecologically linked to a complex "fish migration network".

2.5 The flood

The flood in the LMB is far from being a uniform phenomenon. It is useful to establish a typology of the floods. This typology should be divided into five categories.

Flash floods are floods that occur in the tributaries of the Mekong River after intense or long periods of rain in the catchment. Water in the stream rises fast, water velocity may be very high, but the duration of such a flood is limited to a few hours up to a maximum of a few days. The flash floods are totally independent of the water level in the Mekong River and may occur at any time during the rainy season. It might only be possible to predict such flood events by observing rainfall and water levels along the tributaries where flash flood tend to happen. Flash floods are common in the mountainous areas of the LMB. In those areas, floods are largely considered harmful to people, cattle and infrastructure. Paddy fields are less in danger as the duration of the flood is limited. The mitigation measures for limiting damage from flash floods consist mainly of regulating land use, in avoiding settlement and human activities in risky areas, and, where possible, diverting water from areas liable to flooding. Dams and reservoirs built upstream of the flash flood risk areas may contribute to the reduction of flash floods. Last but not least, the conservation of the forest covering is a key factor for reducing the runoff and flash floods.



Pictures of areas sensitive to flooding events. Causes and nature of inundation vary from one case to another. Floods may be quite exceptional, short and violent in some cases and a smooth rising of the water level during long periods in other places. Management and mitigation strategies need to vary to match different scenarios.

Figure 5: Typology of flood events in the Lower Mekong Basin

Floods in the Mekong River are floods caused by high water levels in the mainstream. The water level may overflow lower sections of the embankment or local backwater may occur in ditches or small tributaries. Additionally, if there is heavy rainfall at the same time in areas where runoff is substantial (urban areas), there

may be limited or no drainage. The flooding period is limited to the time the water level in the Mekong is at its highest, generally not more than one or two weeks. Flooding is seen as damaging as it may wash out infrastructure and houses. Casualties and loss of cattle are generally limited as the flood may be predicted easily by observing the water level of the Mekong, making preparedness easier. The limited duration of flooding does not have much effect on the rice production. Mitigation measures for limiting damage from such floods consist mainly of regulating land use, of limiting settlement and human activities in the risky areas, of diverting the flood to wetland areas where possible and of building embankment protection in urban areas or areas where important assets need to be protected.

Combined floods are floods that occur in the downstream section of large tributaries, close to the outflow into the Mekong mainstream. Those areas are often shallow areas or wetlands. Severe flooding events may be recorded if two conditions are simultaneously fulfilled: high flow in the tributary and a high level of the Mekong. When the level in the Mekong is high, backwater flows into the tributaries and prevents, or slows down, the drainage into the Mekong. Large areas may be flooded for long periods. People living in such areas are accustomed to facing flood situations and are more prepared than people living in "flash flood" risk areas. Flood is essentially seen as harmful by farmers, but at the same time they recognise that backwater is source of soil fertility and is favourable for fish reproduction. Damage caused by such floods is mainly limited to rice fields, particularly in the case of long periods of flooding. Infrastructure such as roads, culverts, irrigation canals and pumping stations may be damaged by erosion. Wetlands are highly valuable for biological diversity and fish reproduction but also for storing water and reducing peak values of the water level in the downstream sections. The mitigation measures for limiting damage from such floods consist of improving land use regulations and making clear delineations between wetlands areas and areas for agriculture. Embankments and, regulators (colmatage canals) with gates aimed at controlling backwater from the Mekong may be efficient if the management of such infrastructure still allows "normal" flooding in order to avoid adverse effects on the environment.

The flood in the Cambodian flood plain is characterised by lateral flows of the Mekong from Kratie to the confluence with the Tonle Sap River and in the Tonle Sap basin and great Lake itself. Up to 4 million ha of lowland areas in Cambodia are inundated annually. Floods are an essential contributor to the wealth of biodiversity, abundance of fish and soil fertility. Yearly damage may be substantial, and preparedness is essential for decreasing accidents suffered by people and livestock. Damage by erosion is quite unavoidable. Damage to rice fields is recorded when the period of high water level flood lasts too long, but it must be taken into account that farmers are used to growing rice in risky areas knowing that there is a high probability they will lose production. Embankments and dykes may reduce the risk of flooding, but as human activities are largely based on fishing rather than agricultural production, the usefulness of increasing such infrastructure should be carefully studied. Helping the people to "live with floods" is likely the most appropriate option.

The flood in the Mekong Delta. The yearly flood is characterised by extended areas inundated by water from the Bassac River, the Mekong River and the numerous natural and artificial canals linking the two rivers that flow laterally to low lands. Sometimes, high water levels in the Bassac/Mekong systems may not drain easily to the sea due to tidal effect This This was the case during the severe 2000 flood in the downstream provinces of the Mekong Delta. Water level rises slowly for a long period. Every year there is substantial damage from these high water levels, primarily as a result of people drowning and from soil erosion damaging houses and infrastructure. Flooding is recognised as essential for soil fertility and biodiversity, but at the same time is perceived as an obstacle to the development of agricultural production and urbanisation. There is great pressure to protect land against floods by building dykes and backfilled areas. Land use planning and keeping the balance between socio-economic and the environmental concerns remains a key issue for the future of the Mekong Delta.

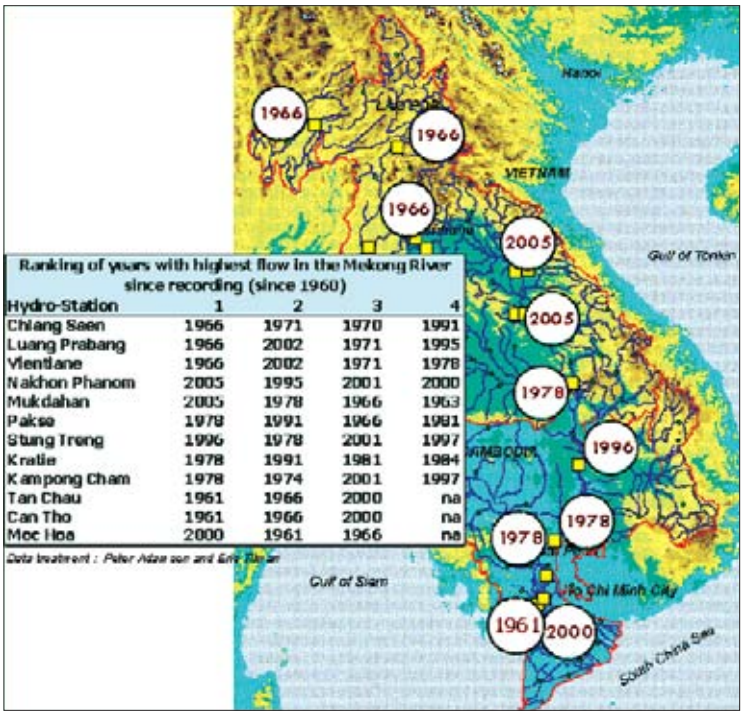
3. THE 2005 FLOOD

3.1 Overview of recent flood periods

In order to obtain a reasonable idea of how severe a flood is, each new flood event must be compared with past events. The information in Figure 6 shows years where the maximum flow of the Mekong River was recorded since data was systematically collected. Only stations where there were complete records have been included.

Year 1966 was obviously the worst year in the upper part of the LMB, with its effects extending to Pakse. *Year 1978* was the most serious flood for the area south of Mukdahan (Savannakhet) up to the confluence with the Tonle Sap river in the flood plain of Cambodia. *Year 1996* recorded a severe flood, but it was limited to the area of Stung Treng at the confluence with the Sekong River. *Years 1961, 1966 and 2000* were nearly equally devastating years for the Mekong Delta, although 2000 was seen as particularly damaging and remains memorable to all the people living in the floodplains. *Year 2005* is definitely the most severe flood for the central area of Lao PDR and Thailand (Nakhon Phanom, Thakek, Mukdahan and Savannakhet). In second ranking: years 1971, 1974, 1984, 1991, 1995 and 2002 may also be considered as severe for one or another section of the LMB.

A severe flood is therefore a quite common situation in the LMB. But localisation of such events varies from one year to another which is why it is locally considered as exceptional. For example, very few people, even those familiar with the hydrology of the Mekong, are aware that 2005 was an "exceptional" flood. The Mekong River system, and its outstanding capability for storing water in low lands, is very complex in terms of hydrology. There are different possible scenarios which vary according not only to the duration and depth of rainfall, but also to the period in the flood season when rainfall occurs, and whether the lowland storage capacities are still available or not.



Ranking of years with highest flow in the Mekong River since recording (since 1960)

Hydro-Station	1	2	3	4
Chiang Saen	1966	1971	1970	1991
Luang Prabang	1966	2002	1971	1995
Vientiane	1966	2002	1971	1978
Nakhon Phanom	2005	1995	2001	2000
Mukdahan	2005	1978	1966	1963
Pakse	1978	1991	1966	1981
Stung Treng	1996	1978	2001	1997
Kratie	1978	1991	1981	1984
Kampong Cham	1978	1974	2001	1997
Tan Chau	1961	1966	2000	na
Can Tho	1961	1966	2000	na
Moc Hoa	2000	1961	1966	na

Data treatment : Peter Adamson and Eric Baran

Figure 6: Years with maximum flood discharge

Another interesting analysis is the comparison of the past six years of flooding in terms of flood peaks and durations for a number of locations along the mainstream. The graphs in Figure 7 show the number of days in each year where water level has exceeded peak values. The section of the Mekong from Chiang Saen to downstream of Vientiane was not particularly critical during 2005, in comparison with the worst year in 2002. However, in the next section, from Nakhon Phanom to Pakse, the peak water level in the Mekong and the duration of the peak were the worst for the past six years. Downstream of Pakse, up to the confluence with the Tonle Sap, the water level in the Mekong stayed at the warning levels for a long period, but without being abnormal and definitely far below the situation recorded in 2000, 2001 and 2002. In the Mekong Delta, the 2005 flood was acceptable, with many days with a high water level, but no days exceeding warning or flooding limits.

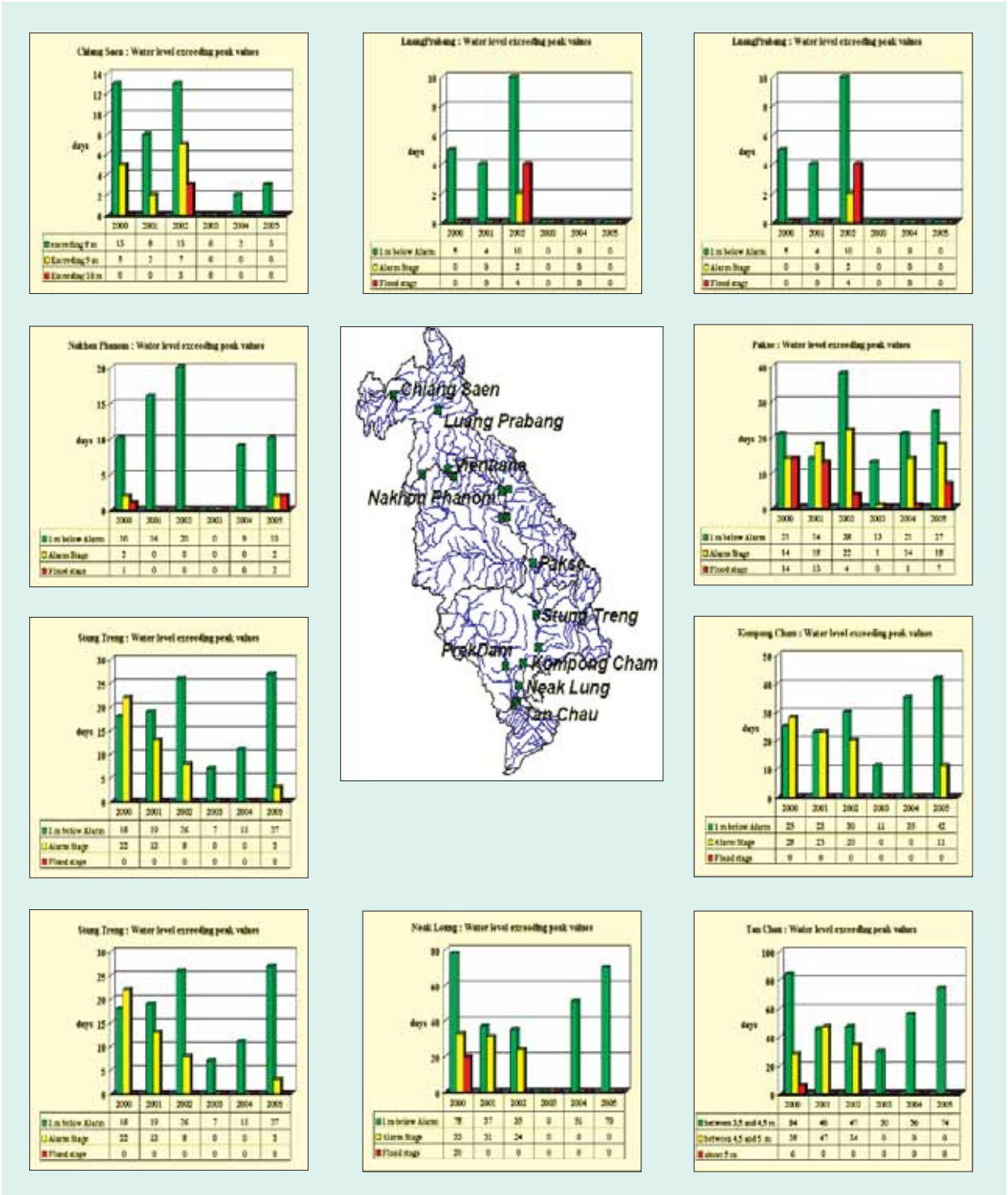


Figure 7: Water levels exceeding peak values in hydrological stations along the Mekong River

3.2 Hydrological analysis of the 2005 flood

In the upper section of the Mekong, from the border with Myanmar (Chiang Saen) to Luang Prabang and Vientiane, the level of the Mekong throughout the season remained quite low, and no flood generated by the Mekong River itself was recorded. Nevertheless, several heavy rainfall events occurred, causing severe flash floods in the Northern Provinces of Lao PDR and in the Province of Chiang Rai of Thailand. In mid-September, due to excessive rainfall, water releases from the Nam Ngum dam caused damaging floods in the cultivated areas of Vientiane Province.

From the end of July to September 2005, the monsoon winds from the southwest and cyclones namely: Washi, Matsa, Vicenty and Damray produced heavy rains. The average rainfall in Lao PDR was far above the normal average, particularly in the provinces of Borikhamxay, Khammouan, Sekong, Saravane and Attapeu which normally record levels around 450 to 550 mm over this period. This generated many flash flood events in the central and southern provinces of Lao PDR.

These rains caused a dramatic increase in the water level in the Mekong River downstream of Borikhamxay, and especially in the section between Thakek to Savannakhet, Lao PDR. This situation affected nearly all the southern provinces of Lao PDR and the provinces located downstream of Nong Khai Province in Thailand, especially the provinces of Nakhon Phanom and Mukdahan. An aggravating factor was the heavy flows in the tributaries of the Mekong located in this critical section which occurred in the same period, from the end of June up to the beginning of September. This meant some districts located on these tributaries suffered from both backwater from the Mekong and flash floods from the tributaries. The drainage of the tributaries to the Mekong was slowed or even stopped, with the consequence that several villages received an exceptionally long period of flooding of over six weeks, the worst situation in nearly 30 years.

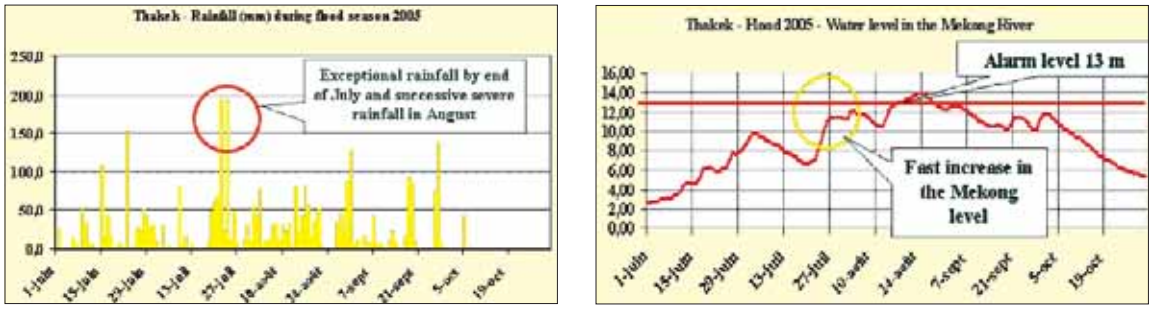


Figure 8: Hydrological rainfall and water level Data of the exceptional flood 2005 at Thakek in Khammouan Province (Lao PDR)

To the south, the situation was still critical in the provinces of Champasak (Lao PDR), Ubon Ratchatani (Thailand) although much less than upstream. The level of the Mekong was comparable to the level recorded in 2002, but below the 2000 level. Low areas in Pakse and Ubon Ratchatani were flooded, but for more limited periods. Heavy rainfalls were recorded in Saravane and Sekong Provinces causing very severe and damaging flash floods.

In Stung Treng, Kratie and Kompong Cham in Cambodia, a quite high water level in the Mekong River was recorded. Nevertheless, the situation was less exceptional and the damage was less severe than in the upper sections. The regulation of the Mun River in Thailand may have contributed to the avoidance of major damage downstream, but this has not yet been confirmed by running hydrological models on that event.

A normal flooding situation was recorded throughout the Mekong Delta below the confluence with the Tonle Sap river.

The graphs in Figures 9, 10 and 11 illustrate the hydrological analysis of the 2005 flood, using data from selected major hydrological-stations along the Mekong River to compare hydrographs and monthly rainfall, as well as comparative rainfall intensity during the 2005 flood season.

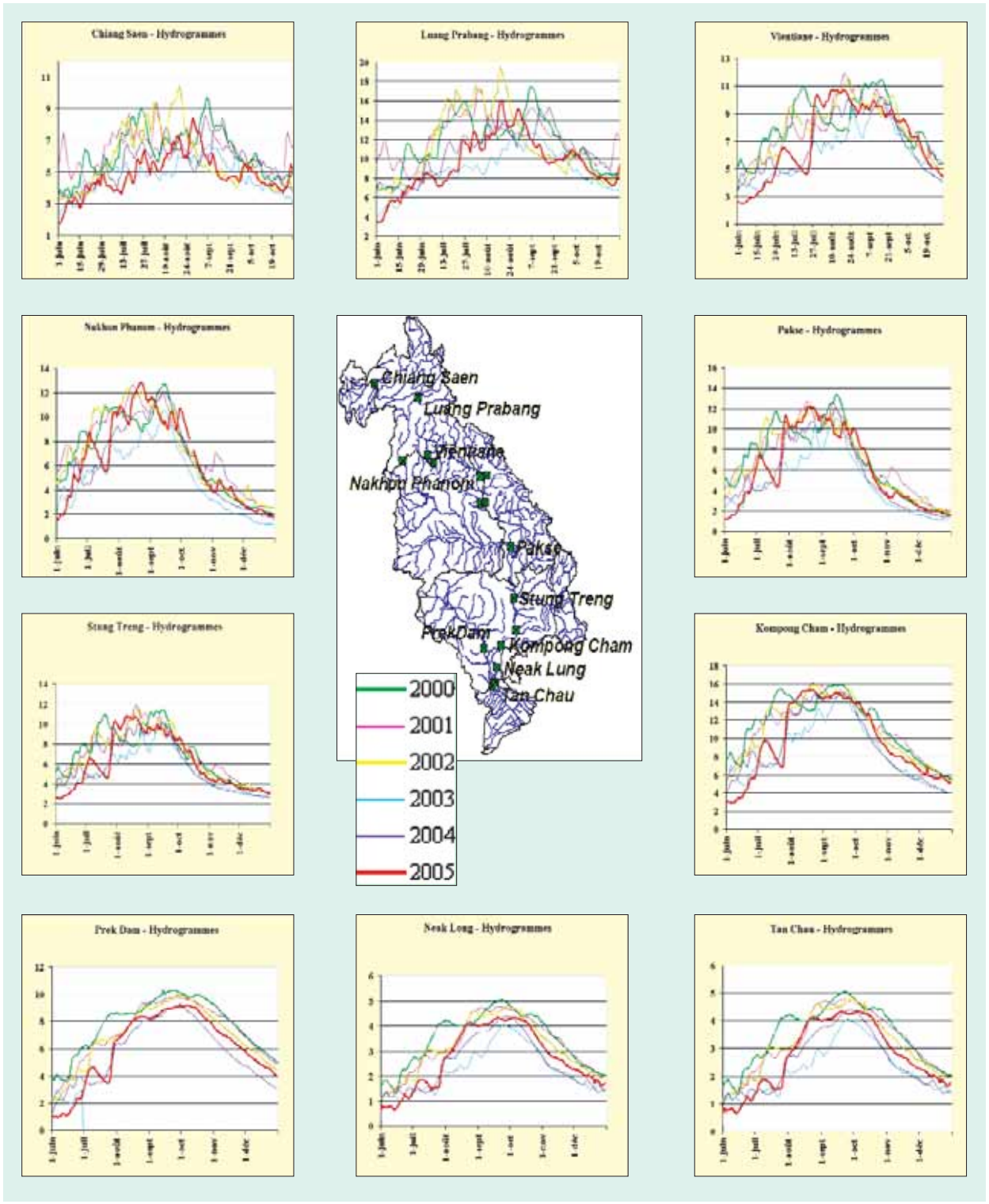


Figure 9: Hydrographs of the flood period at major hydrological stations along the Mekong River

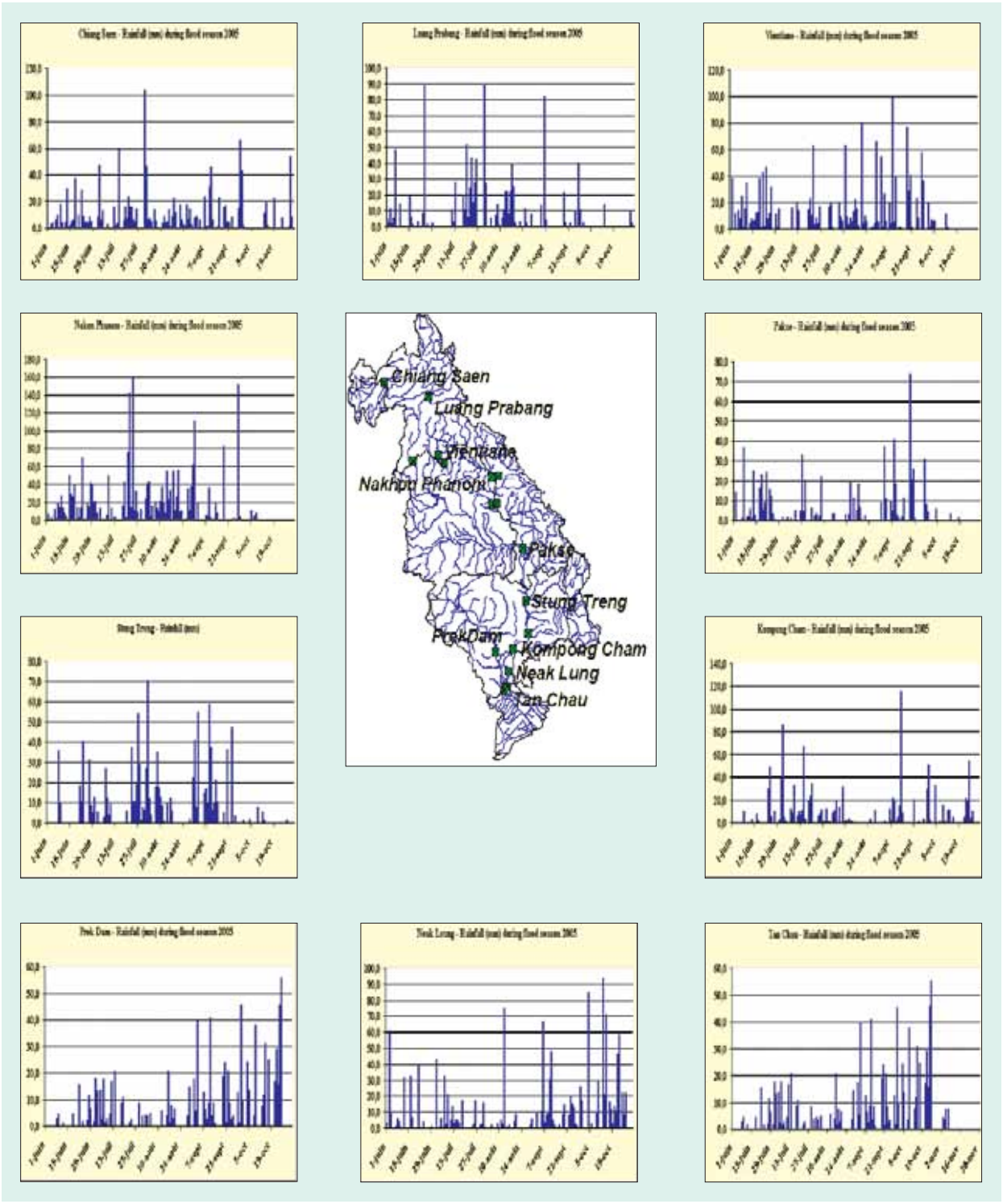
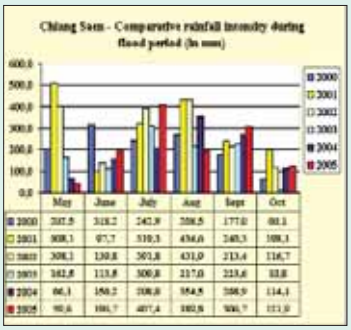
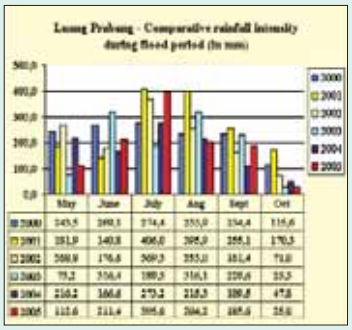
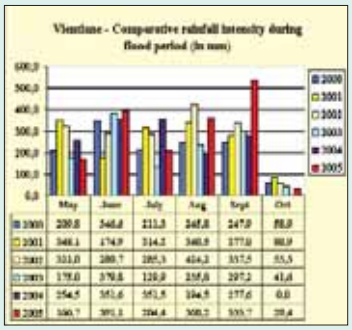
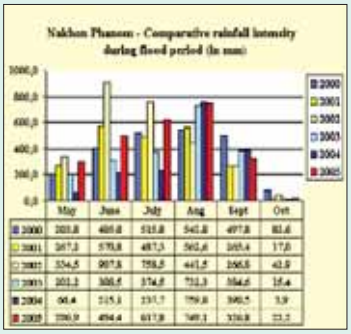


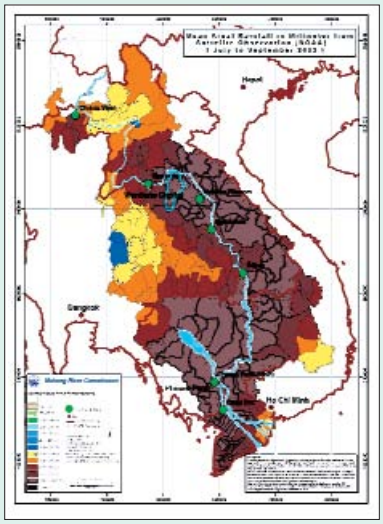
Figure 10: Rainfall during the flood period 2005 at major hydrological stations along the Mekong River





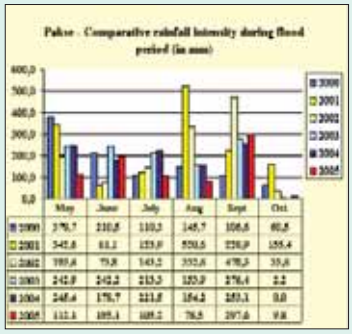


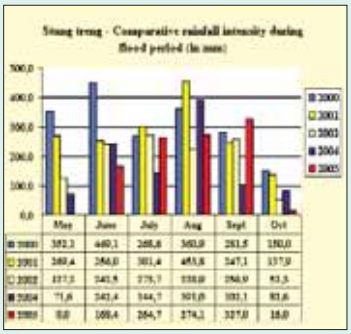


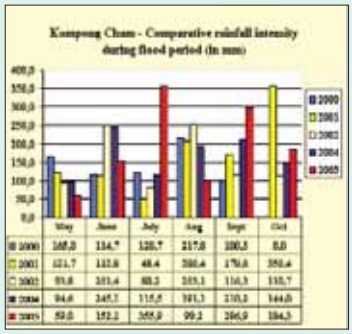


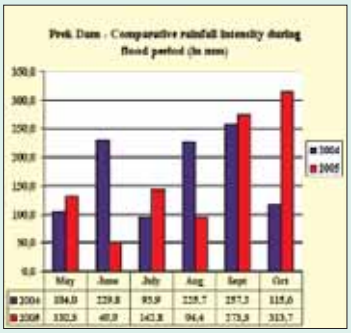
Mean areal rainfall from satellite observation (NOAA), July to Sept 2005

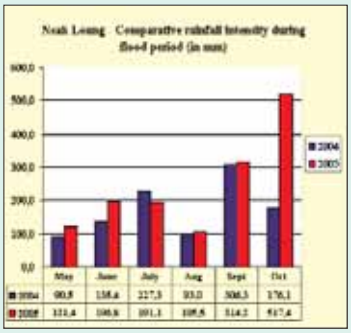
Source: Report on the hydrological conditions in the Lower Mekong Basin in 2005/2006, Twenty-third Meeting of the Joint Committee, 4-5th April 2006, Savannakhet, Lao PDR











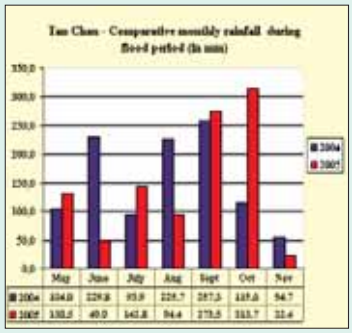


Figure 11: Comparative rainfall intensity in mm/month at major hydrological stations along the Mekong River

The available values of the maximum discharge recorded in 2005 along the Mekong mainstream are shown in Figure 12. This dataset is an estimate prepared by the Technical Support Division of the MRCS (not validated by the countries) on a basis of the operational water level data received daily during in the flood season and the most recent rating curves available at MRCS.

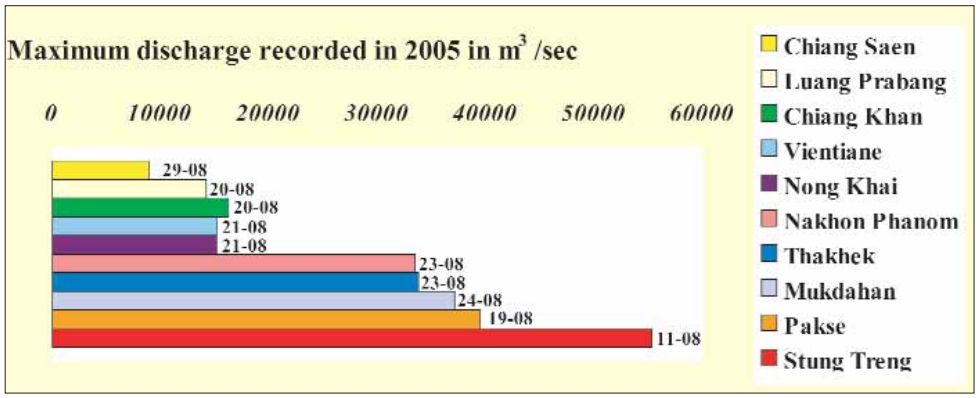


Figure 12: Maximum discharge recorded in 2005 along the Mekong mainstream

The analysis of the hydrographs shows a general drop in the water level of the Mekong in the first half of July. The explanation seems to be that no or low rainfall occurred from the last week of June until approximately 10th July in most of the upper sections of the LMB (see Figure 13).

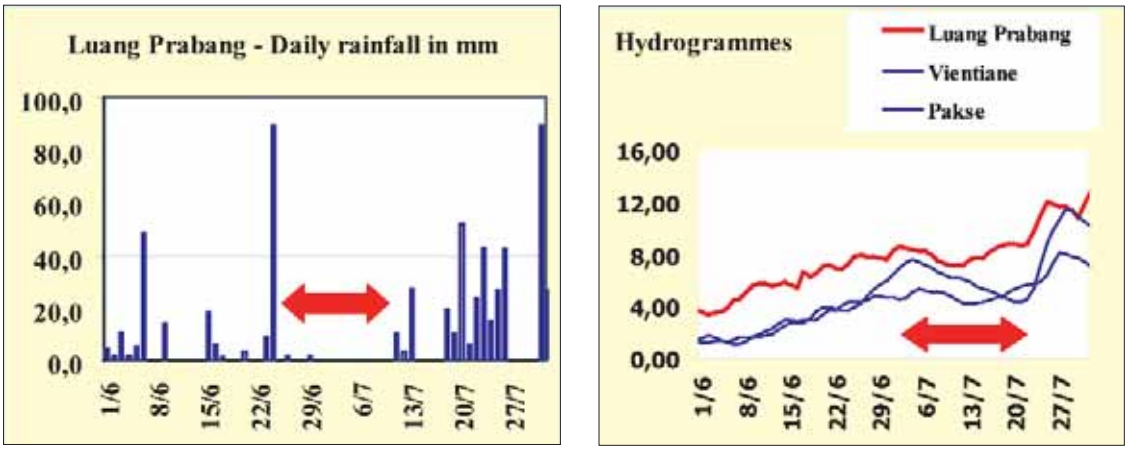


Figure 13: Drop in the water level in the Mekong River in the first week of July 2005.

The speed with which the water in the Mekong rises is an interesting parameter to analyse. The graphs show that in some places the Mekong may rise more than 1.5 m in one day which may be critical for preparedness if no adequate warning information is provided. An interesting finding is also the behaviour of the "early flood" in the Mekong Delta represented by showing the rapid fluctuation of the water level in both Neak Long and Tan Chau hydrostations (Figure 14). At the end of July, two days of rapidly rising water levels were recorded. This singularity may also be seen on all similar graphics from Thakek down to the delta. By the end of July, early heavy rainfalls had occurred in the upper part of the basin, causing rapid rises in the water level, but coupled with poor possibilities of lateral extension for water storage.

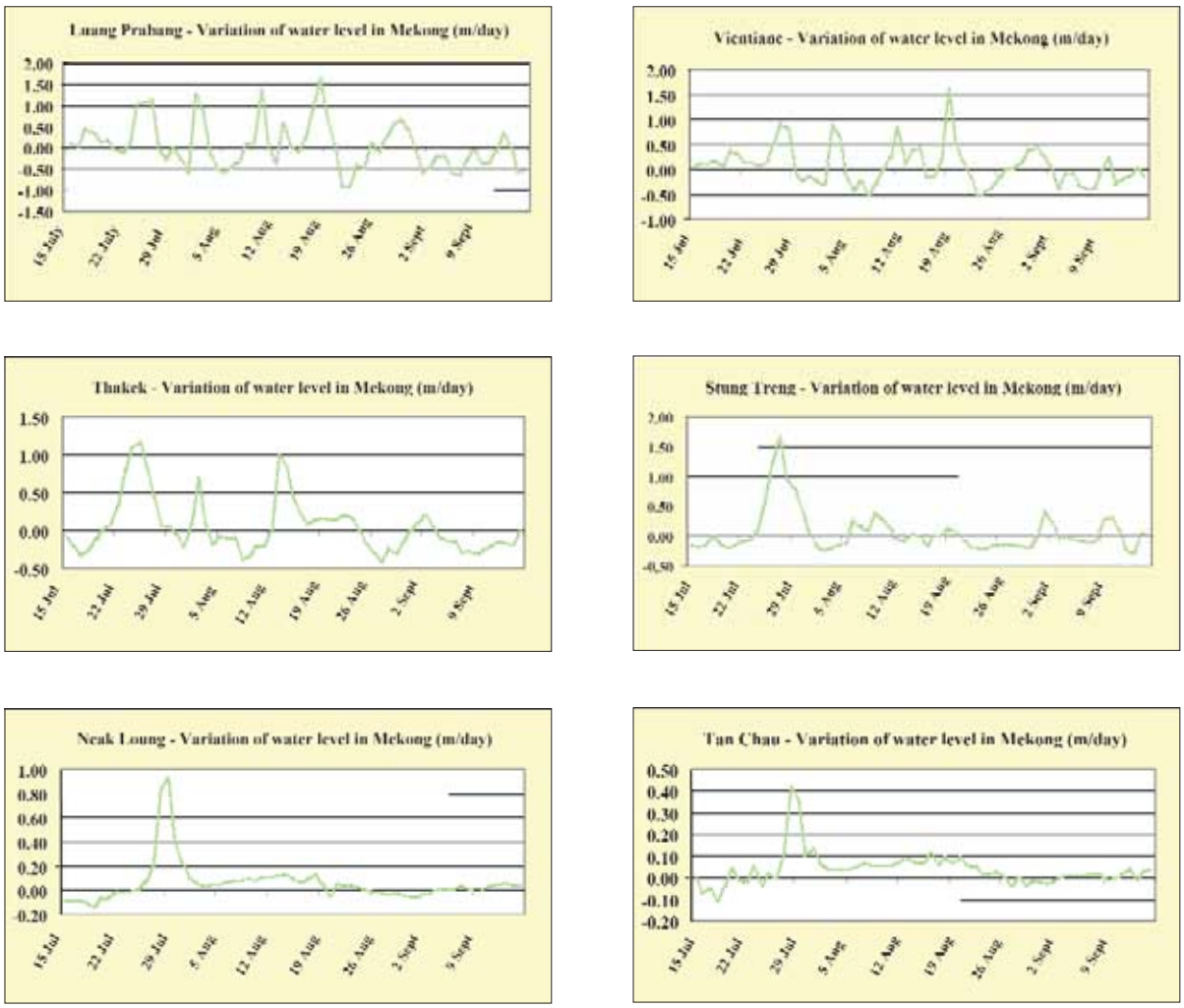


Figure 14: Velocity of water level rises at major hydrological stations along the Mekong River

4. IMPACTS OF THE 2005 FLOOD

4.1 Review of data availability

The detailed figures of the impacts of the 2005 flood are presented by country in an annex to this report. It is impossible to produce a detailed and comprehensive assessment of the impacts of the 2005 flood at LMB level. The process of monitoring the flood and the data collected vary from one country to another. Discrepancies are also often observed between data gathered at national level and data collected at provincial or district levels. Different technical departments may have also their own approach regarding the impacts of the flood (often depending on their specific mandate). Some indicators are not understood similarly throughout the region. All flood events are not necessarily recorded, and a "no data" is not necessarily clearly distinguished from a "zero value". For that reason, more information can be obtained by referring to the sections related to the flood analysis in each country to get a more precise idea of the impacts.

One major component of the damage is nevertheless recorded in each country: the loss of paddy fields. It is generally monitored in nearly every district/province both by villagers and the departments of agriculture. The indicator "loss of paddy fields" gives a good idea of the intensity of the flood and its duration. Although the limit between flooded paddy field (with yield reduction) and total loss of fields is not clear, it is a good indicator for drawing flood maps. It would have been even better if, at the same time, records could have been made of planted areas giving the percentage of losses. But planted areas are not surveyed everywhere in the LMB which means this consolidation is not possible. Damage to livestock may be a good indicator of the suddenness of a flood. Generally, people are well prepared for evacuating livestock from flood risk areas in time. This is not necessarily the case when flash floods occur or when water from the Mekong rises exceptionally fast.

Reports of "damage to infrastructure" (irrigation systems, roads, bridges, school, temples, health centres) are often patchy and damage is generally estimated only when external funds are requested for reconstruction. In many cases, repairs are part of the maintenance budget and no specific assessment is recorded at the Disaster Management Centres, although some data should exist with some individuals or technical departments. The ability to assess "damage to infrastructure" was also reported as a concern due to lack of training.

Damage to houses and costs of resettlement are also not systematically recorded except when authorities have strong plans to address the issue, such as in the Mekong Delta in Viet Nam. The number of people who died from the flood is obviously an indicator of the flood intensity, but many reasons for such deaths may occur: children may be bathing in the water; people fall from houses into water or houses are washed away by landslides. Health issues are generally poorly reported due to the difficulty of estimating a direct link with the flood.

4.2 Impact of the 2005 flood

Severe flash floods occurred on several Mekong tributaries in Lao PDR and in the province of Chiang Rai in Thailand, damaging roads and bridges, irrigation schemes and other village infrastructure such as schools, water supplies and health centres.

Exceptionally abnormal flood conditions affected the central and southern provinces of Lao PDR and the corresponding provinces of Thailand located along the Mekong. This was due to severe flooding in the tributaries coinciding with very high water levels in the Mekong which generated an extended and lengthy backwater effect. This was considered the most damaging flood for more than 30 years. The most affected districts were located in Khammouan Province in Lao PDR and in Nakhon Phanom Province in Thailand. Savannakhet (Lao PDR) and Mukdahan (Thailand) were severely affected as well. These flood conditions also occurred in the southern provinces of Lao PDR, the corresponding provinces of Thailand, as well as in the northern provinces of Cambodia, namely Stung Treng and Kratie, but with less damaging effects.

The province of Kompong Cham in Cambodia, located at the top of the Cambodian flood plain, was well flooded due to the high level of the Mekong but the flood was nothing exceptional. Below its confluence with the Tonle Sap River, the water level of the Mekong decreased in intensity which meant that the flooding situation in Kandal and Prey Veng provinces in Cambodia were recorded as "normal".

In Viet Nam, the flood conditions and impacts were also reported as "normal". Even if substantial damage was recorded in the Mekong Delta, 2005 was the least damaging year since 2000. The production of paddy reached 17.2 million tonnes and, the government considered 2005 a successful year for crop production.

Figure 16 shows an estimate of the damage caused by the 2005 flood in the LMB. Unfortunately, some data could not be reconciled or they are missing. For this reason, a full consolidated listing of the impacts of the flood in the LMB for the year 2005 can not be presented.

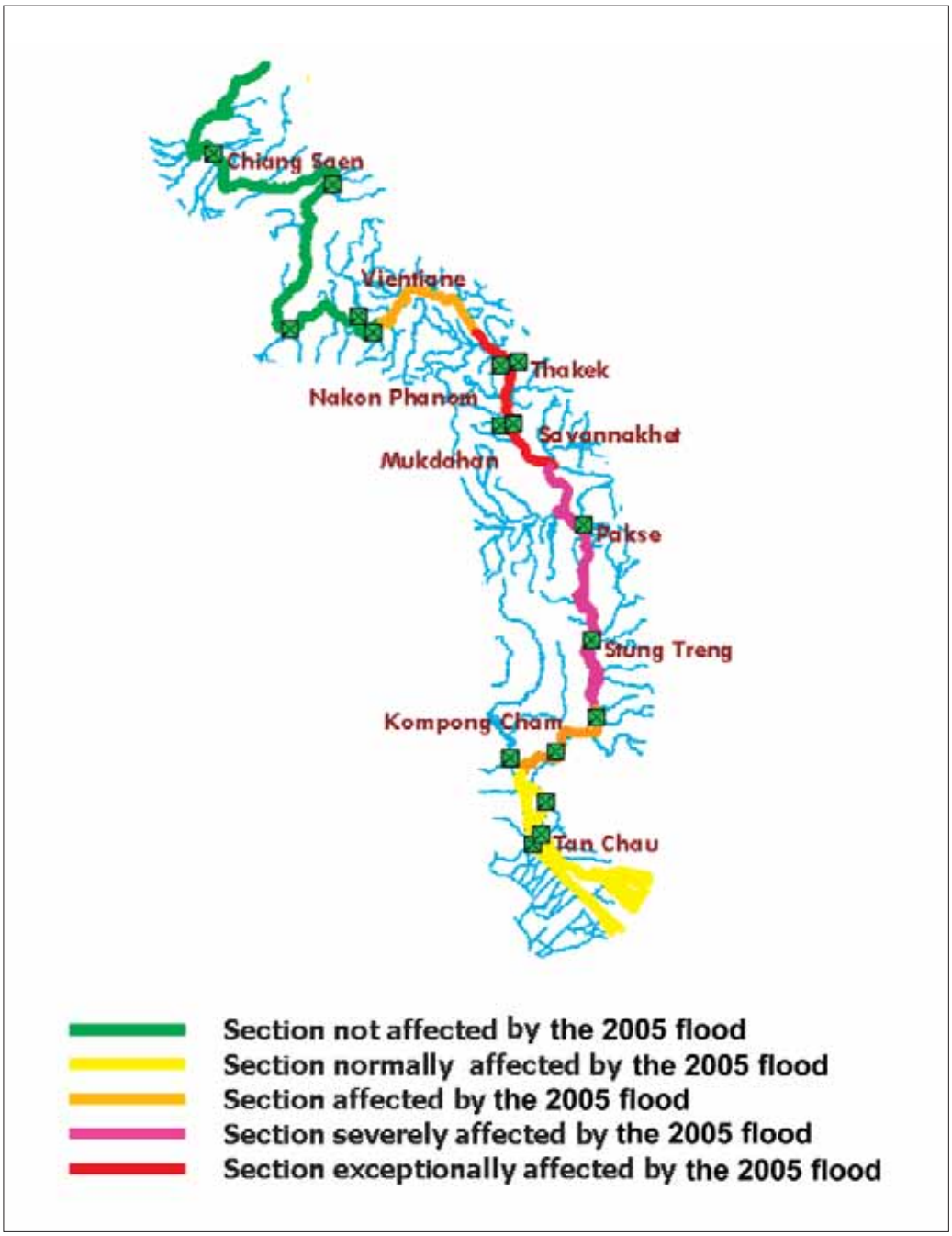


Figure 15: Map of the sections of the lower reach of the Mekong River affected by the 2005 flood

Estimation of damages of the flood 2005 at Mekong River Basin level (consolidation of data considered as sufficiently coherent for comparison)					
Provinces	**Lao PDR**	**Cambodia**	**Thailand**	**Viet Nam**	**Total**
People affected					
No of provinces affected	16	4	5	8	33
No of districts affected	84	35	23	2	144
No of communes affected	NA	195	234	NA	NA
No of villages affected	2,510	NA	NA	NA	NA
No of families affected	85,553	29,549	78,121	NA	NA
No of people affected	480,913	14,408	NA	NA	NA
Houses severely damaged/collapsed	NA	NA	1,275	4,303	NA
Deaths from floods (2)	4	19	0	77	100
People evacuated to safe places	356	4,805	NA	NA	NA
Agricultural production					
Rice planted (ha)	687,555	NA	NA	NA	NA
Paddy field loss(ha)	55,955	9,906	39,538	3,876	109,275
Loss of livestock (Unit)(1)	2,124	28	0	0	2,152
Loss of fishponds (ha)	296	NA	759	NA	NA
Damages to infrastructure	(only scattered information is available - consolidation for MRB may not be done)				
Total estimate of damage US$mil	28.56	NA	NA	15.27	NA

Source and comments related to data: see country reports. '(1) includes buffaloes, cows, pigs, goats
(2) data regarding flash floods not available

Figure 16: Damage caused by the 2005 flood in the LMB

Figure 17 shows the loss of paddy fields by provinces. For future reports, it would be valuable to obtain these data by districts rather than provinces and in percentage of loss rather than in absolute values. The map confirms clearly that the areas most affected by the 2005 flood were the provinces of Khammouan in Lao PDR and Nakhon Phanom in Thailand.

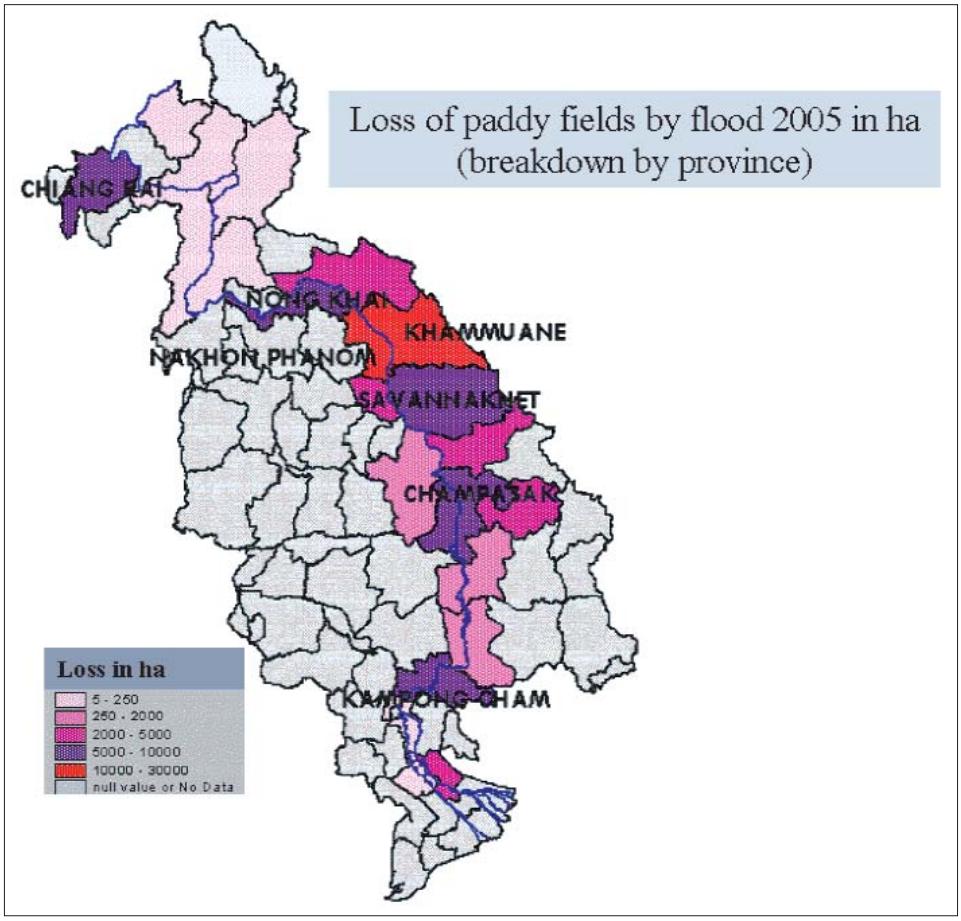


Figure 17: Map of provinces affected by loss of paddy fields in the Lower Mekong Basin

5. RESPONSES TO FLOOD EVENTS

5.1 The Flood Management and Mitigation Programme

The Flood Management and Mitigation Programme (FMMP) was designed to support the MRC member countries to create adequate responses to flood events. The overall development objective of the Strategy is to ensure: "people's suffering and economic losses due to floods are prevented, minimised, or mitigated, while preserving the environmental benefits of floods".

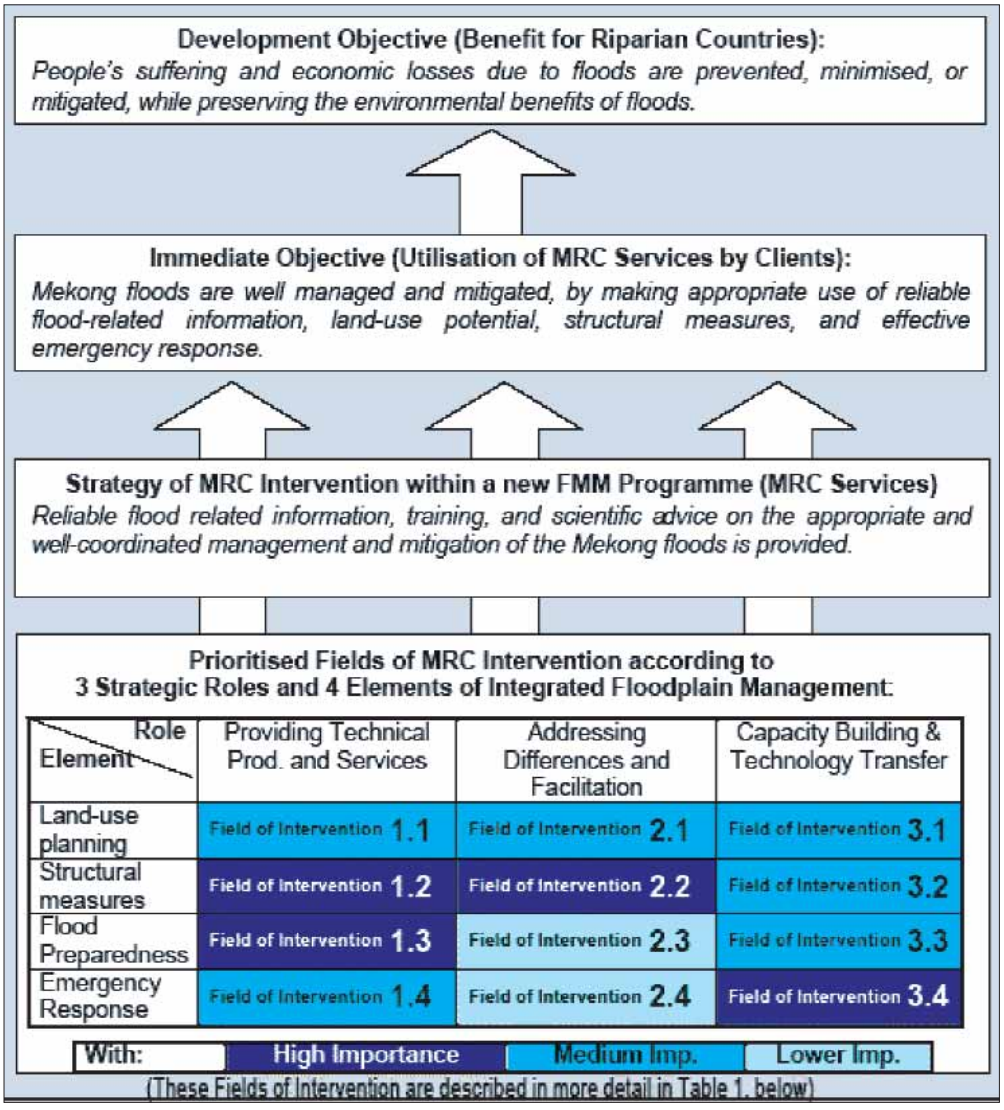


Figure 18: The logical framework of the FMMP (source: MRCS website - www.mrcmekong.org)

The FMMP components and activities are summarised here. More details may be obtained by consulting the available programme documents.

Establishment of a Regional Flood Centre

A Regional Flood Management and Mitigation Centre (RFMMC), based in Phnom Penh, will maintain and further develop flood-related tools, data and knowledge at national and regional levels; produce accurate regional flood forecasts with timely and effective dissemination; and provide accurate and consistent tools for basin wide flood risk assessment and transboundary impact analysis. The Annual Flood Forum is one of the main activities of the Centre and serves as the key platform for coordination of responses concerning flooding on a regional basis. The forums commenced in 2002 and now attract more than 100 national, regional and international experts who come to share their knowledge and experiences.

Structural Measures and Flood Proofing

This component will study the effects of infrastructure (such as reservoirs, embankments and waterways) on flooding, in order to provide guidelines and technical standards to encourage the adoption of good practices. An implementation plan will be developed using a holistic approach giving attention to transboundary issues. Flood-proofing measures will be developed and promoted in flood-prone areas as a cost effective means of flood mitigation at local level. There will be emphasis on working in poor communities when considering building design guidelines, financing mechanisms and conducting awareness-raising activities.

Mediation of Transboundary Flood Issues

A Mediation and Coordination Section will be established to facilitate dialogue and resolution of issues on land management and land use planning, infrastructure development and cross-border emergency management of floods. Formalised procedures, norms and rules for mediation and decision-making regarding non-compliance in transboundary flood management issues will be developed, as well as recommendations on water and land use legislation.

Flood Emergency Management Strengthening

The component will ensure the improvement of existing Emergency Management Systems in riparian countries to deal with the Mekong Floods more effectively, through capacity building, knowledge sharing and public awareness campaigns at the provincial, district and community levels.

Land Management

The component will address the pressing issues of flood probability assessment techniques, improved land use planning methods and damage-reducing land management policies in order to achieve sustainable natural resource management in the Basin.

The Flood Forecasting and River Monitoring System

The Flood Forecasting and River Monitoring System in the Mekong River Commission has, over the years, been improved to provide timely and accurate river forecasts to its member countries in order to reduce the vulnerability of floods and droughts in the Lower Mekong Basin. During the dry season (November-May), seven-day river monitoring and low flow forecasts are conducted and updated weekly at http://www.mrcmekong.org while during the flood season (June-October) five-day flood forecasts at 21 key stations along the Mekong mainstream are updated on a daily basis. The MRC Forecasting System consists of three main components: data collection and transmission, forecast operation, and forecast dissemination.

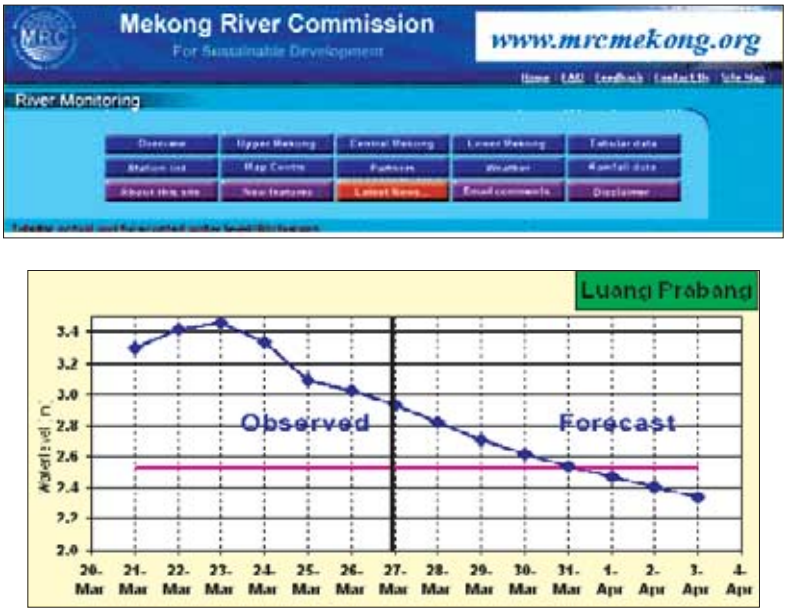


Figure 19: An example of flood forecasting and river monitoring information on the MRC website

Data collected for the operational forecasts are classified into the historical and the operational data. The historical data are updated annually while the operational data are sent by e-mail to MRCS and RFMMC daily in the wet season and weekly in dry season. For timely national forecasts, MRCS will forward the operational data to the countries prior to the operation of regional forecasts. Apart from the data received from the countries, weather data/forecasts from various sources, including those from weather satellites and the Thai Meteorological Department, are also used. A variety of forecasting tools are applied for water levels and discharges: the Streamflow Synthesis and Reservoir Regulation model for the upper part of the basin, multiple regression models for the lower reach of the delta with over bank flow, an Artificial Neural Network model for both, upper and lower reaches, and the ISIS software for flood mapping in Mekong Delta. Forecast products, including water level forecast bulletins, are published on the MRC website and disseminated to the National Mekong Committees, concerned line agencies, National Disaster Management Committees and other interested parties by e-mail.

The existing MRC Forecasting System was deemed adequate in the past. However, rapid population growth in the region, intensification of agriculture, climate change, changes in land use and river morphology, and rapid technology development makes it imperative that the system be upgraded, and a forecasting system, based on modern technology combined with a more effective warning system, be installed. Improvement of flood forecasting operations requires continuous efforts in many fields, including the river monitoring network, data collection, transmission and processing; and development of advanced forecasting techniques, the communication network and assessment of forecasts. To improve the river monitoring network, data collection and transmission system, the hydro-meteorological network is in the process of being rehabilitated and upgraded to provide more timely and accurate data.

5.2 Specific responses to floods in the member countries

More information on response to flood events is contained in the annexes for each of the LMB countries. A summary is presented below.

5.2.1 Cambodia

In Cambodia, flood management coordination for mitigation and reporting the impacts of floods are the responsibility of the National Committee for Disaster Management (NCDM). At provincial level, a similar multi-disciplinary group has been set up. At district level, some of the technical departments are represented in addition to the chiefs of communes. The Communes Disaster Management Committees include the chiefs and responsible members of the villages as well as the "EWS" Volunteers in the villages where an Early Warning System (EWS) has been set up. The United States Office of Foreign Disaster Assistance and the Mekong River Commission signed a Cooperative Agreement on 16th December 2002 entitled, "Provision of Flood Early Warning to Flood-Vulnerable Communities in the Lower Mekong River Basin, Phase 1: Cambodia and Lao PDR". The project is implemented under the overall umbrella of the Flood Management and Mitigation Programme. It started in 2003 in Cambodia in cooperation with the American Red Cross, Action Contre la Faim and the Cambodian Red Cross. The project is also intended to assist flood-at-risk communities to make better use of MRC flood forecasts and warnings, which are issued during the annual flood season.

Limited infrastructure exist in Cambodia for controlling the flood, except some main road sections which have been built on embankments (e.g. National road No 6). No regulators or "colmatage" gates are mentioned in the Northern section of the Mekong that could manage/limit the effect of backwater entering into the tributaries. Four control gates (9m wide and 13.5m long) have been built on National Road No 1 from Phnom Penh to Neak Loung (funded by JICA), controlling the backwater from the Mekong to rice cultivated areas.

The project "Provision of Flood Early Warning to Flood-Vulnerable Communities in the Lower Mekong River Basin" covers a total of 40 villages. It includes the installation of flood markers and flood alarm noticeboards. Support to the villagers for improving their knowledge on flood early warning and emergency response is also provided. The empowerment of the communities' involvement in the project planning, implementation, and monitoring and reporting is developed at provincial level and Red Cross volunteers assume an influential role in each of the villages.

5.2.2 Lao PDR

Disaster management in general and flood management in particular is the responsibility of the National Disaster Management Organisation (NDMO), which coordinates the technical departments and institutions in charge of facing these issues. At provincial and district levels, similar structures (committees) have also been set up. The committee's members coordinate work in the affected areas in order to assess the damage and primary needs and then proceed to emergency measures, each institution according to its field of responsibility.

Officials from the social welfare, public security, defence and health departments and the Lao Red Cross work together in the affected areas to help the victims. A quick assessment of needs is done, then emergency aid is provided by the Lao Red Cross staff who proceed to distribution of relief packets of food, clothes, blankets, etc. Social welfare organises shelters where necessary. Health staff are responsible for taking care of the sick or injured and try to prevent disease outbreaks. They run vaccination programmes and recommend people who have red eyes, diarrhoea or symptoms of malaria to seek medical advice immediately. The Department of Agriculture distributes rice seeds for replanting.

Infrastructure for controlling or mitigating the effects of the flood are very limited. Embankment protection along the Mekong or along the major tributaries has only been built in some sections of the major cities. The rural roads are rarely built on embankments in the flood risk areas. Some NGOs have supported village protection efforts such as small embankments for protecting the villages or small dams in suitable land depressions. These infrastructure are often constructed with limited engineering knowledge and at the lowest cost. In case of heavy flood, they may be washed out easily. In some places, the irrigation and drainage canals are also used for improving the drainage of flooded areas.

5.2.3 Thailand

The institutional framework for disaster prevention and management is organised at National and Provincial levels which coordinates all field operations. Specialised Units generally constitute representatives from the Departments of Water Resources, Agriculture and Irrigation, Transport, Natural Resources and Environment, Health as well as from the police service. Losses in agricultural production caused by floods are compensated in cash on a lump sum basis per hectare, and after a declaration by the farmers and an assessment from the relevant agricultural authority.

Except for non-structural measures, a longer term strategy aims to limit the effects of floods by building or reinforcing bank protection. Several regulating structures have been built in Northeast Thailand. Roads along the Mekong River are heightened on embankments which, at the same time, offer efficient protection for land and housing. More and more sections of the bank of the Mekong itself have been protected against erosion, especially in important villages, semi-urban and urban areas. In addition, the protection of urban areas from runoff water is under way.

5.2.4 Viet Nam

In Viet Nam, the need for a coherent, long-term strategy for managing and mitigating floods became obvious following the 2000 flood. Some measures on dealing with emergencies have already been implemented or are under implementation. Some other structural measures are being examined as they require heavy investments and may have questionable long term impacts. The issue of housing located in risk areas is being tackled. Families living in risk areas are being encouraged and supported to move to safer places. Some new settlement areas have been built for these families and some are still in progress or planned.

Because rice production is highly important, priority is given to building embankments in the lowest areas, in order to retain the early flood to secure the second rice crop. There is also great pressure from farmers in these low lands to build fully protected areas to enable production of a third annual crop during the flooding period. The flood of 2000 was also a starting point for reinforcement of the road network. The national roads have been raised to a cope with water levels equal to those experienced in the 2000 flood. Rural roads still suffer flooding but improvement of the weakest sections is being carried out and monitored step by step. The road network also constitutes an embankment network protecting the low lands against flood.

Fish production in Viet Nam is the second most important industry after rice production in the Mekong Delta. Other activities, such as sand dredging, and commercial exchange (navigation) are also essential. Until now industry has been poorly developed, but efforts are being made to attract investors. The delta is characterised by a high density population (over 800 inhabitants/km^2 in some districts). Activities will partially, but inexorably, shift gradually from the primary sector (farming and traditional fishing in a natural environment) to industrial and services-oriented activities. This implies development of urbanisation and industrial areas, both of which need to be "fully" flood protected by high embankments, protection against erosion and backfilled lands.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Preparation of the MRC Annual Flood Report 2005 - Lessons learned

We have learned many lessons while preparing this MRC Annual Flood Report 2005. At country level, many data related to flood and damage from flood are available, but there are many limitations when gathering those data, for a variety of reasons which are not the same from one country to another.

- There are multiple locations of data: administrative levels such as in villages (communes), districts and provinces and technical levels such as in departments of agriculture, public works, health, etc. Additionally some NGOs may have interesting, but generally very local, data. Some of those data are consolidated at province levels (generally through the institutions in charge of disaster management including the National Red Cross agencies).

- Most of the affected provinces prepare lists presenting consolidation of damage from flood. Those lists however are not standardised, resulting in well detailed indicators in some provinces and the same indicators not monitored at all in other provinces. Units are not necessarily identical, eg some reports consider damage to roads in numbered sections and others in kilometres.

- The meaning of the terms used for describing the indicators may vary from one list to another, eg, "Number of affected people" may refer to people having been flooded for a few days with very little damage or to people who lost all their rice production. It is not always clear that "Area of rice damaged by flood" refers to a full loss of production or a decrease in yield.

- The financial estimate of damage is rarely exhaustive. Some damages are evaluated in order to obtain the budget for repairs. However, when no external fund is accessible, other than the recurrent maintenance budget, no accounting is made available. Some provinces, reported a lack of expertise for making such an assessment.

- In the available lists of damage, it is not always clearly understandable if some data are "not available" or "zero" or "little damage". Very often, only "blanks" appear on the lists. If data are missing, additions are obviously biased.

- The data are rarely centralised at a national level, and even if they are, there are doubts about the reliability of such consolidation when examining the poor coherence of the data collected locally. Experience also shows that meeting with the provinces is the only reliable way to assess the data, and, thorough discussion is needed to better understand the meaning of the data and to fill in the gaps.

- Nearly all documents are (obviously) written in the national languages and very little information is available in English.

All these factors make the consolidation of information at LMB level very problematic.

6.2 How to improve the Annual Flood Report

Refining the objectives of the report in line with the FMMP

The Annual Flood Report is in line with the FMMP strategy and its components. It obviously stimulates the exchange of data throughout the four LMB countries. Additionally, it could become, indirectly, a complementary tool for a pragmatic monitoring of some FMMP activities and a tool for supporting the decision makers when addressing the flood issues.

If such orientation is expected, it would be necessary for the National Mekong Committees and the Line Agencies to refine the objectives of their annual flood reports in regard to the FMMP objectives and components and adapt the methodology and approaches accordingly. It could be recommended, for example, that chapters are developed, addressing and/or monitoring specific themes such as procedures for exchange of data, effect of infrastructure on flood and damage from flood, trans-boundary topics, land management issues and flood warning activities.

Setting up efficient and coherent procedures for collecting indicators and data related to flood events

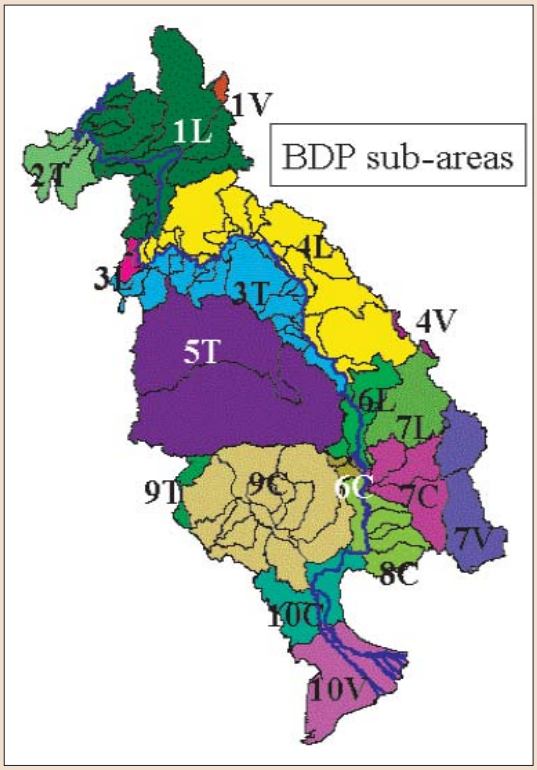
The preparation of the national annual flood reports must start during the flood period, rather than a few months later. Direct observations in the affected areas may be done together with the emergency teams and institutions in charge of managing the flood events. Advice may also be given when monitoring the flood impacts. In the future, the key content of the annual flood reports should be based on coherent databases established at a national level in which all the relevant indicators are included. These databases must nevertheless be as simple as possible to be manageable at district level (or any other institutional level according to the needs of each of the countries). At this stage the consolidation of data would be an easy process and the "National Annual Flood Report" would only require additional elements of analysis and validation of data; including a description of the cause and mechanism of the floods supported by hydrological data, maps and interpreted satellite imagery where necessary.

This Annual Flood Report was prepared by organising numerous meetings at provincial, district and village levels. Those meetings allowed reconciliation of many data, at least in the most affected areas. The people affected are well aware of the narrow limit between beneficial and damaging floods. These meetings with institutions in charge of managing the flood, villagers or people affected, who are generally the best keepers of the memory of the flood events, remain essential. They also reveal the human aspect of the flood which does not appear in the starkness of damage lists. This field work should be conducted during the flood season rather than a few months later and if simple procedures for standardising data collection and data flow are set up, it could be simplified.

The scaling of the data is also an important topic. Data can be made available with breakdowns by provinces, by districts, by communes or even by villages. Actually, some key indicators, eg "loss of paddy fields", should be screened to the largest scale as possible, at least at the district level, because it allows, as seen in this report, for the creation and/or verification of valuable flood maps. For other indicators, such as "damage to roads", data at the provincial level should be enough. All these considerations require some preparation work to be carried out in close collaboration with the four MRC member countries. The following topics should be tackled:

- Refine the expected objectives and outputs of the annual flood reports
- Set up the list of indicators, data and documents to be collected at country level during the flood period, considering both indicators related to damage but also, when possible, some indicators related to the ben efits of the flood.
- In addition to the data available at MRCS level, obtain additional hydrological data such as rainfall and water level in the main tributaries, as well as the most updated rating curves to calculate the flow in the Mekong River.
- Envisage access to data related to the operation of the main regulation infrastructure in order to improve the analysis of the flood graphs.
- Better define the content of the indicators and the units for quantity estimates
- Define the procedures for data flow and data validation at national level and procedures to improve access to those data by MRCS team.
- Define the scheduling for data gathering and validation in order to produce the annual flood report within a reasonable time limit.
- Precise the institutional framework for the whole process including collaboration and contracts to be set up for an easy implementation and identify the needs for training.

A matrix indicating the scale of data (province, district, and commune level) for each of the collected indicators must be set up. Scaling to the commune (village) level is certainly ideal. It allows us to draw precise maps of the flood damage which can be combined with images of the flood extension. It also makes work at sub-basin level possible, in addition to the administrative levels. This work consumes resources and might only be practical for key indicators (e.g. loss of paddy fields). In this framework, a link with the BDP (Basin Development Programme) could also be envisaged.



1. Northern Lao PDR

2. Chiang Rai

3. Nong Khai/Songkhram

4. Central Lao PDR

5. Mun/Chi

6. Southern Lao PDR

7. Se San/Sre Pok/Se Kong

8. Kratie

9. Tonle Sap

10. Delta

Figure 20: Definition of BDP sub-areas of the Lower Mekong Basin

Geographical Information Systems (GIS)

GIS is an appropriate tool to illustrate floods. In this report, it was shown to what degree GIS can support the presentation of data in a quite self explanatory way. Nevertheless, some layers located at MRCS level have proved to be out of date or not standardised. This is the case, for example, for some administrative layers (eg districts); names are not written in a standard way or administrative boundaries have been modified without having been changed in the MRCS database. This makes automatic operations of "combining" files of flood data with existing GIS files impossible and requires complex data handling.

It is therefore recommended that MRCS, together with the NMCs and LAs, draws up a list of standard GIS layers with specific use for flood monitoring, and keeps them updated and standardised accordingly.

6.3 Monitoring of flash floods

Flash floods on the tributaries of the Mekong River caused considerable damage in 2005 Such flash floods occur almost every year somewhere throughout the LMB. Means of monitoring, predicting, managing and mitigating flash floods are, however, different from dealing with floods occurring on the mainstream and in the floodplains of Cambodia or the Mekong Delta in Viet Nam. A decision must be made on whether to include flash floods on tributaries in the next MRC Annual Flood Report. If so criteriawill have to be established to determine specific on locations in the LMB or decide if it would it be better to focus on key watersheds, and which ones should be selected.

6.4 Satellite images

Observing flood events through satellite imagery provides valuable information. However, the agencies that are used to making such observations are not always concentrated on events in the Mekong area. For example interpreted images of the 2005 flood could not be found in the MRCS library. Each Annual Flood Report should be illustrated with satellite images showing the extension of the flood areas.

Those images and the way of interpreting them should be standardised, making comparison from one year to another easier and more accurate. This work was done in the past, but on a "one-shot" basis. For example, MRCS was able to obtain images and interpretation for floods 2000 and 2001 in Cambodia's flood plain when the emotional effect of those damaging floods fostered this work.

For preparing this report, two institutions were contacted : Dartmouth (http://www.dartmouth.edu/%7Efloods/) and the Canadian Space Agency together with Hatfield Consultants Ltd (http://www.space.gc.ca/asc/index.html) which has supported MRCS in the past. The Dartmouth Flood Observatory was kind enough to send the interpreted images for years 2000 to 2005. But while years 2001 to 2004 have been widely analysed, unfortunately 2000 and particularly 2005 were poorly covered. The Canadian Space Agency/Hatfield Consultants Ltd offered its support to prepare a map for the areas affected by the flood 2005. They prepared the image shown in the Cambodian section of this report covering Kompong Cham Province.

Proactive collaboration with institutions or companies able to provide satellite images of flood events is recommended. During a serious flood event, actions may be taken in near-real time to get the most comprehensive images possible through the services from these institutions or companies.

Images and data related to rainfall distribution and cyclones are also available in near-real time on the Internet (e.g. http://trmm.gsfc.nasa.gov/ and http://www.solar.ifa.hawaii.edu/tropical/).

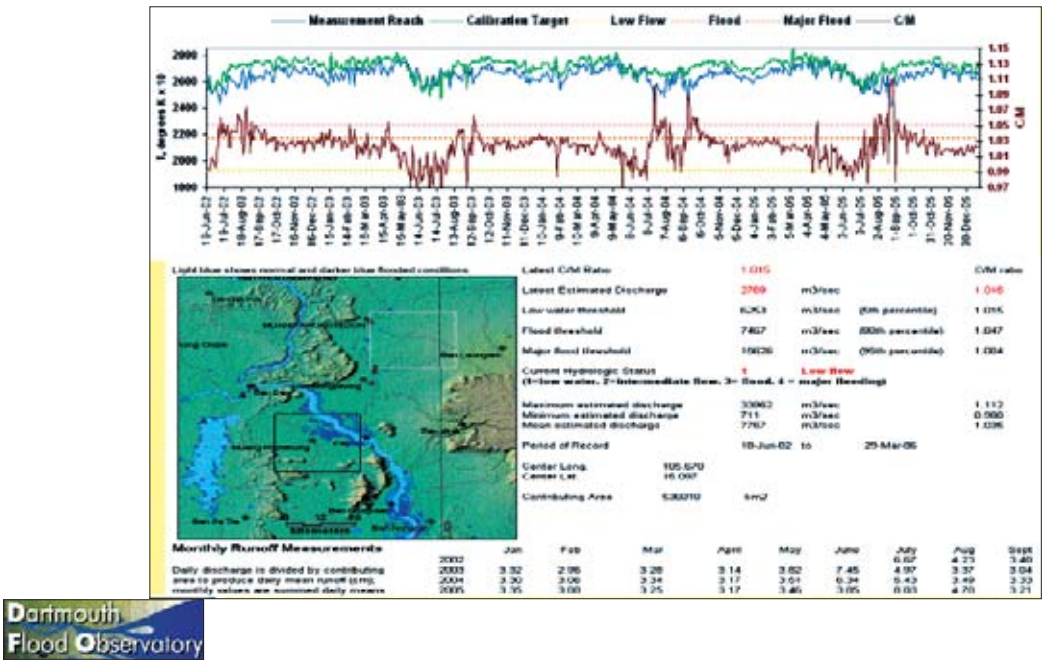


Figure 21: The Darmouth Flood Observatory proposes daily observation of the discharge in the Mekong at Pakse, based on the interpretation of satellite image (http://www.dartmouth.edu/~floods/)

6.5 Extension of flood markers

In Cambodia, several flood markers have been installed at village level with volunteers making daily observations during the flood period. Such flood markers could be extended in other flood risk areas as these could provide very useful information related to the extension of the flood and "in situ" for interpretation of aerial photographs or satellite imagery.

7. IMPACT OF THE 2005 FLOOD - COUNTRY REPORTS

7.1 Impact of the 2005 flood in Cambodia

7.1.1 Background

Floods are an essential contributor to the wealth of biodiversity, abundance of fish and soil fertility in Cambodia. This is especially true for people living in the floodplain, downstream of Kratie where the area is very flat and there is extensive lateral flow of floodwaters from Kratie to the border with Viet Nam. Up to 4 million ha of lowland areas in Cambodia are inundated annually.

In the floodplain of Cambodia, people live with the annual flood and even if the flood is severe, they are accustomed to managing the situation year after year. The water level must be high enough to allow inundation of large areas, bringing sediment for soil and nutrients for fish, as well as to kill rats and other undesirable vermin. However, beyond a certain limit, the flood may be disastrous, killing people, destroying houses, rice fields and infrastructure.

The flood is commonly seen as a source of profit rather than a source of disaster. At the same time, flood-vulnerable communities must be prepared to face severe flooding events if they are to minimise the number of victims and damage. The rural communities contribute widely to two vital sectors of the Cambodian economy, fishing and rice production and need support when an emergency occurs , but also during the “after flood” rehabilitation period.

The flood in the Cambodian floodplain is vital to fishing and navigation, but it may also be damaging.

The years 2000, 2001 and 2002 caused huge damage in terms of human life and economic loss. In 2000, severe flooding affected 22 out of the 24 provinces in Cambodia, with a death toll of 347 people, of which 80% were children. More than 3.4 million people were affected and physical damage totalled US$ 161 million. The flood in 2001 killed 62 people and the total estimated losses were US$ 36 million. Again, in 2002, floods hit the Mekong countries. In Cambodia alone, the flood killed 29 people and the total extent of damage was over US$ 12 million. On the contrary, years 2003 and 2004 were very mild flood years and led to drought issues. The 2005 flood, described in this report may be considered as positively "balanced".

7.1.2 Availability of Data

In Cambodia, data regarding flood damage are centralised firstly at provincial level through the Provincial

Committees for Disaster Management (PCDM). All authorities involved in flood management and mitigation are members of the PCDMs, and they may include involvement by NGOs active in flooding issues such as the Cambodian Red Cross and Action Contre la Faim, amongst others. A provincial report is then produced every year. At central level, the National Committee for Disaster Management (NCDM) issues a summary report covering the whole country. On specific occasions, for example, when an MRC Annual Flood Forum is organised, data from the NCDM reports are gathered and reported at regional level.

The reports established at provincial levels are likely to be the only means of obtaining the most reliable information related to the 2005 flood. The information is consolidated up to the district level in some provinces. There is no standard format for establishing the annual reports at province level, rendering the consolidation problematic by lack of data consistency, typology of damage and standardisation of assessment. The figures presented in this report therefore need to be interpreted cautiously.

For the time being it is not possible to obtain information detailed by communes or villages without undertaking a systematic retro-active survey, which would have been beyond the scope of this work. However, data regarding flood damage exist. The heads of communes and villages are able to present quite a precise picture of the flood in their area. They possess a deep knowledge of flood events and some records are kept in notebooks. Peoples' memories are also a valuable source of information. The aim should be to organise procedures and obtain resources for gathering the information on a simple but coherent and reliable basis.

The province of Kompong Cham appears to be an exception. In this province, the NGO Action Contre la Faim is active in the implementation of the Early Warning System and Flood Preparedness Projects, under FMMP, funded by USAID/OFDA. Detailed surveys of flood damage breakdown by affected villages have been carried out. MRCS should explore the possibilities of reporting the annual flood throughout the Mekong Basin by setting up a similar approach, at least for the major indicators.

It is very difficult to obtain a clear idea of the financial damage caused by a flood. At village level, the communities do not have tools for making this estimate. At district or provincial levels, only large and key infrastructure are subject to an accurate estimate when there are plans for rehabilitation or reconstruction through a tendering process. Tendering recognised that staffs at that level are not trained enough nor did they have clear procedures for making assessments of the flood damage.

It is likely that severe flooding events like those that occurred in 2000, 2001 and 2002 were subject to a better assessment in terms of damage and economic costs, considering that reconstruction had to be supported by external funds. In case of a "balanced" flood, such as in 2005, local repairs and reconstruction are generally undertaken by the villagers themselves with sporadic support from NGOs. The repairs of district or provincial infrastructure are part of the regular maintenance budget and are not reported by the PDMCs.

7.1.3 Overview of impacts at the national level

The provinces of Stung Treng and Kratie were affected by high water levels in the Mekong River that created backwater in the lowest areas and in tributaries that could not drain easily into the river. The province of Kompong Cham was well flooded due to the high level (but not exceptional level) of the Mekong. The flooding situation in Kandal and Prey Veng provinces was recorded as "normal", the water level of the Mekong having decreased in intensity after the confluence with the Tonle Sap River. Additionally, some flash floods occurred in Battambang province (from a tributary of the great Lake).

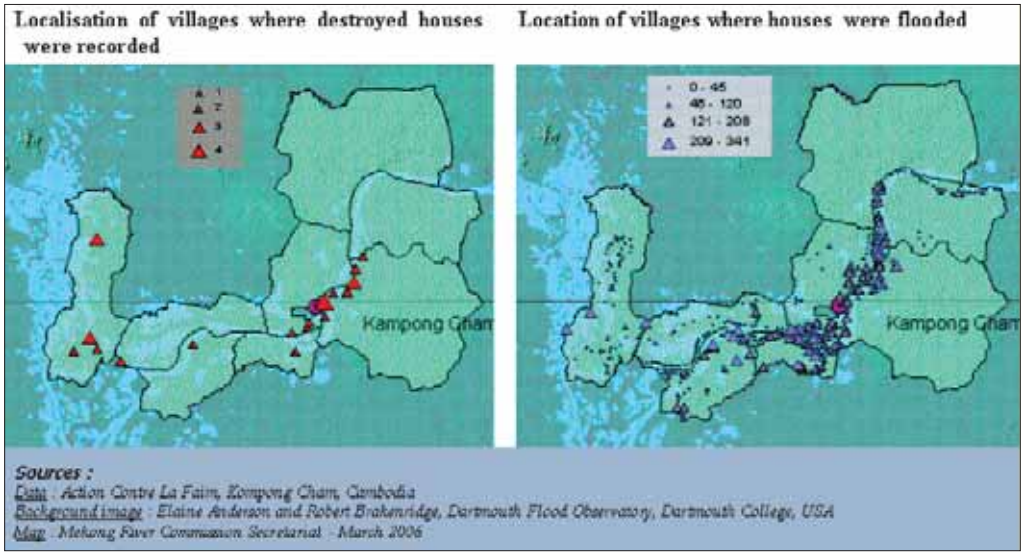


Figure 22: Example of possible data treatment if more elaborate monitoring of the flood is set up (data from the database "Action Contre La Faim, Kompong Cham")

The impacts on the flood are detailed in Figure 23 by provinces, and for two provinces by districts, according to the data made available for this report. Data were provided by the Provincial Disaster Management Committees and may sometimes differ from the data gathered at national level.

7.1.4 The most affected areas

The 2005 flood caused damage in four provinces in Cambodia: Stung Treng, Kratie, Kompong Cham and Kandal. The satellite imagery of the flood in the province of Kompong Cham was provided courtesy of the Canadian Space Agency and Hatfield Consultants Ltd.

Impacts on the people

The 2005 flood had negative impacts on the population of the provinces of Kratie and Kompong Cham where provincial authorities respectively recorded that 361 and 429 people were evacuated to safer places. This is an indicator of the severity of the flood. They also reported that 20 people died from flood, nine of these were male children, who are often the most vulnerable. The major reason is bathing accidents.

Estimate of damage caused in Cambodia National Disaster Mangement Committee				
Districts affected				35
Communes affected				195
Families affected				29,549
Persons affected				144,408
Evacuated to Safe place		Families		1,127
		Persons		4,805
Deaths by flood		TOTAL		19
		Young	Male	9
			Female	4
		Old	Male	10
			Female	4
Houses destroyed	all			19
	part			5,929
Rural roads (in metre)	flood			308,995
	Destroyed			7,288
Bridges	Flood			12
	Destroyed			5
Rice fields	Flood			4,138
	Destroyed			NA

Source: Management Disaster Management Committee

This table presents data provided by the National Disaster Management Committee. These data are different from the data obtained from the Provinces affected. For example, at national level, about 144, 000 people were affected by the 2005 flood. If we consolidate the figures from the four affected provinces located along the Mekong, they show that more than 275, 000 people were affected. The number of people who died due to flood also varies, when broken down into 'male and female' and 'young and old'. The definition of the indicators and the procedures for collecting and consolidating data at national level needs some improvement.

Figure 23: Estimate of damage caused by the 2005 flood in Cambodia

Damage to houses is difficult to estimate. No precise data were available for Stung Treng and Kratie. In Kompong Cham and Kandal, many houses were recorded as having been flooded and/or having suffered minor damage, but only few houses were destroyed. In many cases, the destroyed houses were built along the embankments of the Mekong and may have been washed away by bank erosion.

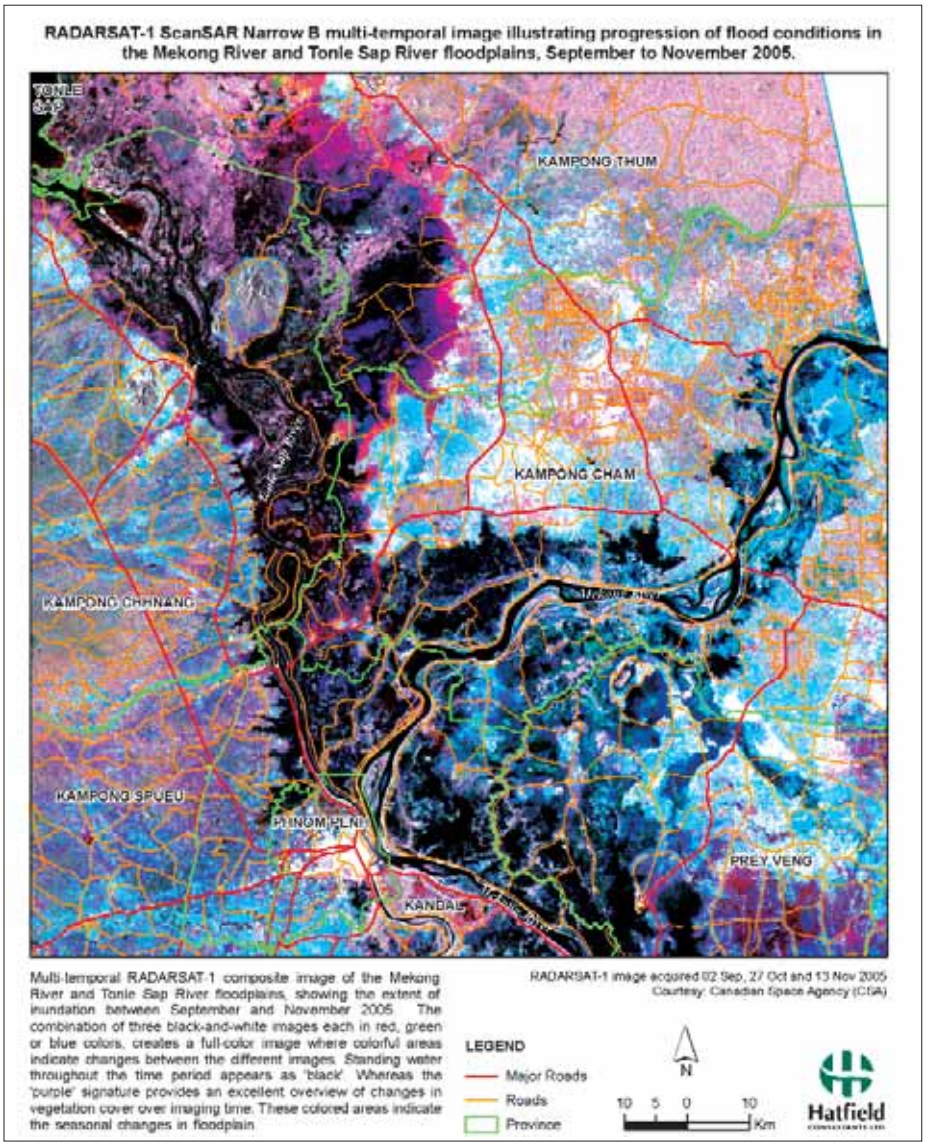


Figure 24: Satellite imagery of the 2005 flood in the province of Kompong Cham (courtesy of the Canadian Space Agency and Hatfield Consultants Ltd)

Affected Provinces	Affected Districts	People affected by Flood			Evacuated to safe places	Deaths by flood				
						Young		Old		
		Villages	Families	Persons	Families	Male	Female	Male	Female	Total
Stung Treng		94	10866	55397	0	0	0	0	0	0
Kratie		138	NA	NA	361	1	0	3	0	4
	Chhlong	29	NA	NA	115	0	0	0	0	0
	Kratie	41	NA	NA	246	0	0	3	0	3
	Prek Brosob	42	NA	NA	0	1	0	0	0	1
	Sambo	26	NA	NA	0	0	0	0	0	0
	Snol	NA	NA	NA	0	0	0	0	0	0
Kompong Cham		289	26100	127097	429	9	1	5	1	16
	Batheay	10	2290	11095	0	1	0	0	0	1
	Kompong Cham	NA	NA	NA	0	1	0	0	0	1
	Kampong Siem	58	NA	NA	0	0	0	0	0	0
	Kang Meas	62	NA	NA	0	4	0	1	0	5
	Kaoh Soutin	NA	NA	NA	59	0	0	0	0	0
	Krouch Chhmar	28	6047	30160	0	1	0	1	1	3
	Orang Ov	13	1832	9160	0	0	0	0	0	0
	Ponear Krek	NA	NA	NA	0	0	0	0	0	0
	Prey Chhor	14	814	3969	109	0	0	0	0	0
	Srei Santhor	37	1008	5446	4	2	0	3	0	5
	Stung Treng	26	6521	30453	8	0	1	0	0	1
	Tboung Khmum	41	7588	36814	249	0	0	0	0	0
Kandal		NA	5303	25803	18	0	0	0	0	0
Total		571	56069	277297	808	10	1	8	1	20

Source: Provincial Disaster Management Committees

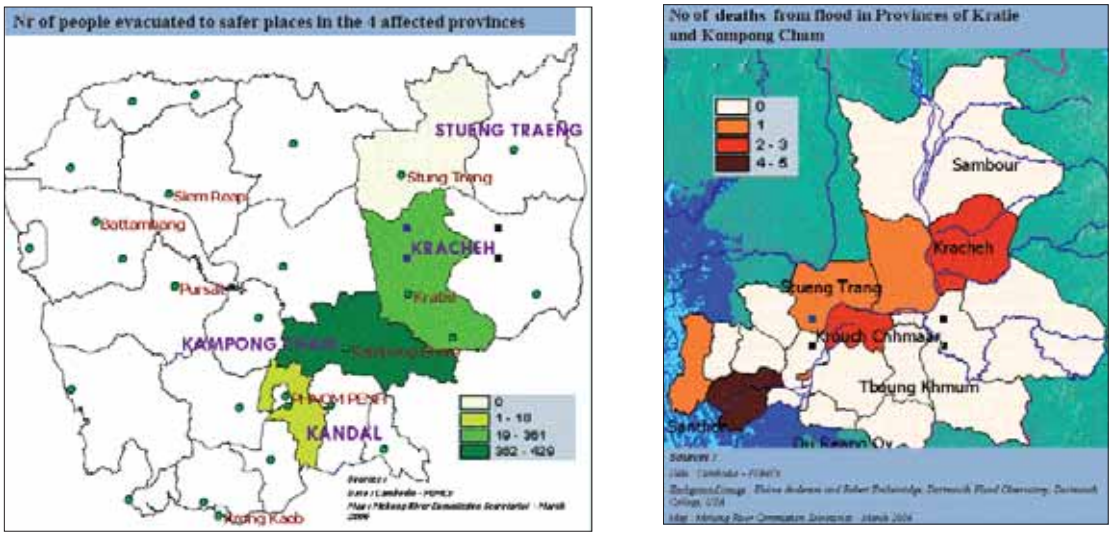


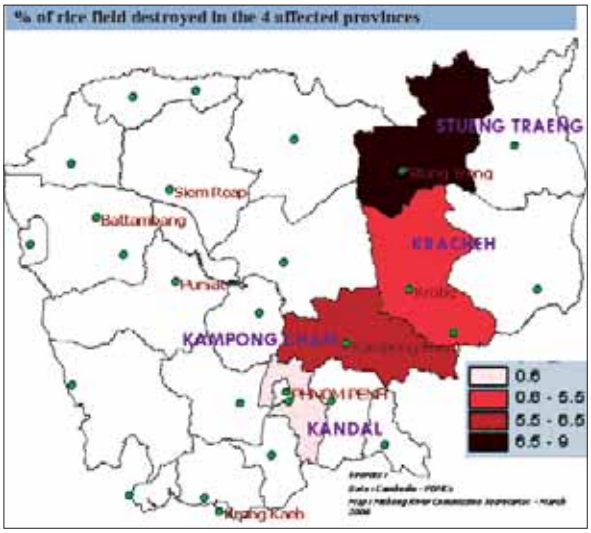
Figure 25: People affected by the 2005 flood in Cambodia

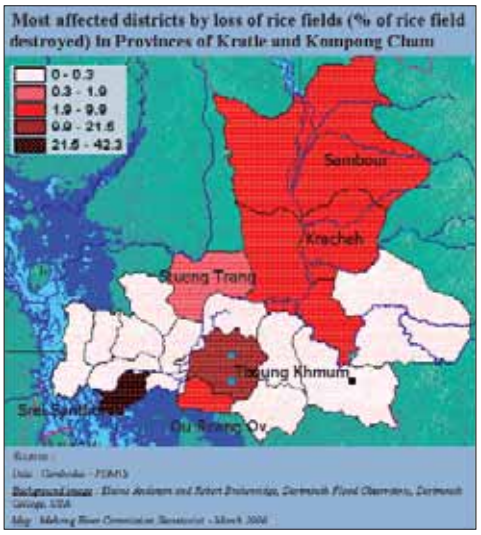
Impact on agriculture

The 2005 flood destroyed an estimated 6.7 % of the total area planted with rice. Some districts were particularly affected, such as the districts of Srei Santhor and Tboungkhmun in Kompong Cham province. Loss of livestock was very limited. Assuming that the data were correctly recorded, it would mean that the preparedness in the affected areas is effective and that the villagers took appropriate measures for evacuating the livestock to safer places before the water level rose.

Province	District	Rice fields Planted	Flooded	Destroyed	% lost	Other crops
Stung Treng		19827	2992	1784	9.0%	166
Kratie		27221	2585	1487	5.5%	155
	Chhlong	1302	162	75	5.8%	28
	Kratie	9202	1168	449	4.9%	127
	Prek Brosob	3090	515	306	9.9%	0
	Sambo	8760	697	657	7.5%	0
	Snol	4867	43	0	0.0%	0
Kompong Cham		103051	2045	6665	6.5%	750
	Batheay	15926	352	32	0.2%	0
	Kompong Cham	137	0	0	0.0%	0
	Kampong Siem	6330	30	0	0.0%	0
	Kang Meas	335	0	0	0.0%	0
	Kaoh Soutin	32	0	0	0.0%	0
	Krouch Chhmar	2669	610	9	0.3%	0
	Orang Ov	11415	159	476	4.2%	0
	Ponear Krek	17865	0	0	0.0%	12
	Prey Chhor	18339	0	12	0.1%	0
	Srei Santhor	5249	894	2219	42.3%	0
	Stung Treng	7187	0	140	1.9%	67.5
	Tboung Khmum	17567	0	3777	21.5%	670
Kandal		52732	981	329	0.6%	2379
Total		150149	7672	9986	6.7%	1121

Source: Provincial Disaster Management Committees





Affected Provinces	Loss of Livestock Cow Unit	buffalo Unit	Goat Unit	Pig Unit
Stung Treng	0	0	0	0
Kratie	0	0	0	0
Kompong Cham	1	1	1	0
Kandal	8	1	0	16
Total	9	2	1	16

Source: Provincial Disaster Management Committees

Figure 26: Impact on rice production and livestock in Cambodia

Impact on infrastructure

The damage to infrastructure was limited. Many infrastructure were flooded, causing some erosion but very few were destroyed. The province of Stung Treng seems to have been the most affected, but these figures must be considered with caution as it is not clear if the difference between flooding and destruction was made. It is also likely that some data are missing in the following table as it was not possible to reconcile "no data available" and "zero" value.

		National Roads		Rural Roads		Bridge		Culvert		Irrigation	
		Flood	Dest	Flood	Dest	Flood	Dest	Flood	Dest	Flood	Dest
Province	District	km	km	km	km	No	No	No	No	m	m
Stung Treng			0.95		36.4		NA		30		
Kratie		0	0.00	51.78	0	0	0	11	0	39	0
	Chhlong			11.49						25	
	Kratie			21.86				11		4	
	Prek Brosob			18.38						9	
	Sambo			0.05						1	
	Snol										
Kompong Cham		0	0.00	123.08	6	17	3	38	2	277944	3129
	Batheay			13.00		2	2	33	1	232352	1093.0
	Kompong Cham										
	Kampong Siem										
	Kang Meas			0.03	0.03						
	Kaoh Soutin			0.38	0.381	1	1			305	305
	Krouch Chhmar			20.20		1				68	68
	Orang Ov									2.50	2.50
	Ponear Krek										
	Prey Chhor									600	10
	Srei Santhor			36.47	0.703	5				40375	1461
	Stung Treng			24.00	0.085	4		1		4232	189
	Tboung Khmum			29.00	5	4		4	1	9	
Kandal		0	0.00	36.44	0	25	0	11	0	2351	0
Total		0	0.95	211.29	42	42	3	60	32	280334	3129

Source: Provincial Disaster Management Committees

		School		Hospital		Pagoda	
		Flood	Dest	Flood	Dest	Flood	Dest
Province	District	no	nor	no	no	no	no
Stung Treng		NA	NA	NA	NA	NA	NA
Kratie		45	0	1	0	14	0
	Chhlong	7				1	
	Kratie	9		1		4	
	Prek Brosob	28				9	
	Sambo	1					
	Snol						
Kompong Cham		65	0	3	0	51	0
	Batheay					1	
	Kompong Cham						
	Kampong Siem						
	Kang Meas						
	Kaoh Soutin	28				22	
	Krouch Chhmar	13		1		10	
	Orang Ov						
	Ponear Krek						
	Prey Chhor						
	Srei Santhor						
	Stung Treng	11				9	
	Tboung Khmum	13		2		9	
Kandal		13	0	2	0	0	0
Total		123	0	6	0	65	0

Source: Provincial Disaster Management Committees

Estimate of damage caused by the 2005 flood Department of Social Affairs	
Provinces affected (No)	16
Districts affected (No)	84
Villages affected (No)	2,510
Families affected (No)	85,553
People affected (No)	480,913
Ha of rice planted	687,555
Ha of rice flooded	87,724
Ha of rice damaged	55,955
Estimate damage to agriculture production (US$)	19,000,000
Estimate damage to irrigation infrastructure (US$)	1,500,000
Estimate damage to livestock and fisheries (US$)	165,000
Estimate of road damage (US$)	7,900,000
Total cost of flood damage (US$) ([1])	28,565,000

([1]) estimate damage to private infrastructure not available

Figure 27: Impacts on infrastructure in Cambodia

Site visit to the affected areas

The team in charge of preparing the MRC Annual Flood Report 2005 visited the three most affected provinces: Stung Treng, Kratie and Kompong Cham. Meetings with the provincial and distrtict Authorities and visits to some particularly affected villages were organised. Informal discussion with head of villages and villagers allowed the Team to get a better understanding of the severity of the flood, and the way the villagers and authorities tackled this difficult situation before, during and after the flood period.

Local women from the the villages of Phum Kang Cham and Phum Poung Touk, Stung Treng Province shared their experiences: "My house has been flooded every year from 1996 to 2005. In 2005, when the water level was 0.82 m, the Red Cross told us to evacuate to a safe place, but my house and my rice field were flooded. In my village 20 families were affected by the flood in 2005. The paddy fields were also flooded and we could harvest only 20%, so we did not have enough food last year. We received some support from the community and the Government but we think it was not enough."

The Mekong does not normally overflow from the mainstream in the provinces of Stung Treng and of Kratie. Heavy floods are seen by the villages as a serious concern, even if they are used to coping with this situation. It is likely that the flood contributes to increases in fish production, but agriculture (which is the most important activity) is generally affected by severe flood. Therefore, flooding events with water levels overtopping the river embankment are not perceived as profitable. Such floods do not occur every year and people have to deal with exceptional situations. Floods occurred in many villages in 2005, mainly near the confluence with tributaries or in places, where the level of the Mekong embankment is loweras a result of as a result of backwater effects.

In the province of Kratie, infrastructure and settlement were affected by flooding but to date it has not been possible to obtain a comprehensive report on the damage. The figures reported by the province (PDMCs) do not quantify the level of damage, nor the assessed amount needed for repair or reconstruction. Some figures probably do not exist at technical department levels, but are most likely partial and are not necessarily validated.

Flood in Kratie Province - pictures PDWRAM, 13 September 2005

The section downstream of Kratie is typical of the Cambodian floodplain conditions. Large areas are flooded every year. People are accustomed to managing this situation, by protecting the livestock, making provision of food and harvesting earlier when necessary. The 2005 flood was perceived as a "balanced" flood even if many villages were affected. The villagers recognised that the 2005 flood improved fishing activity, brought sediments in the cultivated areas and eradicated rats.

Village of Prek Toch - Kompong Cham Province: The chief of the village reported that the flood had to top a well known mark to be profitable, but should not top another mark otherwise it would become more damaging than profitable. It is likely that many villagers in the floodplain have a clear understanding of what is the minimum and maximum limit of water level that makes the difference between a "balanced" flood and a "damaging" flood. It should be possible to create a map showing those limits by carrying out village surveys.

10 deaths of children were recorded in 2005. Bathing in the river is one of the main causes of death. Housing is adapted for the long periods of flooding that occur every year in the Cambodian floodplain. Homes are built on high pillars and generally the water does not rise above the floor of the living quarters.

7.2 The impact of the 2005 flood in Lao PDR

7.2.1 Background

The hydrological network in Lao PDR is characterised by numerous tributaries, flowing to the Mekong, which drain large and mountainous catchment areas. This means that when strong rainfalls occur in those catchments, those rivers may generate severe and damaging flash floods before reaching the Mekong. These flash floods are not easily predictable due to the lack of hydrological stations on the tributaries and due to the difficulties of estimating rainfall which may be subject to a considerable spatial variation. The observation of tropical storms remains, at the moment, the best way for forecasting possibilities of such flash floods. Unexpected flood situations like this may make it difficult to be prepared. The intensity of the water flow is a major danger for human life and livestock and a source of damage to infrastructure such as bridges, roads and irrigation structures. The damage to cultivated areas is less important, except for areas located near the streams. Rice fields may be inundated up to 15 days without irreversible damage, while the duration of such flows is much shorter. Nearly every year, severe flash floods occur in the country but location may vary from one year to another. Nevertheless, regarding flash floods, the year 2005 was exceptionally favourable for flash floods in Lao PDR.

Erosion of the river bank is a serious issue. The picture on the left shows severe bank erosion that took a house away. Resettlement is also a major problem. those who lose their houses often have no place to resettle and no money for reconstruction. The picture on the right shows the resettlement of the owner of the same house washed away by erosion. A family member provided some land and very little external support was reported received. Solidarity between the community members is sometimes very low due to the extreme precariousness of the people's livelihoods.

When such tributary flows approach the Mekong, the situation may be quite different. Severe and long duration flooding events can be recorded if two conditions are simultaneously fulfilled: high flow in the tributary and high water levels in the Mekong. Prediction of such events requires a good knowledge of the hydrological conditions in the upper section of the tributaries and the rainfall depth and intensity in their basins as well as the ability to forecast the level of the Mekong. People living in such areas are accustomed to facing floods and are more prepared than people living in "flash flood" risk areas. Damage to houses and livestock is often limited. The most severe damage is caused to the paddy fields that may be flooded for long periods. This kind of flooding event occurs nearly every year, although serious damage to paddy fields is less frequent and depends on the duration of the flood.

The Mekong itself may sometimes reach such a high level that it overflows its banks. Some of the lowest points in the embankment may be source of local flooding that may affect villages located nearby. For such situations, flood forecasting may be of considerable help for early warning and preparedness. Severe damage from such floods does not occur often, although years 2000, 2001 and 2002 were considered as severe floods for those in proximity to the river embankment. Mekong River bank erosion is also a major concern for Lao PDR whatever the flood intensity.

In summary, in Lao PDR, the flood is generally considered as a source of problems more than a source of benefits. Other than those who have embankments to protect their paddy fields (and this is not common), the farmers who live in flood risk areas fear lose all or a significant part of their production every year. Fishing activity in fish ponds may also be affected by flood.

7.2.2 Availability of data

In Lao PDR, data are centralised at provincial level, through the Provincial Disaster Management Committees (PDMCs), in which the technical departments and the districts are represented. Data are collected from the field by technical departments. In addition, the village chiefs often keep records of the damage, with a major focus on paddy fields.

In Lao PDR, flood is generally seen as a source of problems. In 2005, infrastructure were severely affected by flash floods and from long periods of flood in the low-lying areas located close to the Mekong River. Long flooding periods affected the paddy fields and ruined farmers' incomes. Fish production carried out in fish ponds was also affected by the excessive flooding.

In Piaka District of Champone, in Savannakhet, the Village Head was able to show a very precise inventory of the damage caused by the 2005 flood. In his book, he had written the names of heads of families, the number of people living in the family and for each farmer, the area planted and the area destroyed. As the village was concerned about having sufficient seedlings for replanting, the seedling damage was also reported. As the village expects to be flooded every year, damage to livestock and other assets was generally limited, and was not recorded precisely.

The reliability and coherence of the data collected at provincial levels, strongly depends on the coordination quality of the Provincial Committees and on the severity of the flood. In some provinces, eg Khammouan, which was particularly affected by 2005 flood, an exhaustive report was prepared in 2005, including a table of damage, PowerPoint presentations and pictures. In other provinces, data were not reconciled nor validated at Committee level and discrepancies in the figures collected by the different institutions may be observed. In some places data are not available at all.

At central level, data are collected through two means. The Technical Departments have their own reporting from their provincial branch offices, while the National Disaster Management Organisation (NDMO) collects the information from the Provincial Committees. This may also generate some inconsistencies when comparing the consolidated figures.

For the time being, a considerable effort is being made in Lao PDR to obtain more exhaustive and accurate data on flood damage. Nevertheless, there is a strong need to improve coordination and data flow procedures to gather those data at the central level.

7.2.3 Overview of the impacts at national level

Flash floods occurred during 2005 in many provinces of Lao PDR, damaging roads and bridges, irrigation schemes and other village infrastructure such as schools, water supply and health centres.

The most affected provinces are located in central and southern parts of Lao PDR. They had to face both flood from the tributaries and backwater from Mekong. In some places, the combined effect caused the severest flood event for more than 30 years. The most affected districts were located in Khammouan Province.

Figure 28 is a tentative consolidation of the damage encountered during the 2005 flood in Lao PDR. Based on the analysis of inundated and damaged areas at country level, the flood in 2005 affected wider areas and lasted longer than the flood in 2002. It affected 84 districts, and roughly 480,000 people in 2,510 villages, mainly in the central and southern provinces of Lao PDR. The estimated total damage is more than US$ 18 million just for the sectors of agriculture and forestry. Roads were also damaged by the 2005 flood, some roads were cut off and some bridges were destroyed. The estimate of the total damage to roads was nearly US$ 8 million.

Estimate of damage caused by the 2005 flood Department of Social Affairs	
Provinces affected (No)	16
Districts affected (No)	84
Villages affected (No)	2,510
Families affected (No)	85,553
People affected (No)	480,913
Ha of rice planted	687,555
Ha of rice flooded	87,724
Ha of rice damaged	55,955
Estimate damage to agriculture production (US$)	19,000,000
Estimate damage to irrigation infrastructure (US$)	1,500,000
Estimate damage to livestock and fisheries (US$)	165,000
Estimate of road damage (US$)	7,900,000
Total cost of flood damage (US$) ([1])	28,565,000

([1]) estimate damage to private infrastructure not available

The table presents consolidated figures for 2005 flood as prepared by the Department of Social Affairs, National Disaster Management Office. The reconciliation of the figures from the different technical departments and from the different administrative levels (provinces, district, villages) is a complex operation. This is why some figures may differ from those obtained when analysing sectoral or regional situations. The NDMO is improving its database tools and better coherence and reliability of data may be expected in future.

Figure 28: Estimate of damage caused by the 2005 flood in Lao PDR

Deaths caused by flood are not systematically reported. Some figures exist for districts which were particularly affected, for example, four people died in the province of Savannakhet and five in Oudomxay. The direct impacts of floods on health are difficult to analyse and are not very well known. Some partial information is given further in this report at least for the most affected areas.

Impacts on the people

In Figure 29, the figures are broken down by provinces. Sources may be different from the national table but the final figures are eventually quite similar. Some data are also missing, but it may be assumed that in general when data are missing, it is likely that no exceptional damage occurred. It appears clearly that the provinces most affected by the Mekong flood are the southern provinces of Khammouan, Savannakhet and Champassak. Severe flash floods occurred also in Saravane, Oudomxay, Borikhamxay, Sekong and Huaphan Provinces.

		Social impact		
Provinces	No of districts affected	No of Villages affected	No of Families affected	No of People affected
Luangnamtha	4	48	1,200	7,200
Oudomxay	7	110	1,150	6,900
Luangprabang	8	75	851	5,106
Xayabuli	1	8	116	696
Huaphan	7	280	5,600	28,000
Vientiane	5	101	4,476	22,380
Borikhamxay	4	136	6,028	36,168
Khammouan	9	483	27,253	145,151
Savannakhet	10	285	9,249	53,976
Saravane	3	197	4,004	21,532
Champassak	8	322	5,729	30,363
Sekong	4	258	12,631	83,984
Attapeu	4	54	2,633	14,295
Total	74	2,357	80,920	455,751

Source: Ministry of Agriculture and Forestry, NDMO Oct 3 2005

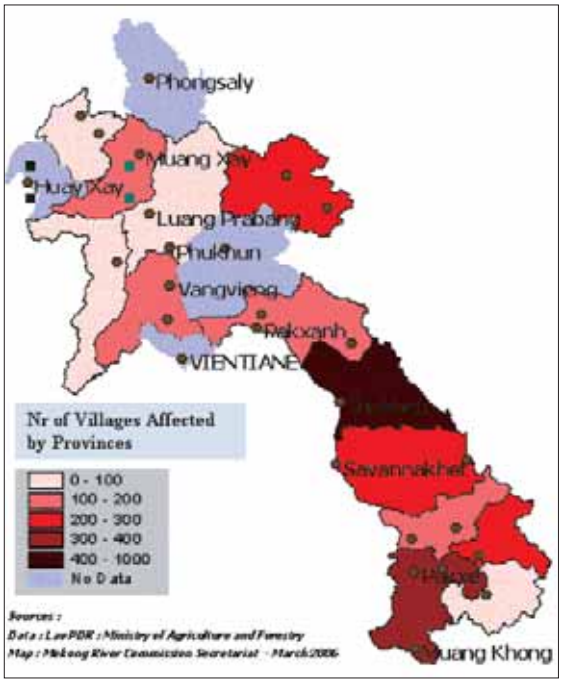


Figure 29: Estimated number of people affected by the 2005 flood, by provinces

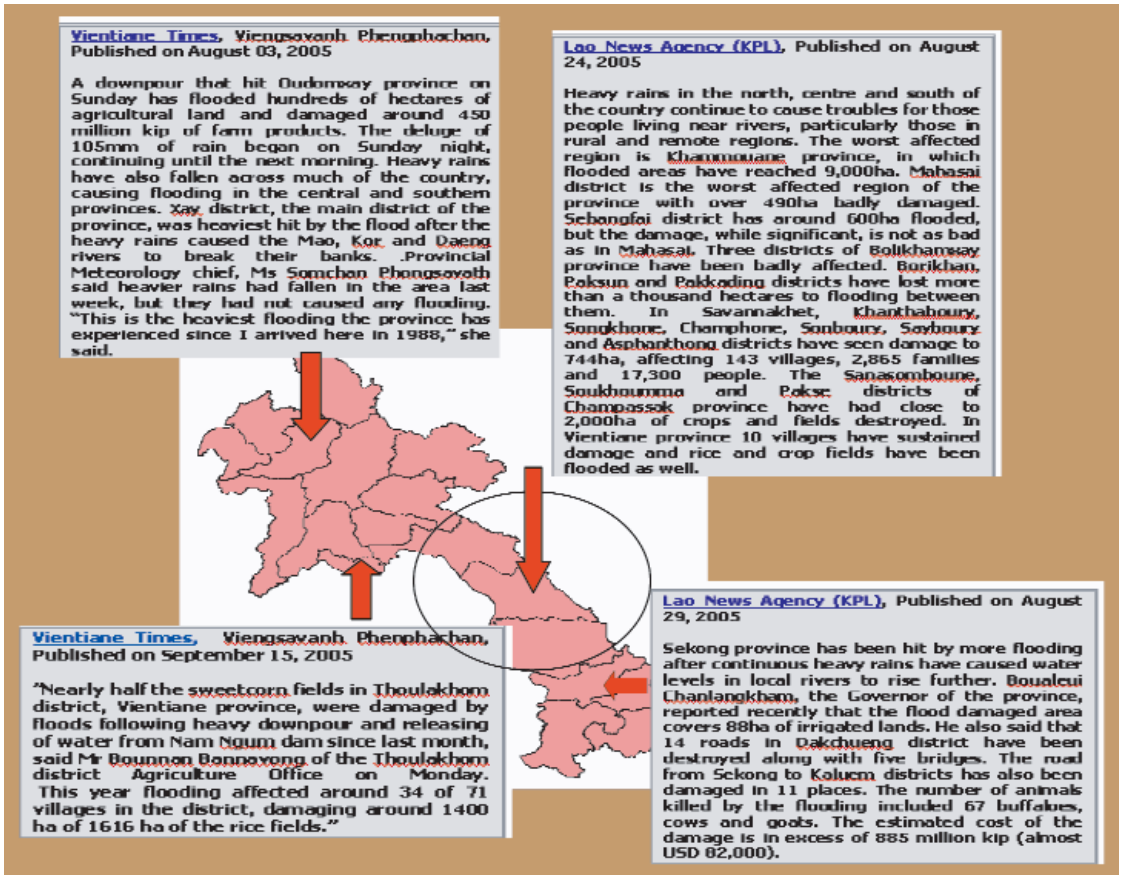


Figure 30: The successive events of the 2005 flood were widely reported in the Vientiane Times and in the Lao News Agency (website laomedia.net).

In 2005 Lao PDR was severely affected by floods, the worst recorded since several decades. The effects were twofold: high water levels and, in some places, exceptionally long duration of flooding.

Impacts on Production Areas

The main source of information for estimating the impacts of the 2005 flood on agricultural production are the statistics dated 3rd October 2005 issued by the Disaster Management Focal Point of the Ministry of Agriculture and Forestry, NDMO. Nevertheless, in this document, the breakdown by province differs from the consolidated estimate of damage for the country. This is due to lack of data in some provinces and assessment from different sources. Although, the overall figures are quite comparable when considering the challenge of reporting damage at a national level.

The estimated number of hectares of rice lost by floods in 2005 varies from 44,479 to 50,215 ha on a total planted area of approximately 659,000 ha. This is nearly 8% of the planted areas, which is considerable if compared with the 34,000 ha loss in the 2002 flood, considered as the most severe flood in recent years.

Provinces	Impact on rice cultivation ha planted in affected areas	ha flooded	ha destroyed
Luangnamtha	13,730	140	140
Oudomxay	21,290	646	70
Luangprabang	13,600	246	246
Xayabouly	35,570	150	80
Huaphan	11,830	230	40
Vientiane	47,235	125	5
Borikhamxay	32,880	6,278	2,446
Khammouan	53,361	28,146	22,462
Savannakhet	139,495	17,725	6,500
Saravane	64,310	6,295	3,340
Champassak	91,125	10,063	6,470
Attapeu	14,600	6,500	2,680
Total	539,026	76,544	44,479
Total planted in Lao PDR :		659,220	ha

Source: Ministry of Agriculture and Forestry, NDMO Oct 3 2005

Figure 31: Estimated damage to agricultural production from 2005 flood, by provinces

The impact on livestock was also particularly heavy in areas where flash floods occurred. In such cases practically no warning systems were available and the people were not prepared for exceptional events. Heavy losses of livestock were recorded in Sekong, Saravane and Khammouan Provinces.

Provinces	Loss of Animals (Units) Buffalo	Cow	Pig	Goat	Total animals livestock	Poultry	Fish ponds (ha)
Oudomxay	2				2		
Luangprabang	5		42	20	67	1230	2.70
Huaphanh	1		101		102	613	12.70
Vientiane			4	18	22	1041	10.10
Borikhamxay					0		15.00
Khammouan	37	39	130		206	2031	43.00
Savannakhet	6	20	5	8	39	1293	105.00
Saravane	22	46	169	120	357	1220	86.00
Champassak					0		11.30
Sekong	5	10	0	52	67	1500	5.00
Attapeu	27	8	233	24	292	4573	5.20
Total	105	123	684	242	1,154	13,501	296.00

Source: Ministry of Agriculture and Forestry, NDMO Oct 3 2005

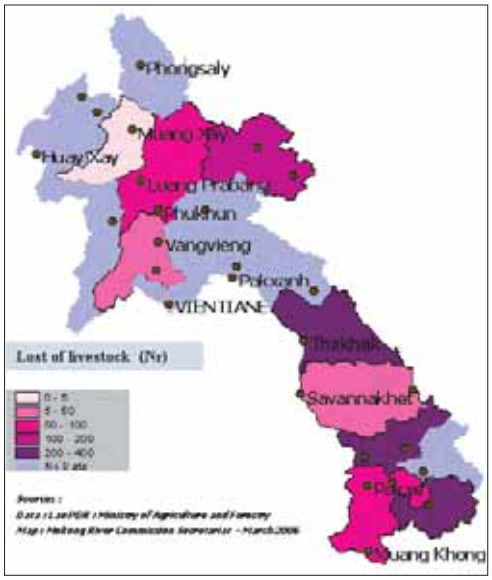


Figure 32: Estimated damage to livestock from the 2005 flood, by provinces

Impacts on Infrastructure

Data concerning the damage to irrigation infrastructure are not exhaustive. This is due to a lack of procedures and expertise for covering this sector.

Province	No. of Projects	Damage to pumping stations (unit)	Canals destroyed (m)	Canals covered by landslide (m)	Estimated Cost (US$ 1000)
Luangnamtha	24	24			0.13
Oudomxai	32	22	325	350	0.24
Luangprabang	26	18	1,631	10	0.17
Huaphanh	17	6	9,291	4	0.16
Khammouane	45	11		12	0.39
Savannakhet			No data available		
Saravane	12	1	3,540		0.30
Champassak	12				0.05
Sekong	12			12	0.05
Attapeu	1				0.10
Total	181	82	14787	388	1.59

Source: Ministry of Agriculture and Forestry, NDMO Oct 3 2005

Figure 33: Estimated damage to irrigation infrastructure from the 2005 flood, by provinces

7.2.4 The most affected areas

As shown, the 2005 flood affected numerous provinces in Lao PDR. Nevertheless, it is commonly admitted that the most affected districts were those which experienced both backwater from the Mekong and flooding from the tributaries. Those areas suffered from an exceptionally long duration of the flood. The analysis is more meaningful when examined by district. The Districts of Hinboun and Nongbok in Khammouan Province were generally considered the most affected by flood in 2005.

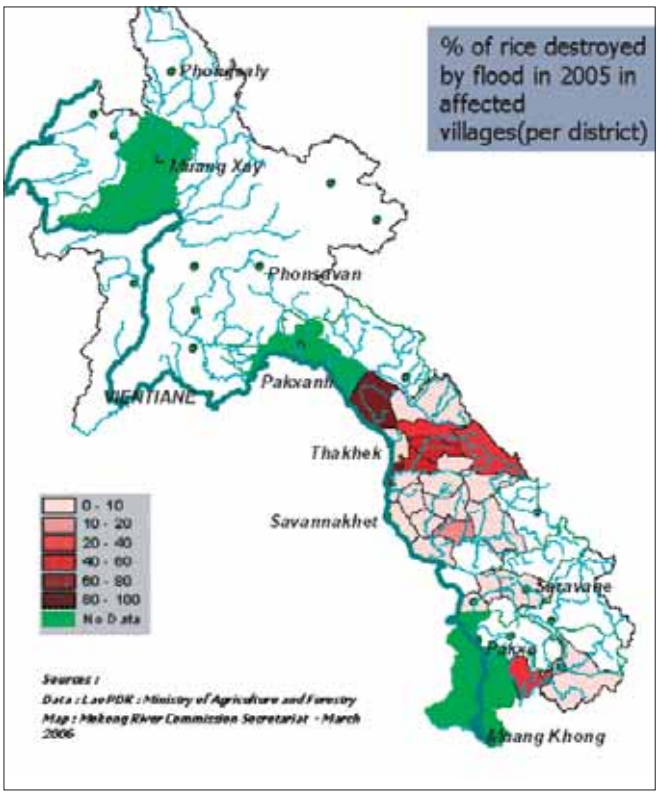
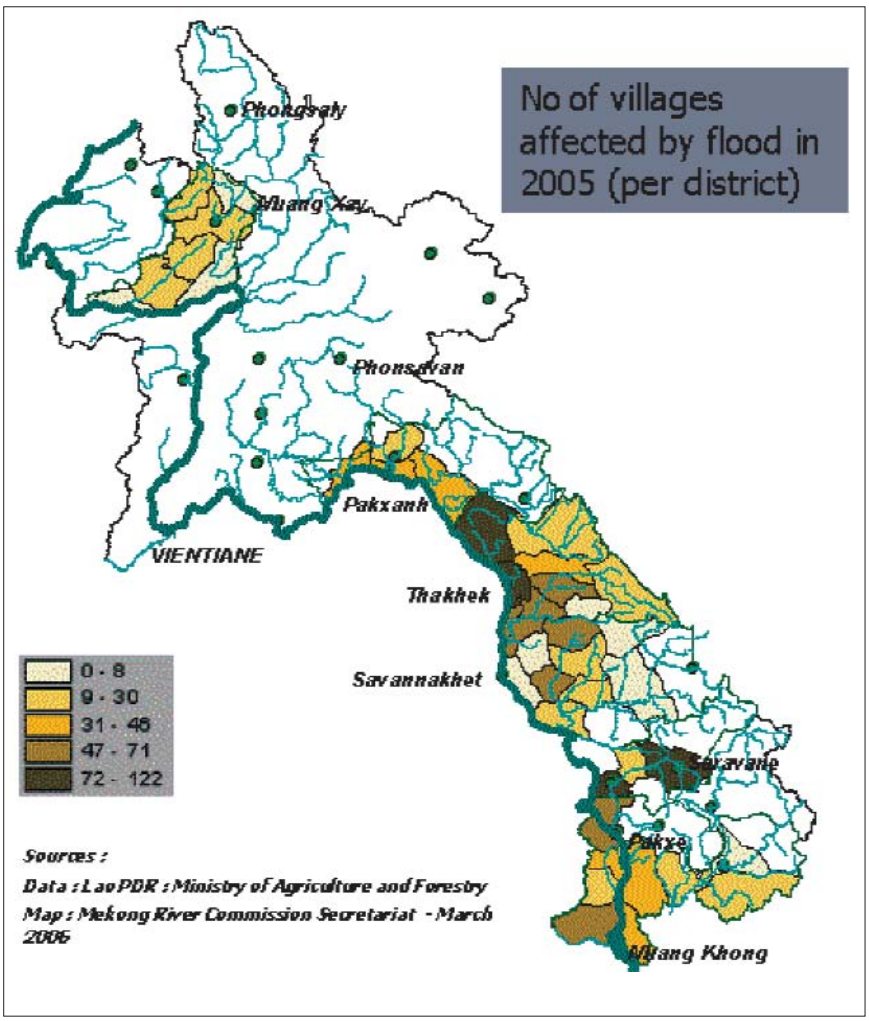


Figure 34: Percentage of destroyed paddy fields, breakdown by districts

Figure 34 shows a breakdown by districts illustrating the situation in terms of rice production. The three parameters of planted rice, flooded rice and destroyed rice are suitable indicators for estimating the severity of the flood for two reasons: firstly, these parameters are generally recorded at all levels, village, district and province; and secondly, they integrate to a certain extent two essential parameters which characterise the flood - extension and duration. The flooded areas may give an idea of the extension of the flood, and the destroyed areas indicate roughly where the flooding period exceeded two weeks. This table also shows that, although these indicators are essential for characterising the flood and are representative of the most important damage suffered by farmers, many data are missing. It does not necessarily mean that the data were not recorded, but most likely that the communication channels for making the information available at central level (NDMO) did not run properly.



Provinces affected	District affected	Villages affected	Families affected	People affected	Rice - area planted	Rice - Area affected	Rice - area destroyed by flood
Oudomxay	Naxay	27	602	3958	NA	302	0
	Meuangla	17	105	1,092	NA	38	3
	Meuangsay	40	512	2317	NA	110	62
	Meuangbang	34	1,149	6770	NA	159	2
	Meuangnga	2	8	NA	NA	8	2
	Meuanghun	25	1,407	NA	NA	29	0
	Pakbang	2	13	82	NA	5	0
Borikhamxay	Borlikhan	21	1116	NA	NA	850	268
	Thaphabath	33	125	NA	NA	850	212
	Pakkading	46	3165	NA	NA	3024	1523
	Paksan	36	1622	NA	NA	1532	443
Khammouan	Hinboon	126	8806	48759	7920	7096	6336
	Nakhai	27	839	4195	1443	114	77
	yommalath	36	1919	10919	4560	1760	1397
	Boualapha	28	1894	10342	3500	2262	1190
	Thakek	90	2762	13948	9530	2073	829
	Mahaxay	70	2590	14159	6520	3830	3568
	Xebangphai	44	2119	10880	5580	3200	2726
	Xaybouathong	25	449	2934	4300	449	294
	Nongbok	71	4841	27961	10008	7510	6574
Savannakhet	Xaybouly	53	1487	8379	12768	2693	930
	Artsaphone	62	2002	12628	10115	1483	708
	Vilabouly	8	NA	NA	4750	328	105
	Outhoumphone	0	NA	NA	12805	4	4
	Artsaphangthong	28	848	6505	9544	1706	238
	Phine	0	NA	NA	5255	15	0
	Khanthabouly	3	NA	NA	10239	302	50
	Champhone	70	1807	11842	17380	1959	0
	Sonbouly	25	1547	8556	10940	2582	1228
	Songkhone	29	1388	13818	22500	2946	270
Salavane	Salavan	89	1869	9345	20467	2500	816
	Vapee	23	461	3227	10374	709	249
	Khongsedon	85	1674	8960	14268	3911	1384
Champassak	sanasomboon	50	595	NA	NA	2331	1700
	Phonthong	53	752	NA	NA	1400	1300
	Pakse	17	277	NA	NA	215	76
	Phathumphone	41	1492	NA	NA	1725	500
	Champasack	41	985	NA	NA	1246	975
	Soukkhumma	30	340	NA	NA	1014	930
	Moon	58	1288	NA	NA	1579	795
	Khong	32	NA	NA	NA	553	194
Attapeu	Xaysetha	7	284	1420	2718	0	0
	Samarmxay	23	1412	8190	5003	0	1966
	Samakkexay	7	230	1150	3488	0	230
	Phuvong	17	707	3535	610	610	0

Source NLMO

Figure 35: Percentage of affected villages, by district

The Team in charge of preparing the MRC Annual Flood Report 2005 visited two affected provinces: Khammouan and Savannakhet. This visit included meetings with the Provincial and Distrtict Authorities (with participation of the technical departments) and visits to some particularly affected villages. Informal discussions with the chief and villagers allowed the Team to get a better understanding of the severity of the flood, and the way the villagers and authorities tackled this difficult situation before, during and after the flood period. Testimonies of villagers were recorded during this field trip.



The village of Chokbo, District of Nongbok, Province of Khammouan was one of the villages most affected by the 2005 flood. The villagers reported:

"Our village is located along the Xebangfay river about 4 km from the district town and 6 or 7 km from the Mekong River. We are 108 families all are rice farmers. Fishing and vegetable gardens are activities only for household consumption. Our rice field area covers approximately 134 ha, all located in a flood risk area. Of this 77 ha are irrigated. The village has water and electricity. We are used to having a flood every year from the end of July to September. Every family has one boat on average. The oldest people remember the dreadful flood of 1972 where we recorded 1 m of water in the village and up to 3 m in the paddy fields, and this lasted more than one month.

Last year, in 2005, we had to face an even more serious situation. The water started to rise in the first week of August. We worked very hard fighting the inundation using sand bags. But on the 27th August we could no longer prevent the flood from entering into the village. At that time, the Mekong water level was getting very high and the extension of the backwater in the Xebangfay River was about 42 km. The water level reached more than 1 m in the village and nearly 3 m in the paddy fields. We had to face nine successive floods. The flood lasted for nearly 45 days.

Our paddy fields were totally destroyed. Other damage was fortunately limited. No one died, but several fish ponds and one house were damaged. The loss of livestock was limited to poultry. We received assistance from the district for food, water, medicine and 500 kg of seedlings for replanting, far under our needs. The impact of the flood on the villagers' health was limited to foot diseases, diarrhoea and fever.

On the other side of the river, just in front of us, is the district of Xaybuly, Savannakhet Province. Their villages are protected by an embankment. They were safer than us, but we think that we have been more severely affected by the flood because of this embankment. We can generally manage the consequences of flood ourselves, except for what is the most important for us, our paddy fields. Many families in the village are now fearful of replanting during the rainy season. We also need embankments and access roads.

We received good emergency support from the province and yhe district. They all did what they could, but we know that their means are vey limited".



The Chief of Khengphoun village reported:

“This village is located in the District of Champone, Savannakhet Province. It has 546 inhabitants, 101 families and is entirely located in a flood risk area. All 183 ha of land planted with rice in the rainy season are located in this area. In 2005, we planted 166 ha and all of this has been lost. We are used to experiencing floods every year. We do not fear floods and we are prepared and well organised to manage it, but in 2005, it was exceptional. We do not remember such a serious flood since 1978. In 1978, we got 3.5 m of water in the paddy fields and 2.5 m in the village, but the flood period was not so long.

In 2005, we “only” got 2.5 m-3 m in the paddy fields and 1.5 m in the village. But it lasted from end of July to end of September. We had to face seven successive flood peaks. Paddy fields were flooded for 47 days, which is why we lost all the production. All the families in the village were affected.

Our problem with the flood in 2005 was its duration. We have TV and radio and we sometimes receive information from the district when a risk of flood is forecasted. But we also have our traditional way of predicting the flood, for example by observing trees. We prepare ourselves, and proceed with the evacuation of the livestock to safer places. It is why, in 2005, only three cows and six buffaloes were lost. But generally we do not lose livestock.

During the flood we were given support through the provision of dry food and drinking water. After the flood we wanted to replant, but we had to face the problem of getting seedlings. We received some from district, but far less than our actual needs; so many villagers could not afford to replant rice after the flood.”

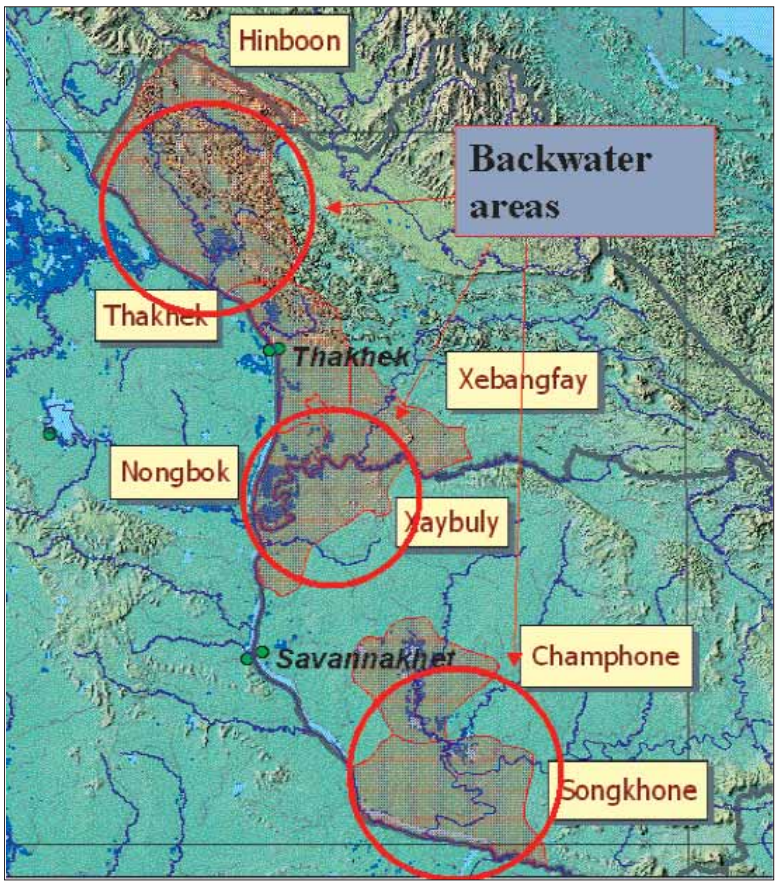


Figure 36: Districts most affected by 2005 flood in Lao PDR

People affected

Figure 37 shows the extent to which people in these districts were affected. Four people died due to the flood in Savannakhet Province and more than 300 people were evacuated to safer areas in Khammouan Province. There was minimal damage to houses with only one house in Savannakhet Province and two in Khammouan Province reported as destroyed.

		People affected by Flood			Evacuated to safe places	Deaths by flood				
Province	District	Villages	Families	Persons	Families	Male	Young Female	Male	Old Female	Total
Savannakhet		189	9133	51074	321	1	1	1	1	4
	Songkhone	58	1639	11078	200	0	0	1	0	1
	Champone	75	4078	23965	81	1	0	0	1	2
	Xaybuly	56	3416	16031	40	0	1	0	0	1
Khammouane		241	15766	87600	35	0	0	0	0	0
	Xebangfay	44	2119	10880	0	0	0			0
	Nongbok	71	4841	27961	6	0	0	0	0	0
	Hinboon	126	8806	48759	29	0	0	0	0	0
	Thakhek	90	2762	13948	0	0	0	0	0	0
Total		430	24899	138674	356	1	1	1	1	4

Source: Meeting of MRCS Flood 2005 team with Provinces/District Feb/March 2006

Figure 37: Damage to people in the most affected districts

Agriculture and livestock

The most important damage caused by the 2005 flood was seen in the paddy fields. Long periods of flooding reduced the rice production by nearly 50% in the Province of Khammouan, approximately 90% in the district of Hinboun and 75% in the district of Nongbok. In Savannakhet Province, the district of Champone was also severely affected with loss of nearly 30% of rice production.

District	Rice fields ha	Flooded ha	Destroyed ha	Loss of Livestock Cow U	Buffalo U	Goat U	Pig U	Total	Poultry U	Fishpond U
Savannakhet	50552	13094	11538	13	4	3	11	31	796	620
Songkhone	22500	3505	3182	11	1	3	5	20	646	12
Champone	18520	5434	4825	2	3	0	6	11	150	320
Xaybouly	9532	4155	3531	0	0	0	0	0	0	288
Khammouane	33038	19879	16465	125	54	3	340	522	7065	1477
Xebangfay	5580	3200	2726	91	12	0	210	313	4010	167
Nongbok	10008	7510	6574	9	5	3	30	47	100	658
Hinboon	7920	7096	6336	19	20	0	100	139	2094	104
Thakhek	9530	2073	829	6	17	0	0	23	861	548
Total	83590	32973	28003	138	58	6	351	553	7861	2097

Source: Meeting of MRCS Flood 2005 team with Provinces/District Feb/March 2006

Figure 38: Damage to agriculture production in the most affected districts

Damage to livestock was high as well. People are normally prepared for flood events and evacuation of livestock is a common preparation measure. In the case of the 2005 flood, water rose very quickly both in the Mekong and in the tributaries. Some villagers reported that the flood occurred overnight and they did not have sufficient warning to take action.

Infrastructure

Damage to infrastructure was pieced together during a meeting with provinces and district authorities.

Province	District	National Roads Flood km	Dest km	Feeder Roads Dest km	Dest nber	Irrigation Pumping Station Unit	Damage US$	School Flooded Unit	Severely Damaged or Unit	Hospital Flooded Unit	Severely Damaged or Unit	Pagoda Flooded Unit	Severely Damaged or Unit	Water Supply Flood Unit
Savannakhet		0	0.00	86.2	16	28	1900	19	0	0	0	1	1	1
	Songkhone	0	0.00	37	4	6	100	1	0	0	0	0	0	0
	Champone	0	0.00	33	8	13	100	1	0	0	0	1	1	1
	Xaybuly	0	0.00	17	4	9	1700	17	0	0	0	0	0	0
Khammouane		14	0.40	33	6	28	1900	97	29	6	1	72	3	0
	Xebangfay	0	0.00	5	1	9	1300	13	2	1	1	1	0	0
	Nongbok	0	0.00	6	3	4	2100	21	5	5	0	71	3	0
	Hinboon	4	NA	16	0	14	5100	51	19	0	0	0	0	0
	Thakhek	10	0.40	6	2	13	1200	12	3	0	0	0	0	0
Total		14	0	119	22	56	3800	116	29	6	1	73	4	1

Source: Meeting of MRCS Flood 2005 team with Provinces/District Feb/March 2006

Figure 39: Damage to infrastructure in the most affected districts

Health

Some data were issued by the Department of Health in the province of Khammouan. These incidents may not have been directly induced by the 2005 flood. Typhoid cases are, for example, recorded every year. In 2005, 12 people died from typhoid in the Khammouan Province, but the relationship to flood events is not obvious. After interviewing the authorities and the villagers, it seems that people's health was not seriously affected by the 2005 flood. No epidemics occurred, and there is no mention of abnormal malaria. The major concern was clean drinking water and sanitation. District authorities provided treatment by chlorination of boreholes and supplied drinking water.

Some indicators of health situation in Khammouane Province during 2005 flood	
Severe Diarrhoea	9 cases
Dengue Fever :	566 cases
angue Haemorrhagic Fever	12 cases
Dengue Shock Syndrome	1 case
Dysentery	15 cases
Food Poisoning	9 cases, and 1 death
Typhoid	259 cases
Leptospirosis	258 cases

Source: Department of Health, Khammouan Province

Figure 40: Health indicators in the 2005 flood in Khammouan

7.3 The impact of the 2005 flood in Thailand

7.3.1 Background

The Mekong River Basin in Thailand is shown in Figure 41. It represents only 36% of the country separated in two areas. One is located in the mountainous and forested section (Province of Chiang Rai) close to the borders of Myanmar, China and Lao PDR and is subject to frequent flash floods.

The other area is known as the Mun-Chi River System. It covers the Issan region. The Mun-Chi river system, as well as other major tributaries such as the Songkhram river are highly developed low-relief basins with low runoff potential and significant reservoir storage for dry season irrigation. Wide low level plains are inundated every year. When the water of the Mekong is high, the combined effect of backwater from the Mekong and reduced drainage may cause serious flooding.

In rural areas, rice growing in paddy fields is the main activity, and these are the poorest and least developed areas in Thailand. The trend is therefore to develop infrastructure for securing production in case of flood and developing irrigation during the dry season. The economic and social justification of such a policy is strong. Simultaneously, however, there is competition with the protection of large territories of wetlands containing a high biological value and important fishing activities. These areas also provide water storage possibilities during the flood periods reducing peak floods downstream.

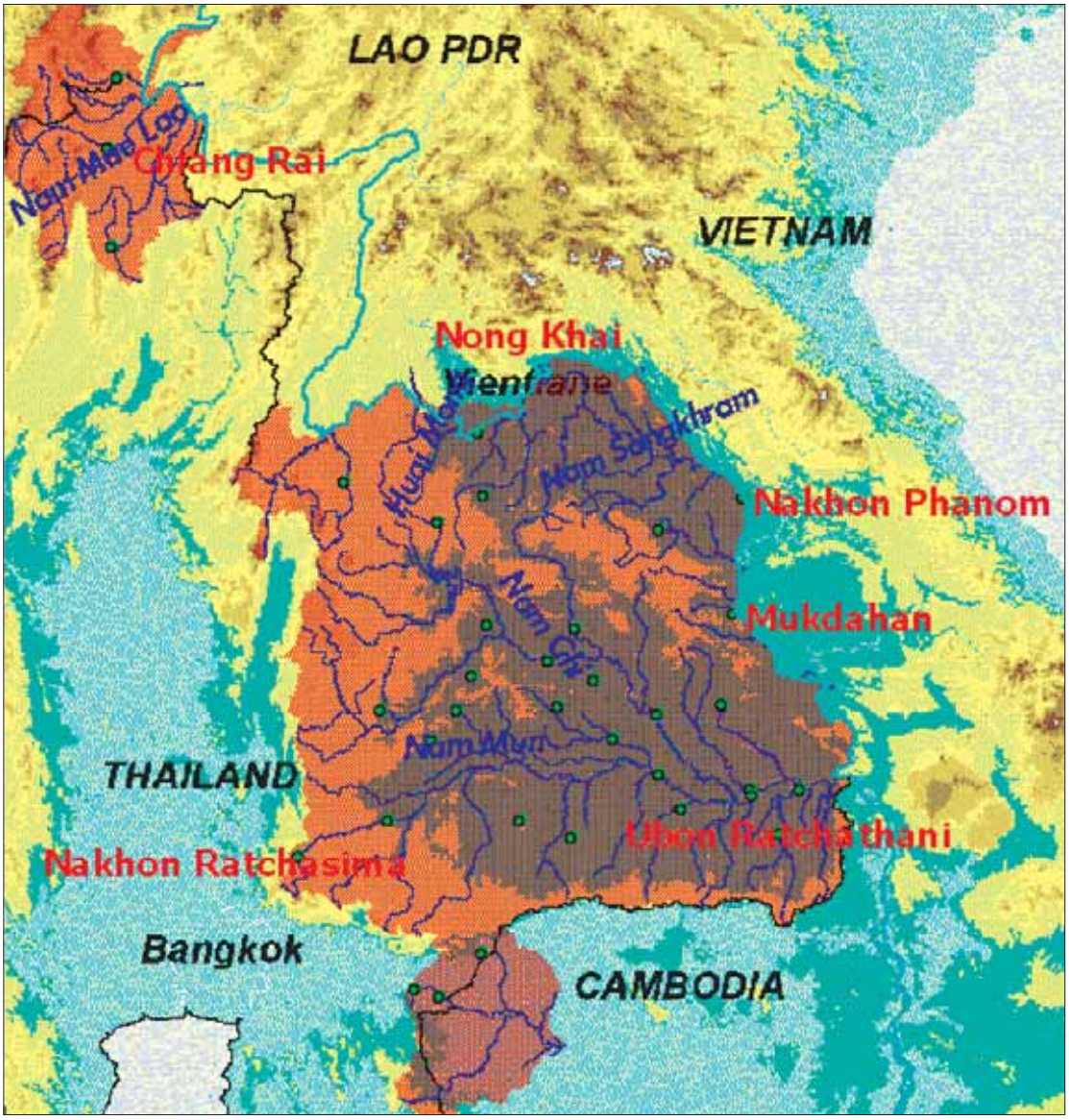


Figure 41: The Mekong River Basin in Thailand

Although flash floods may be considered as more damaging than beneficial, this is more relevant when speaking about the Mekong flood in the Northeast Region. Urban, semi-urban and rural areas located along the embankment of the Mekong are obviously affected when strong floods occur. The appreciation of flooding in the low plains depends on how land is being used. Farmers generally consider it harmful, while conservation advocates and fishers see it as beneficial. It is likely to remain a sensitive issue for years to come.

Floods caused by heavy rainfall near urban areas such as Nong Khai, Nakhon Phanom and Mukdahan are also a cause for concern in this area. Runoff increases in relation to increased surfaced areas. When the level of the Mekong is high, drainage becomes problematic. This was particularly the case in 2005 with substantial difficulties experienced in Mukdahan.

7.3.2 Availability of Data

Data related to damage from floods are recorded at tambon (commune) and district level by the Technical Departments mainly for establishing budgets and funding requests for repairs and reconstruction. From this information, in theory, the National Disaster Mitigation and Prevention Centre establishes lists of the major events at national level, broken down by province. Unfortunately, it appears that carrying out these reports is a long process and reports for 2005 were not available when we were preparing this annual flood report.

Data are available at provincial levels and experience shows that direct contacts with the provincial authorities are the best and, to some extent, the only, way to obtain access to information. Additionally, the data are not recorded consistently from one province to another. Some indicators are monitored in one province and not in another, rendering data reconciliation and consolidation at national level impossible, except for loss of rice production.

Recently, damage to agricultural production has been subject to cash lump sum indemnities rather than compensation in kind. For example, the loss of one rai (0.16 ha) of paddy field is compensated at the rate of 243 baht (approximately US$ 6). Damage is declared by the farmers to the Department of Agriculture and a field assessment is done for approval of the indemnities to be paid. Data on agricultural damage may therefore be considered as clearly identified and recorded. Nevertheless, the planted areas are not monitored in the existing process of collecting data related to flood damage. It is therefore not possible to estimate the loss in terms of percentage of planted areas, which is likely to be the most significant indicator of the severity of the floods. Those figures have most likely been collected but would require additional effort to obtain them.

In Nong Khai province, the loss of paddy fields due to floods has been recorded for the past 10 years. Unfortunately, those data are not linked to the planted areas, but are nevertheless a good indicator of the intensity of the floods that involve the Mekong-tributaries system.

Figure 42 shows that 1996, 1998 and 2001 were the most damaging years. Keeping records of annual loss of paddy fields could be an outstanding indicator for historical analysis of flood events.

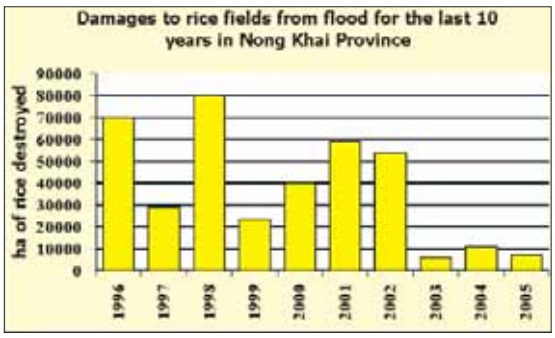


Figure 42: Damage to rice fields in the last 10 years in Nong Khai Province (Source: Province of Nong Khai)

7.3.3 Overview of the impacts at national level

The 2005 flood mainly affected two areas. The Northern region of Chiang Rai was affected by two flash flood events and the section of the Mekong starting downstream of Nong Khai province and covering the provinces of Nakhon Phanom and Mukdahan recorded high levels in the Mekong for a substantial period causing backwater from the Mekong to flood the lower areas. This was combined with intensive rainfall which considerably reduced the possibility of drainage from major tributaries to the Mekong. In addition, urban areas (mainly in Mukdahan) were severely affected by heavy runoff caused by rainfall which was unable to drain into the Mekong.

Mukdahan was severely affected by the 2005 flood. The combination of heavy rainfall and high levels of the Mekong restricted the drainage of runoff water.

Figure 43 tentatively attempts to consolidate the data related to the damage caused by 2005 flood in the Thai part of the LMB. This exercise is nevertheless very approximate. On one hand, it has not been always possible to distinguish clearly between missing data or zero data. Therefore, addition has been made, but is not consistent. On the other hand, we may expect that sometimes "no data" may mean that only minor damage occurred, making the figures quite close to a zero value.

The flood 2005 in Thailand - Consolidation of available data											
Provinces affected	No of tambon affected	No of villages affected	No of households affecetd	Farmers affected	Houses damaged	Ha of rice fields destroyed	Ha of orchards destroyed	Ha of fishponds destroyed	Sections of roads damaged	Bridges and culverts damaged	Amount of damage in US$
Nong Khai	54	357	39831	5084	NA	5178	NA	282	218	-	620,000
Nakhon Phanom	95	752	28535	NA	NA	29638	68	305	116	4	1,410,000
Mukdahan	44	180	4595	NA	1246	4722	31	172	145	6	NA
Ubon Ratchatani	41	124	5160	NA	29	648	188	145	121	5	540,000
Chang Rai	NA	NA	NA	7520	NA	8183	596	1	NA	NA	248,000
Total	**234**	**1413**	**78121**	**12604**	**1275**	**48369**	**883.48**	**905**	**600**	**15**	**2818000**

Source: Provinces, Disaster Prevention and Mitigation Offices

Figure 43: Consolidation of available data on estimated damage in Thailand

7.3.4 The most affected areas

The most affected areas during the 2005 flood in Thailand were in the downstream area of Nong Khai Province (reasonably affected) and the provinces of Nakhon Phanom and Mukdahan (badly affected). Further downstream, in the province of Ubon Ratchatani, less damage was recorded. The flash floods that occurred in the province of Chiang Rai were specific events not linked to the Mekong River itself, but some basic information on the damage caused is presented in this chapter as well.

7.3.4.1 Damage to agricultural production and extension of the flood

The damage recorded to agricultural production in the three provinces, broken down by districts are a good relative indicator of the intensity of the flood. The problems started in the District of Bun Khan (opposite Paksan in Lao PDR) and the worst places were situated in Nakhon Phanom Province, more especially in the low lying areas of the river Songkhram.

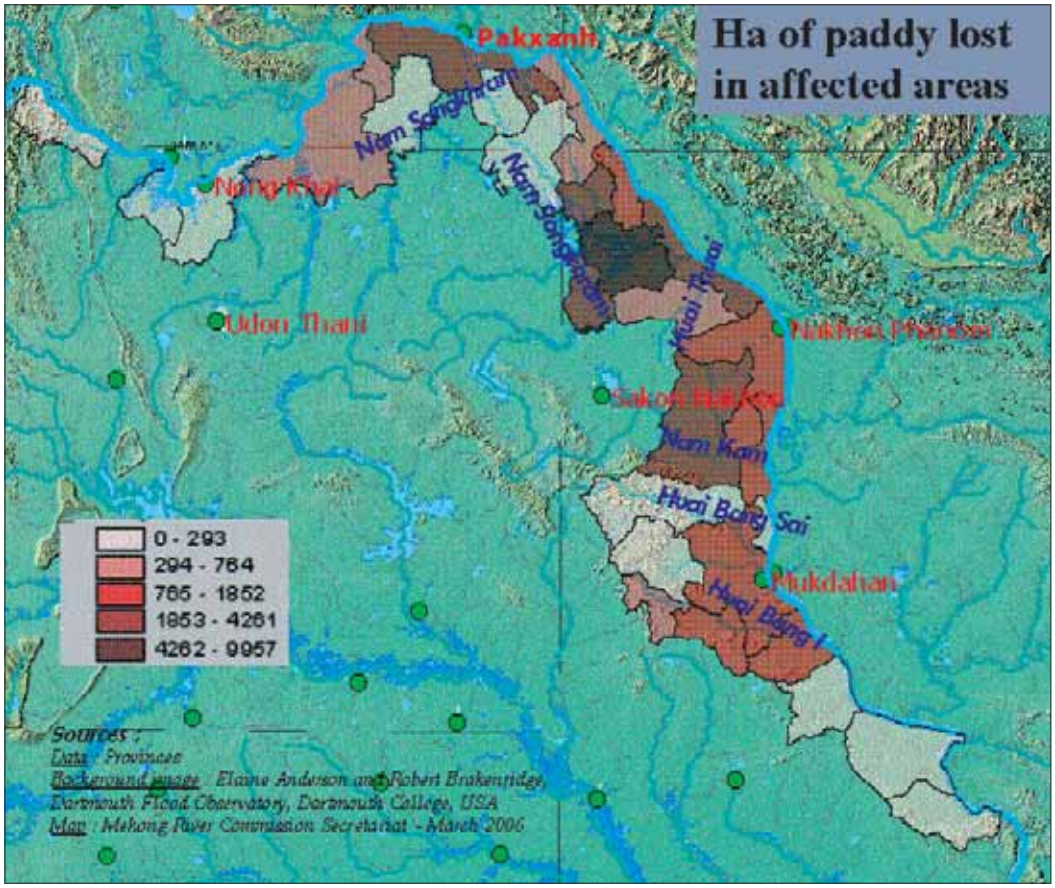


Figure 44: Hectares of paddy fields lost in the affected districts.

Province of Nong Khai			
	Farmers affected	Rice Fields Ha of paddy destroyed	Ha of fishponds destroyed
Muang Nong Khai	54	75.2	0
Bung Kan	2044	2542.24	68.5
Phon Phisai, Fao Lai, Rottai	935	691.68	36
Seka	7	0	18.5
Tha Bo	49	42.56	61.25
Sangkhom	30	6.08	8
So Phisai	1	0	0.75
Pak Khat	440	680.32	1.5
Bung Khong Long	538	436	8.5
Si Wichai	217	226.56	0
Bung Khla	769	477.12	78.75
Total	5084	5178	282

Source: Province of Nong Khai , Disaster Prevention and Mitigation Office

Province of Mukdahan							
Districts Affected	No of tambons affected	No of villages affected	No of households affecetd	Ha of rice fields destroyed	Ha of other crops destroyed	Ha of orchards destroyed	Ha of fishponds destroyed
Muang Mukdal	12	25	988	1407	38	4	21
Khumcha-i	6	21	389	87	0	0	0
Nong Sung	6	19	363	370	0	0	14
Wan Yai	4	27	181	293	8	0	7
Don Tan	3	9	641	1270	145	20	91
Nikom Kham S	7	37	1598	1024	1	5	34
Dong Luang	6	42	435	271	165	2	5
Total	44	180	4595	4722	357	31	172

Source: Province of Mukdahan

Province of Nakon Phanom						
Districts Affected	No of tambons affected	No of villages affected	No of households affected	Ha of rice fields destroyed	Ha of orchards destroyed	Ha of fishponds destroyed
Muang Nakhon	13	105	2478	1852	3	0
Tha Uthen	9	0	1864	2688	16	0
That Phanom	12	93	4746	1709	43	76
Na Wa	6	66	2980	4261	6	61
Ban Phaeng	6	56	2049	1526	1	0
Pla Pak	22	183	5847	3322	0	6
Phon Sawan	7	74	2100	764	0	0
Renu Nakhon	8	62	1416	1102	0	0
Sri Songkhram	9	85	4195	9957	0	162
Na Thom	3	28	860	2457	0	0
Total	95	752	28535	29638	68	305

Source: Province of Nakon Phanom

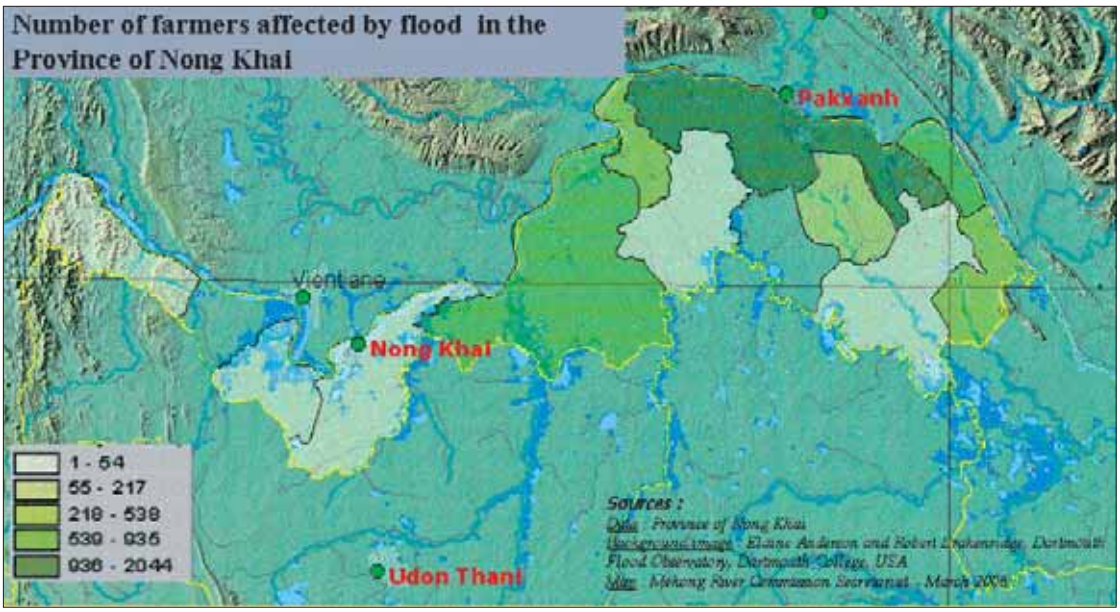


Figure 45: Estimates of agricultural damage in Thailand

7.3.4.2 Other Damage

Province of Nong Khai

	People affected				Damage to roads	
	No of tambons affected	No of illages affected	No of households affected	No persons affected	Section of road damaged	Amount of damage in million baht
Muang Nong Khai	14	147	12300	40500	30	5.2
Bung Kan	12	NA	20297	83298	52	5
Phon Phisai, Fao Lai, Rottaw	3	39	712	3562	19	NA
Seka	7	NA	3290	13852	26	3.15
Tha Bo	NA	NA	NA	NA	NA	NA
Sangkhom	2	13	380	2100	5	1
So Phisai	7	54	1760	7356	NA	2.3
Pak Khat	NA	NA	NA	NA	NA	NA
Bung Khong Long	4	53	NA	NA	33	NA
Si Wichai	5	51	1092	3700	53	8
Bung Khla	NA	NA	NA	NA	NA	NA
Total	54	357	39831	154368	218	25

Source: Province of Nong Khai, Disaster Prevention and Mitigation Office

Province of Nakon Phanom

Districts Affected	Sections of roads damaged	Bridges and culverts damaged
Muang Nakhon	0	0
Tha Uthen	8	0
That Phanom	37	0
Na Wa	12	0
Ban Phaeng	30	0
Pla Pak	0	0
Phon Sawan	0	2
Renu Nakhon	0	0
Sri Songkhram	14	1
Na Thom	15	1
Total	116	4

Source: Province of Nakon Phanom

Province of Nakon Phanom

Districts Affected	Amount of Damage in US$
Muang Nakhon Phanom	71,000
Tha Uthen	140,000
That Phanom	129,000
Na Wa	204,000
Ban Phaeng	90,000
Pla Pak	126,000
Phon Sawan	51,000
Renu Nakhon	42,000
Sri Songkhram	442,000
Na Thom	115,000
Total	1,410,000

Source: Province of Nakon Phanom

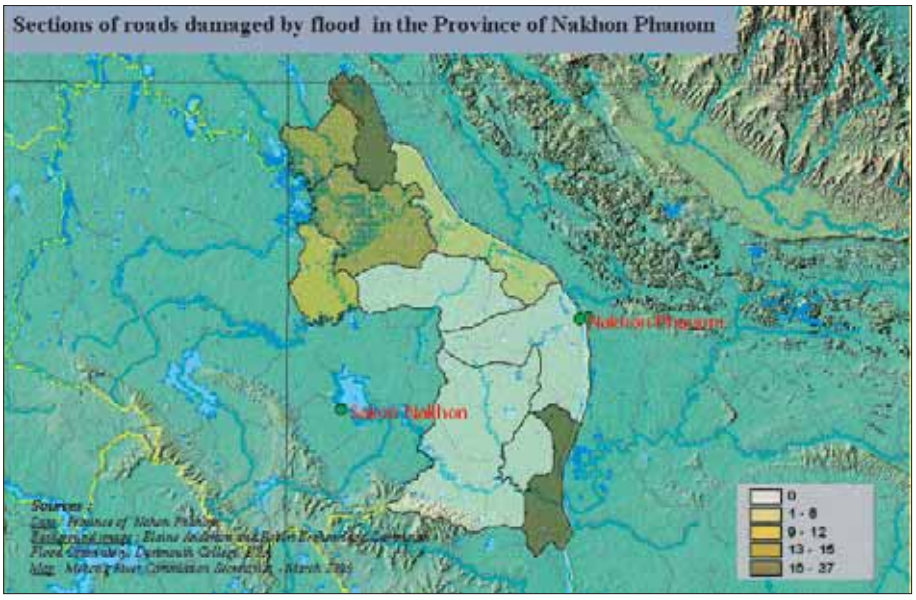
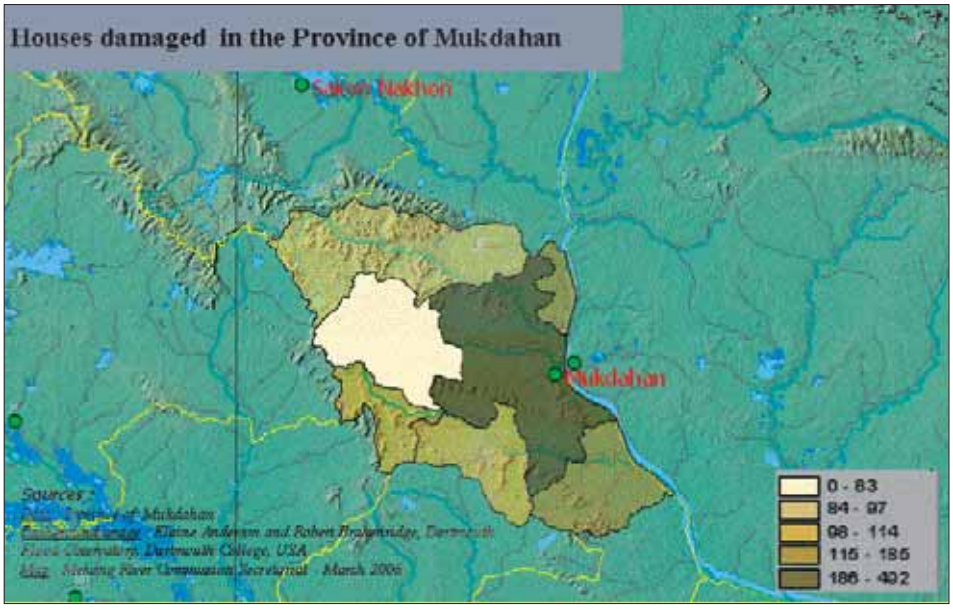


Figure 46: Estimates of flood damage in Thailand

Province of Mukdahan			
Districts Affected	Road sections damaged	Bridges damaged	Houses damaged
Muang Mukdal	47	0	492
Khumcha-i	36	4	83
Nong Sung	23	1	114
Wan Yai	19	0	185
Don Tan	4	0	166
Nikom Kham S	1	1	109
Dong Luang	15	0	97
Total	145	6	1246

Source: Province of Mukdahan



Province of Ubon Ratchatani											
District	No of Tambons affected	No of villages affected	No of household affected	No of persons affected	Damage to houses	Sections of roads damaged	Bridges damaged	Ha of rice Lost	Upland crop (rai)	Orchard (rai)	Fish pond (rai)
Pho Sai	4	7	187	300	-	-	-	114	0	4	1
Khemarat	2	19	392	655	29	-	-	258	42	26	22
Natan	2	14	-	-	-	-	-	196	0	0	0
Kong Jiam			67	315	-	-	-	0	0	0	0
Buntrik	2	2	812	3410	-	-	3	0	0	0	0
Na Cha Luai	5	27	2753	10832	-	10	-	0	0	0	0
Muang Sam Sib	-	-	-	-	-	-	-	0	0	0	0
Phibun Mangsahan	13		-	-	-	60	-	0	0	0	0
Don Mod Daeng	4	47	-	-	-	27	-	0	0	0	0
Sam Rong	-	-	-	-	-	6	-	0	0	0	0
Na Bia	3		-	-	-	4	-	80	0	0	0
Kud Khao Pun	1	1	71	315	-	1	1	0	0	0	0
Warin Chamrab	3	7	878	4699	-	7	-	0	0	0	0
Muang	2		-	-	-	-	-	0	0	0	0
Det Udom	-	-	-	-	-	6	1	0	0	0	0
Sawang	-	-	-	-	-		-	0	0	0	0
Total	41	124	5160	20526	29	121	5	649	42	30	23

Source: Province

Figure 47: Estimates of flood damage in Thailand

7.3.4.3 Flash floods in Chiang Rai province

The following two tables in figure 48 show the damage recorded during the two flash floods that occurred in the province of Chiang Rai in 2005.

Flood during 21 July 2005 to 31 August 2005			
District	Damage to crops (rai)		
	Rice	Upland crops	Orchard and others
Muang Chiang Rai	467	120	9
Chiang Khong	96	136	7
Chiang Saen	461	496	16
Mae Sai	220	0	0
Mae Suai	217	186	32
Phan	264	3	0
Thoeng	55	257	1
Wiang Pa Pao	140	60	7
Wiang Chai	646	1	0
Mae Lao	10	0	11
Wiang Chiang Rung	620	414	1
Doi Luang	659	475	12
Total	3854	2149	95

Province of Chang Rai Flood during 28 Sept 2005 to 12 Oct 2005			
District	Damages Crops (rai)		
	Rice	Upland crops	Orchards and others
Muang Chiang Rai	324	2	2
Thoeng	2293	1292	34
Khun Tan	1627	254	22
Mae Lao	86	10	7
Total	4329	1558	65

Source: Province

Figure 48: Estimates of flash flood damage in Chiang Rai, Thailand

Flash flood damage in Chiang Rai, Thailand

7.4 The impact of the 2005 flood in Viet Nam

7.4.1 Background

Covering 8% of the Mekong River Basin and contributing 11% of total flow volume to the main river, the Vietnamese Mekong River Basin stretches from the north to the south of Viet Nam and includes 21 provinces which are home to some 20 million people. These areas include two sub-areas: five provinces of the Central Highland and 13 provinces of the Mekong Delta (as well as small areas of Dien Bien, Quang Tri and Thua Thien-Hue provinces). Two typical regions represented by two different topographic features of the mountain and plain landscapes which are characterised by two types of flood events: flash flood and tidal plain flood.

The "Mekong Delta" covers an area of approximately 39,700 km^2 and has a population of 17 million people (roughly 400 inhabitants/km^2). Some districts have a density close to 1000 inh/km^2. The Delta produces 50% of the country's food staples and 60% of its fish. Urbanisation is growing rapidly and industrialisation is increasing. The yearly flood is characterised by extended areas inundated by water, including the Bassac River, the Mekong River and the numerous natural and artificial canals linking these two rivers which flow laterally to tbe low lands. In some years, high water levels in the Bassac/Mekong systems may not drain easily to the sea due to strong tidal effects.

Nine serious flood events occurred in the Mekong Delta in the past 45 years of data recording. The years 1961, 1966, 1978, 1984, 1991, 1996, 2000, 2001 and 2002 were the biggest flood events represented by water level[2] (in metres) at the main hydrological stations:

Year	Tan Chau	Chau Doc	Can Tho	My Thuan	Moc Hoa
1961	5.28	4.94	2.09	1.96	2.98
1966	5.27	4.89	2.00	1.80	2.29
2000	5.23	4.94	1.90	1.87	3.44

Figure 49: Water heights in flood years

People alter their lifestyles during the "high water" period and large areas become similar to "lake villages". Many infrastructure such as roads, small embankments, canals and gates are under water for several weeks. So even "soft" floods may generate damage, mainly by erosion of embankments or by sedimentation of the canal systems. Even in "soft" flood years, casualties happen among the several hundred thousand people living for several weeks "on" water. A large proportion of the victims are children.

The perception of flood, locally called "high water season", is very different in the delta from any other areas of the Mekong Basin. People know that water will rise every year and they are prepared. The second rice crop is tuned for harvesting before the early flood. Water rises slowly and regresses slowly. People in rural areas are mainly affected by the erosion of land and embankments. Every year house and land losses are recorded

Benefits from floods are widely recognised. The positive effects of flood flows are huge, such as supplying fresh water for irrigation and domestic use, increased fishery resources, improving navigation transport, bringing more.

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[2] Warning system for flood events in the Vietnamese Mekong Delta as determined by MRC representing by water levels at Tan Chau and Chau Doc Stations (refer to Ha Tien Datum) as following:

Class		Tan Chau (Mekong River)	Chau Doc (Bassac River)
Class	1	3.0	2.5
Class	2	3.6	3.0
Class	3	4.2	3.5 (alarm level)

natural fertiliser, killing insects, flushing acid water caused by sulphate soils, pushing salt water toward the sea, etc. On the other hand, the flat natural conditions of the Delta receive nearly the whole flood volume of the Mekong and this, together with increasing human activities, means that the damage caused by floods is considered the cause of negative effects on economic development and to people's livelihoods.

Prior to 1978, farmers living in the Mekong Delta considered the flood season a time which brought natural resources and they had learned to live with floods. After flood 1978, building of infrastructure to control floods began, with the aim of developing the socio-economy of the Mekong Delta. This rapid growth led to the 2000 flood becoming the most damaging flood in terms of human life and assets. Many lessons were learnt from the 2000 flood and the strategy and response methods for dealing with heavy floods were quickly reviewed. Embankments have been heightened using the 2000 water level as a reference, resettlement areas have been created, and rescue teams are better prepared. In principle, less damage may be expected if a similar flood happens again.

However the rapid pace of development is increasing the risk of potential damage in case of severe floods. Protecting the paddy fields and other crops, and ensuring the security of the population is a legitimate major concern of the decision makers. But it may be to the detriment of the conservation of flood prone lowlands, which not only are recognised as bringing benefits but which also have a key role in limiting the peak water level in the Mekong/Bassac system.

Even in the dry season, an important part of life is on water, at least in the upper part of the Mekong Delta. Casualties involving children occur in about the same proportion in the dry season as in a normal flood season.

7.4.2 Availability of Data

In the Mekong Delta, data are collected very precisely, sometimes comparing the evolution of parameters since the “dreadful” flood of 2000, where huge damage was recorded. Many lessons were learnt from that flood, including the need for precise monitoring of the impacts of floods and the measures which should be taken to limit the damage in the event of a similar flood. As infrastructure are very exposed to the annual rising of water, assessment of damage is done not only in order to establish a budget for repairs, but also to consider improvement of the "black" sections. The situation regarding housing is also well monitored, with the policy being to gradually relocate people living in flood risk areas to safer places, where resettlement areas, based on the water levels of 2000, have been built.

7.4.3 Overview of the impacts at National Level (Mekong River Basin)

The peak level in Tan Chau[3] reached 4.53 m on 31st October 2005; this corresponds to a discharge of 21,900 m3/s. The highest tide occurred at Can Tho on 18th October 2005 with a water level of 1.95 m and in My Thuan on 20th October 2005 with a water level of 1.86 m. Local rainfall reached some 1500 mm compared to long-term annual rainfall 1600 mm. Maximum on-farm inundation depth was recorded at Moc Hoa station on 15th October 2005 with a level of 2.39 m. The rainy season came 15-20 days later than normal in the Delta, starting at the end of May 2005 and finishing at the end of November. The flood from upstream also came late in the Delta as the peak flood occurred by the end of October.

Nine provinces of the Vietnamese Mekong Delta (VMD) were affected by flooding. The flood can be divided into three inundation zones: deep inundation area (> 2 m), average inundation area (1-2 m) and little inundation area (<1 m). The provinces of Dong Thap, An Giang and Long An (which belongs to the Vaico River Basin, but hydraulically is connected with the Mekong through lowlands and artificial connections) are classified as deep inundated provinces while other provinces were considered as average or mildly inundated ones. Figure 50 summarises the damage recorded in the Mekong Delta by provinces. The national 2005 flood report, established by the National Committee for Disaster Management does not mention any additional damage in the other areas. The Team therefore assumes that this table represents the summary of the damage caused by the 2005 flood in the Vietnamese part of the Mekong River Basin. In the Vietnamese Mekong Delta, the year 2005 was considered a "balanced" flood, even though 77 people died, some property was lost and damage of US$ 3.5 million was recorded. This was the least damaging year in the Delta since the 2000 flood. In 2005, the production of paddy reached 17.2 million tonnes and it was considered a successful year for crop production.

Number of deaths	No	13	16	33	3	9	2		1	77
Housing										
Innundated house	Unit	5,673	4,043	797	1,359	5,420	18,318		6,491	42,101
Number of households to be removed	Unit		5,600	412	89					6,101
Removed households	Unit	110	5,548	294						5,952
Collapsed houses	Unit	794	697	1,317	742		596	157		4,303
Schools, Health Centres										
Innundated school	Unit	29		37	27	18	2		76	189
Innundated classrooms	Unit	119	26	14	32	20	18			229
Innundated, damaged clinics	Unit	2		2					6	10
Agriculture Production										
Loss of paddy fields (3rd crop)	ha	154	3,524	83		115				3,876
Paddy fields inundated	ha	1,795	1,396	2,105		9,450	4,531		2,888	22,164
Other crops inundated	ha	89		31		245	187	1.30	243	797
Innundated orchards	ha		1,286			1,742		0.30	4,658	7,686
Sugar cane inundated	ha	595								595
Fishery & aquacultutre										
Area lost	ha	57.9	0.34	17.0			751			826
Rroad damage										-
National roads inundated	km									-
Provincial road inundated	km	39.0	219.5	112		115			189.2	675
Erosion on roads	km			24		64	109.55		25.04	222
Bridges damaged	Unit			1						1
Temporary bridges damaged	Unit	247	70	28		56			105	506
Erosion quantity	1000m3		78							78
Irrigaton Infrastructure										
Sedimention in canal	1000m3	100	270							370
Length of sedimentation canal	km			258			1.2			259
Eroded road,dyke, embankment	km		69.5	604					179.3	853
Pumping station damage	Unit			1						1
Sluicegate damage	Unit		79	27			124		644	874
Erosion damage										
Erosion location	Section		84						5	89
Length of erosion	Km		65.66	8.5					2.91	77
Eroded area	ha		36.71	9.39			1.2			47
Total estimate of damages by flood in 2005	MUSS	5.44	1.84	2.43	0.85	0.87	3.32	0.13	0.38	15.27

Source: Provincial Committees for Disaster Management

Figure 50: Summary of damage in Viet Nam by 2005 flood, by provinces

[3] ref. Ha Tien Datum

Referring to the Tan Chau station, the ideal water level for a "nice" flood stands between 3.5 and 4.5 m. Above 4.5 m, it becomes a "serious" flood and damage other than natural erosion and accidents start to be recorded. Above 5 m, it is considered as a "dreadful" flood that capable of producing lot of casualties and generating heavy damage to infrastructure. If the water level is below 3.5 m, production of fish decreases, soil fertility is less, and downstream of the delta, soil cannot be washed and salinity increases. This is why year 2005 was considered as a "nice" flood, with benefits and little damage.

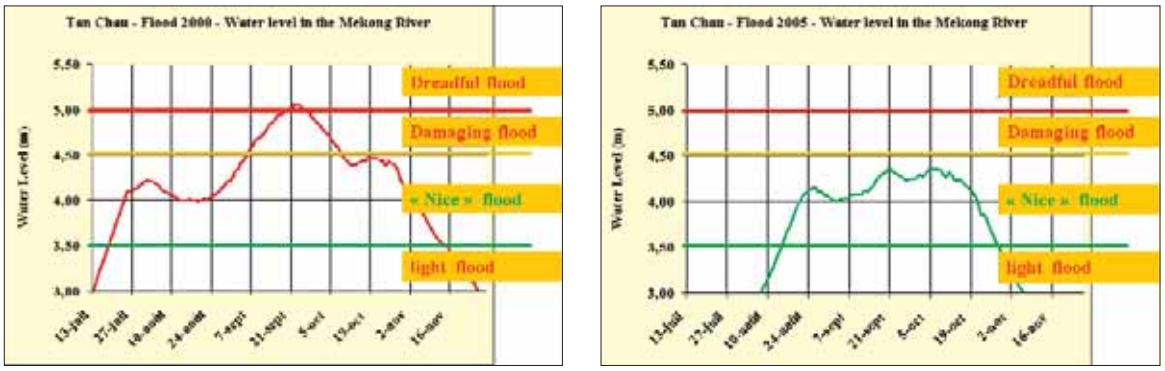


Figure 51: Water levels and their relation to levels of flooding.

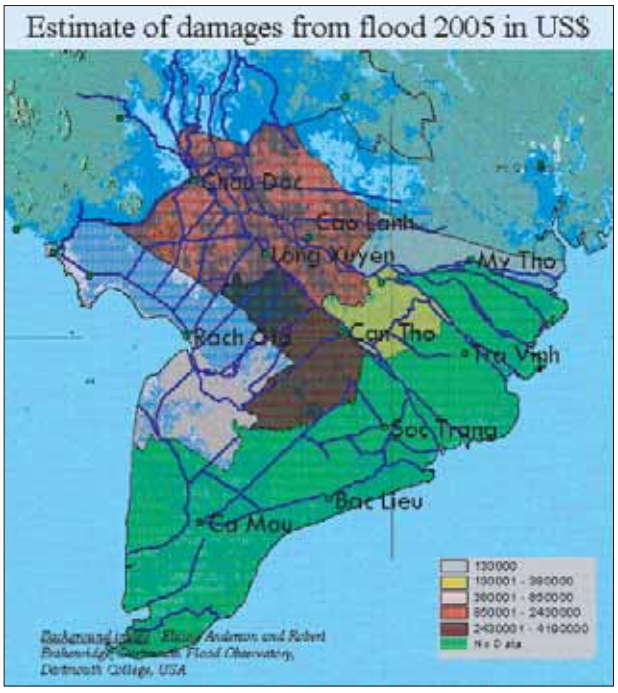


Figure 52: Estimate of damage from the 2005 flood in US$.

7.4.4 The affected areas

The team in charge of preparing the MRC Annual Flood Report 2005 visited two "affected" provinces: An Giang and Dong Thap. Meetings with the provincial and district authorities (with participation of the technical departments) were organised as well as field trips. Informal discussions with stakeholders provided us with a better understanding of the problems of flooding in the Mekong Delta and how this situation is tackled before, during and after the flood periods based on lessons learnt from the 2000 flood. Except in the Province of Long An, which is a special case as it is partly influenced by the Mekong and partly by the Vaico River, the provinces of An Giang and Dong Thap were considered as particularly affected by the flood in 2005; nevertheless, damage was more a normal consequence of water rising in the delta than actual flood damage due to an exceptional event.

In these two provinces, 45 to 50 people died from the flood in 2005, mainly due to accidents involving children falling into water (this figure may vary according to the interpretation of the concept "death by flood"). Damage to roads and infrastructure was caused by erosion. These structures are inundated every year whatever the level of the flood. Damage to agricultural production was very limited. The province of An Giang is one of the most annually exposed to flood in the delta. Figure 54 allows an interesting comparison between the damage generated by the "dreadful" 2000 flood, the heavy floods in 2001 and 2002 and damage normally sustained as a consequence of the annual rises in the water level in 2003, 2004 and 2005.

In the Province of Dong Thap, some analysed figures, broken down by district, show that major damage was due to annual erosion (See Figure 55). Damage to crops, which is a good indicator of the severity of the flood, was limited. The loss of the second crop was recorded only in the District of Hong Ngu, particularly in the low lands. This was most likely due to inadequate timing of the cropping period so the rice could not be harvested before the early flood.

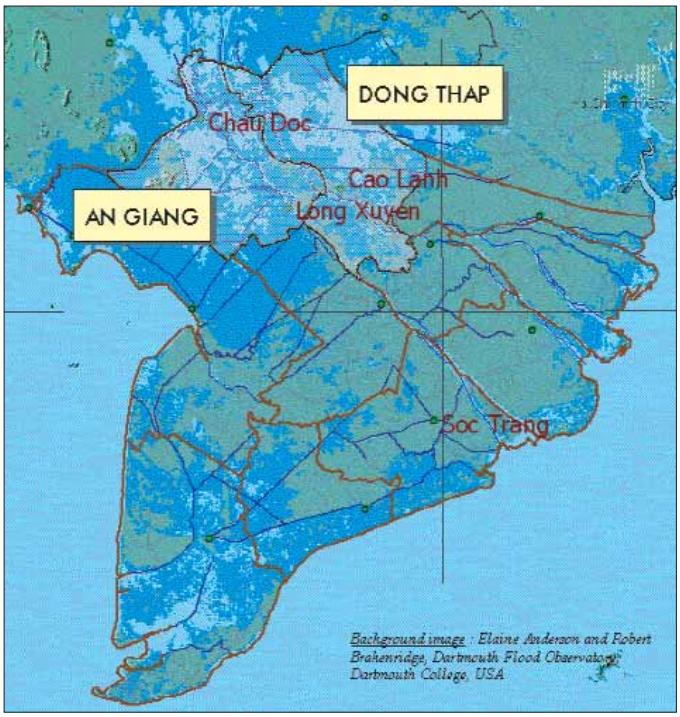


Figure 53: The regions affected by flood in Vietnam

Province of An Giang							
	Unit	2000	2001	2002	2003	2004	2005
Total estimate of damage from flood in US$ mil	1 US$ mil	53.3	10.9	4.4	0.12	0.65	0.5
Deaths - Total	No	134	135	77	6	16	33
Deatsh - Children	No	94	104	69	6	15	30
Housing	No flooded	151867	32951	20743		1989	797
	No collapsed	966	350	378		46	58
	No damaged	9221	4583	2472	0	651	335
Paddy fields lost	Ha	4947	972	327	0	121	17
Fishery lost	Unit	2478	387	23	0	7	1
Livestock	Unit	22103	127	2704			
Schools flooded	Unit	461	171	64		16	3
Health centres flooded	Unit	53	43	3		3	
National roads damaged	Km	31	1				
Rural roads damaged	Km	162	74	44		6	11
Bridges damaged	Unit	273	98	110		54	27
Irrigation dykes damaged	Km	1573	865	890		113	131
Sedimentation in irrigation canals	Km	2457	3374	810		272	258

Source: Provincial Disaster Management Committee

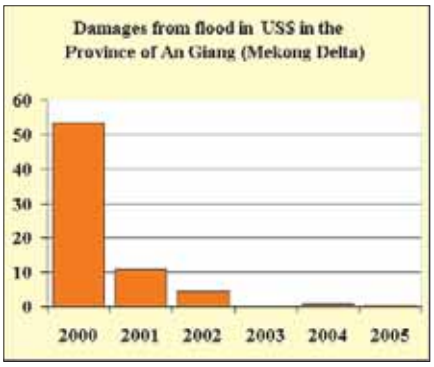


Figure 54: Damage caused by flood over the past five years in An Giang Province.

Province of Dong Thap							
		Rice production				Fruit trees	
		2nd crop		3rd crop			
Districts	Casualties (only children)	Planted (ha)	Loss (ha)	Planted (ha)	Loss (ha)	planted (ha)	inundated (ha)
Hong Ngu	3	19,705	3,000	3,187	468	35	
Tan Hong		21,562	0	3,964	24	172	
Tam Nong	4	28,945	0		0	18	
Thanh Binh	1	20,420	0	2,895	0	460	115
Cao Lanh	1	26,139	0	11,803	0	4,136	
TX Cao Lanh		2,192	32	1,987	0	1,528	
Thap Muoi		32,856	0	23,965	0	1,565	
Lap Vo	4	10,486	0	9,556	0	1,763	
Lai Vung		11,207	0	8,547	0	3,788	
Chau Thanh		11,782	0	11,554	0	5,620	1,171
Sa Dec	3	1,229	0	984	0	1,052	
Total	16	186523	3032	78442	492	20,137	1,286

Source: Provincial Disaster Management Committee

Figure 55: Damage caused by the 2005 flood in Dong Thap Province.

Erosion is the major cause of damage generated by the rising water level in the Mekong Delta. This situation is dangerous for people and housing, damages infrastructure and reduces agricultural lands. Sedimentation also has adverse impacts, mainly by colmating the irrigation and drainage canals. The balance of erosion-sedimentation is not well known, but infrastructure aimed at concentrating the flow in the mainstream could increase erosion as it increases the flow velocity.

8. RESPONSES TO FLOOD EVENTS - COUNTRY REPORTS

8.1 Responses to flood events in Cambodia

8.1.1 Non-structural

In Cambodia, flood management, mitigation and reporting on flood impacts are the responsibility of the National Committee for Disaster Management (NCDM). This Committee acts at four levels. The national level works under the coordination of a ministerial level working group, which is chaired by the Ministry of Water Resources, and includes the Ministries in charge of agriculture, health, environment, public works, interior, defence and municipalities. A similar multi-disciplinary group has also been set up at provincial level. At district level, some of the technical departments are represented in addition to commune chiefs. The Communes Disaster Management Committees include the village chief and responsible members of villages as well as the Red Cross "EWS" Volunteers in the villages where an Early Warning System (EWS) has been set up.

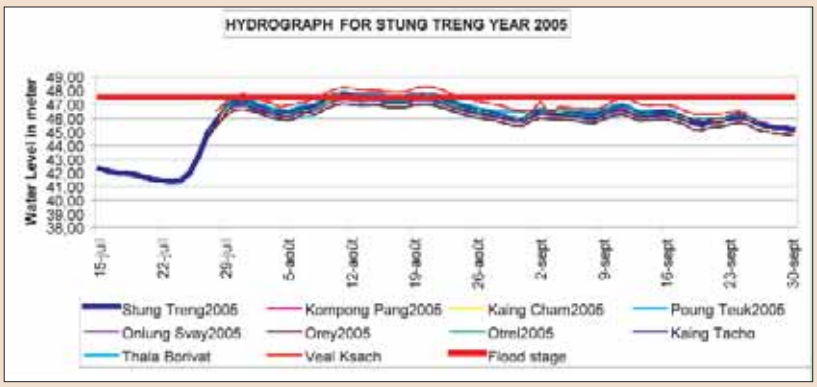
8.1.2 Flood Early Warning and Disaster Preparedness

The United States Office of Foreign Disaster Assistance and the Mekong River Commission signed a Cooperative Agreement on 16th December 2002 entitled, "Provision of Flood Early Warning to Flood-Vulnerable Communities in the Lower Mekong Basin, Phase 1: Cambodia and Lao PDR". The project is implemented under the overall umbrella of the Flood Management and Mitigation Programme (FMMP). It started in 2003 in Cambodia in cooperation with the American Red Cross, Action Contre la Faim and Cambodian Red Cross. A similar project is expected to start in 2006 in Lao PDR. The project is also intended to assist flood-at-risk communities to make better use of MRC flood forecasts and warnings, which are issued during the annual flood season.

In Cambodia, the project covers a total number of 40 villages. It includes the installation of flood markers and flood alarm stage boards. Support to the villagers for improving their knowledge on flood early warning and emergency response is provided as well. The empowerment of the communities' involvement in the project planning, implementation, and monitoring and reporting is developed at provincial level and Red Cross volunteers assume an important role in each of the villages.

It is important to note that in those provinces, there were complaints about the MRCS standard level for defining alarm stages and flood stages. In Kratie, the warning level is 22 m although when the level of Mekong exceeds 20 m some villages are already flooded. This means that a level of 1 m under the flood warning can cause damage.

The Department of Hydrology and Water Resources (DHRW) plays an essential role in installing and monitoring the village flood markers. They also provide daily flood forecasting data to the villages, comparisons between observed and forecasted daily water levels in every village as well as correlation hydrographs between the main stations and the village flood markers.



Flood markers have been installed within the framework of the Flood Early Warning project in approximately 40 villages in Cambodia. The flood marks have been level surveyed. The measurement of the geographical locations, position and elevation of 15 villages was based on the benchmarks of the main hydrological stations. This work is not only useful for gathering data and information, but also for modelling and other purposes in the future, especially for water resources management and flood forecast routing. This also allows us to obtain data not only on the Mekong, but also at village levels and measurements show that levels recorded at the Mekong station in Stung Treng may be lower than in some villages. This justifies the need to extend flood prediction to the level of communities at risk.

In Kompong Cham Province, The Disaster Preparedness Programme of the European Community Humanitarian Office (DiPECHO) supports Action Contre la Faim, Oxfam and the Provincial Committee Disaster Management (PCDM) in broadcasting flood information through three radio spots in Khmer language. Prior to the floods the spot focuses on the causes of floods and preparedness before the flood season, highlighting simple measures villagers can take. During the floods, the spot focuses on the dissemination of flood information/early warning systems and the responses when the warning level is reached. After the floods, the spot explains important and simple measures to be taken when floods are receding in order to avoid health problems and accidents.

The project "Provision of Flood Early Warning to Flood-Vulnerable Communities in the Lower Mekong Basin, Phase I" which is under the umbrella of the FMMP, aims at reducing the vulnerability of communities in Cambodia to higher-than-normal annual floods and flash flooding, by providing timely flood warnings. Communities are equipped with tools and trained at the same time. The establishment of a continuous dialogue and exchange of information between MRCS and the target communities ensures accurate and appropriate flood information and assessment of community flood-warning needs.

8.1.3 Infrastructure

In Cambodia there is limited infrastructure for controlling floods, except for some main road sections built on embankments such as National Road No 6. There are no regulators or "colmatage" gates in the Northern section of the Mekong that could manage/limit the effect of backwater entering into the tributaries. Four control gates (9m wide and 13.5m long) have been built on National Road No 1 from Phnom Penh to Neak Loeung (funded by JICA), and these control the backwater from the Mekong to rice cultivated areas.

Road No 6 has been built between Tonle Sap River and the Mekong floodplains on an embankment with bridges which allow the flow from the Lower Mekong Basin to the Tonle Sap River/great Lake in the event of high water levels in the Mekong.

8.2 Responses to flood events in Lao PDR

Disaster management in general and flood management in particular is a multi-sectoral concern. In order to provide an adequate response to disaster issues in Lao PDR, the National Disaster Management Organisation (NDMO) was formed. The Chairman is the Minister of Labour and Social Welfare and several Ministries are represented in order to cover all relevant sectors.

At provincial and district levels, similar structures (Committees) have also been set up. The Committee members coordinate work in the affected areas in order to assess damage and primary needs. Each institution works according to their field of responsibility and expertise. The efficiency of this coordination varies from one province to another.

Early warning is the responsibility of the Department of Meteorology and the Department of Agriculture. However, due to the lack of necessary human resources, lack of technical training, limitation in communication equipment (radios, mobile phones) the procedures for disseminating the information are still far from being fully operational. Villagers get some information from the district but local methods of flood forecasting, based on

observing weather and fruit trees, are still widely used. Thai television is also a reference for obtaining meteorological forecasts. Up to now, no flood marks have been installed in the villages. Poor early warning conditions mean that people may be caught in the fast rising water. Preparedness instructions are given by the districts two or three weeks before flooding. The population located in risky areas is mobilised to collect rain water for drinking and clean drains and irrigation systems to ensure they don't overflow easily. Dispensaries and schools flooded in the past are checked. Farmers are invited to store spare seeds for replanting if necessary.

During the flood, the affected villages inform the Districts' Search & Rescue Team when they need to evacuate people to safe locations. Representatives from social welfare, public security, defence and health authorities as well as the Lao Red Cross are present in the affected areas to help victims. They make a quick assessment of needs and provide emergency help. Lao Red Cross staff then proceed with distribution of relief packets, consisting of food, clothes, blankets, etc. Social Welfare organises shelters where necessary. Health staff are responsible for taking care of sick or injured persons and preventing disease outbreaks. They run vaccination programmes and urge people who have red eyes, diarrhoea or symptoms of malaria to seek medical advice immediately. The Department of Agriculture distributes rice seeds for replanting.

The expenditures for Emergency Relief are paid by the government budget, grants from donor countries and NGOs such as the Lao Red Cross.

Training has been provided within the framework of the Disaster Preparedness Programme implemented by Concern Worldwide, through the NCDM and financed by ECHO, European Union. Seven districts in Savannakhet and Khammouan Provinces received training for disaster preparedness disaster (not only flood oriented) from 2001 to 2003.

Flood damage reporting is supposed to involve all departments. However, coordination in gathering data varies from one province to another. So far, there is no standard for monitoring indicators, or procedures for assessing the damage, level of details, etc.

In Lao PDR, infrastructure for controlling or mitigating the effects of the flood are very limited. Embankment protection along the Mekong or along the major tributaries is strictly limited to some sections in the major cities. Rural roads are rarely built on embankments in the risky flood areas. Some NGOs have helped villagers build protection (small embankments for protecting villages, small dams in depression areas). These infrastructure are often built using limited engineering knowledge and at the lowest cost. During heavy floods, they may be washed out easily. In some places, irrigation and drainage canals are also used to improve the drainage of flooded areas.

The village of Piaka, located in the District of Champone, Savannakhet Province has 103 families. Flooding occurs every year. The picture on the left shows the remains of a small dam (built by the villagers with the support of an NGO) which collapsed in July 2005. The collapse of this dam led to the loss of 224 ha of paddy fields and the inundation of the village. Such infrastructure may be very profitable in economic terms and help families earn more money, but they need to be built to a proper standard. The picture on the right shows local small embankment.

8.3 Responses to flood events in Thailand

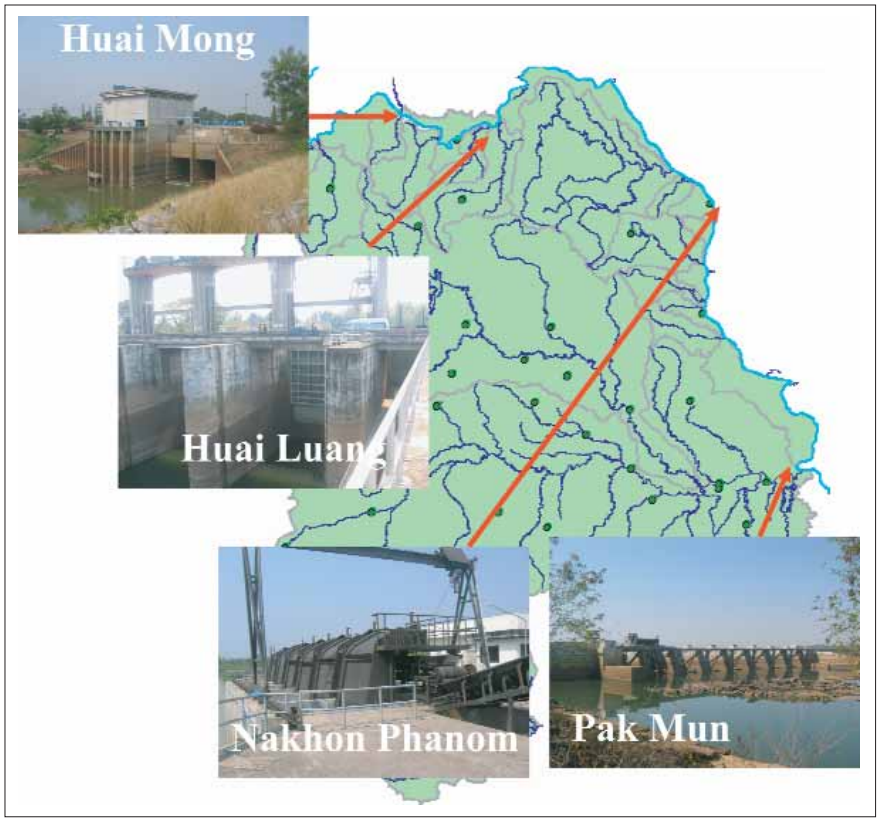
The institutional framework for disaster prevention and management is organised at national and provincial levels and coordinates all field operations. Specialised Units are generally made up of representatives from the Departments of Water Resources, Agriculture and Irrigation, Transport, Natural Resources and Environment, Health as well as the police service.

Loss of agricultural production due to flooding is compensated in cash, on a lump sum basis per ha and after a declaration by the farmer and assessment by the agricultural services.

Apart from these non-structural measures, a longer term strategy aims to limit the effects of the flood by building or reinforcing protection along the river. Several regulating structures have been built in the North Eastern Region. Roads along the Mekong River are heightened on embankments which also offer efficient protection for land and housing. More and more sections of the Mekong river bank have been protected against erosion, especially in larger villages, semi-urban and urban areas. Additionally, the protection of urban areas is underway. In Nakhon Phanom systems are in place which will pump water in the event of the town being inundated.

The Huai Mong project, the Huai Luang project and the Pak Mun dam are the most important regulation structures located at the mouth of those tributaries with the Mekong River. In general these structures are multi-purpose. Storage of water upstream of the structure and pumping in the Mekong during the dry season will bring water for irrigation. In case of heavy flooding in the tributaries, the flow to the Mekong may slow down, decreasing erosion. In case of high water levels in the Mekong, the gates are closed and backwater effect is controlled.

The objectives of such structures are therefore not only oriented to the mitigation of floods, but also provide solutions to water shortage problems allowing agricultural production throughout the year by providing irrigation.



To live with flooding or to increase protection? The case of the Lower Songkhram River

There is a tendency to report floods negatively in Thailand. Flooding occurs every year in the North East Region of Thailand as part of a natural, age-old pattern. There is much pressure from farmers for better flood protection in this area as well as calls to increase irrigation.

The case of the Lower Songkhram[4] , affected by the 2005 flood, which covers parts of Nakhon Phanom, Sakhon Nakhon, Udon Thani and Nong Khai Provinces is typical. Heavy rainfall is recorded almost every year, and varies between 1,600 and 2,400 mm/year. A second factor leading to annual flooding is the influence of the Mekong River's level in inducing a backwater effect when river levels rise. Many villagers along the lower river report seeing reverse flows on tributaries carrying sediment rich waters from the Mekong flood into the Songkhram and say this helps maintain soil fertility on the floodplain.

The Songkhram River Basin resembles a large shallow lake, no deeper than 1-2 m at most points, with trees and bamboo shoots protruding above the surface. The floods may extend up to nearly 2,000 km² in a particularly "wet" year, although they are more typically around 1,000 km². Villages have traditionally been located on levees or slightly elevated spurs of land above the floodwaters and are very rarely inundated, although access roads may be temporarily flooded requiring boat transport. Because of the regular annual nature of the floods the villagers are accustomed to flooding and have adapted their livelihood strategies accordingly. For example, cattle and buffalo are moved to elevated areas known as "dawn", which offer safe grazing and shelter, or are stable-fed under houses for the duration of the flood period. Rice cultivation in the rainy season is mostly limited to areas of low-risk to flooding, although some villagers do take the risk of planting seedlings in low-lying areas and losing their crops in higher than average flood years.

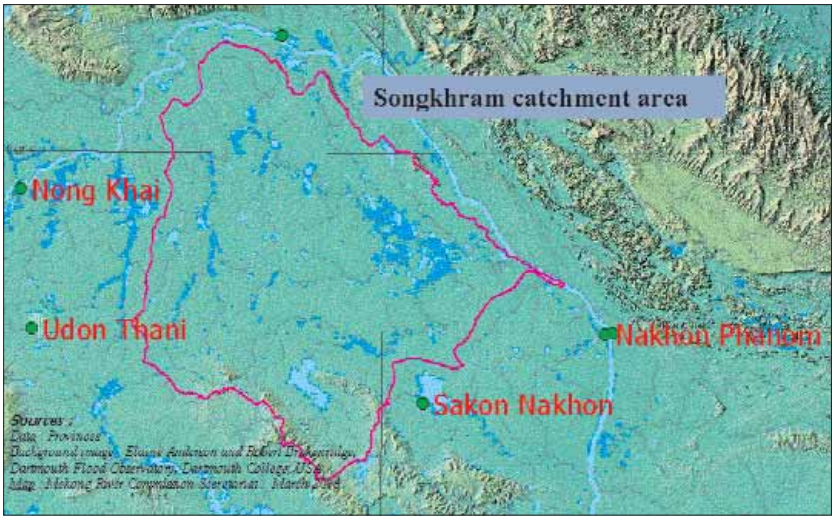


Figure 56: Songkhram catchment area in Thailand

People have also developed a wide variety of fishing gears to harvest the flood recession fish migration, both to sell and to preserve for later consumption. In the case of certain species of migratory fish-eating birds, their arrival from northern Asia to the Nam Songkhram wetlands would appear to coincide with the period of maximum fish migration. Floods in the Songkhram River Basin play an important role in the maintenance of natural wetland ecosystems, demineralisation of nutrients, groundwater recharge, sediment and nutrient retention. They also probably offer a level of protection from flooding for other land further down the Mekong valley, through temporary storage and gradual release of floodwaters which would otherwise flow directly downstream. Ultimately, the wide aquatic and terrestrial biodiversity and wetlands-based livelihoods found in the Lower Songkhram River Basin are closely intertwined and dependent on the natural hydrological and geomorphologic cycles of flooding. Any alteration to hydrological cycles or reduction in flooding duration and extent may have undesirable and negative impacts on biodiversity and local livelihoods.

Seeing floods only as a problem can lead to emergency interventions to alleviate or reduce flooding being implemented and, this, in turn, undermines the natural benefits that flooding provides. A well balanced and concerted land use policy, which integrates stakeholders' concerns as well as recognising the necessity to preserve the biodiversity as a highly valuable natural and economic asset, is a key factor when defining strategies and investments for flood management and mitigation.

[4]Source : Mekong Wetlands Biodiversity Conservation and Sustainable Use Programme - Floods - Observation from the lower Songkhram river basin: joint UNDP-IUCN-MRC-GEF funded programme See Lit [6]

Every year protection of the Mekong embankment improves in urban and semi-urban areas, with priority going to the places most vulnerable to erosion. This provides considerable protection for the villagers whose houses were seriously threatened by floods in the past.

The development of infrastructure such as regulators and embankments provide good protection for villagers and their paddy fields. At the same time, they support the development of irrigation. However, they limit the natural inundation in the flood plains. Large floods are ecologically profitable: sediment-laden waters carry soils downstream, some of which are deposited on the floodplain each year, rejuvenating soils and adding nutrients to the food chain.

8.4 Responses to flood events in Viet Nam

The need for a coherent, long-term strategy for managing and mitigating floods occurred as a consequence of the 2000 flood. Some emergency measures have already been implemented, or are under implementation. Other structural measures are being examined, but require heavy investment and may sometimes be questionable in their long term impacts.

The security stake: People remember the dreadful flood of 2000. They are afraid that such a situation will happen again. They say they “want to live peacefully and safely with the flood". The security of people living in the area is a priority for the authorities and the institutions responsible. They have addressed the issue of housing located in risky areas for several years now. Families in risky areas are encouraged and supported to move to safer places. For that purpose new settlement areas have been built. Some are still in progress and some are planned. For example, in the Province of An Giang, the resettlement programme started in 2002. From 2002 to 2005, 37,058 households moved to 212 settlement areas totalling 816 ha with a total investment of roughly US$ 50 million. Non-structural measures have also been taken, such as promoting child safety, development of kindergartens which will watch young children during the flood periods or the provision of swimming lessons. The Annual Flood Report 2005 Team were told that presently, the number of children who die from drowning during a normal flood season is comparable to that in the dry season.



The security of people living in risky areas is a major concern. People are encouraged to move to safer locations where resettlement areas are being prepared.

The rice stake: The main revenue in the Mekong Delta, is the production of rice. The average production is close to 1,000 tonnes per inhabitant. In the Mekong Delta, in theory, three rice crops are possible (even up to seven crops every two years in the downstream areas). The first crop starts after the end of the flood period in December and is harvested in March. Pumping the water from the fields may be necessary to start this crop in time in the event of a long flooding period. The second crop starts in April, after the first rainfall and is expected to end when "early flood" starts, generally by end of July. Some irrigation may be necessary for starting this crop in time when there is not enough rainfall to fine tune harvesting before the early flood. The short cycle rice varieties are preferred. The third crop, starts in August and ends in November and is only possible in the highest lands or lands artificially and fully protected from flood.



Agricultural production is an essential source of revenue in the Mekong Delta. Rice is the major crop, and there is heavy pressure to fully protect the production from flood.

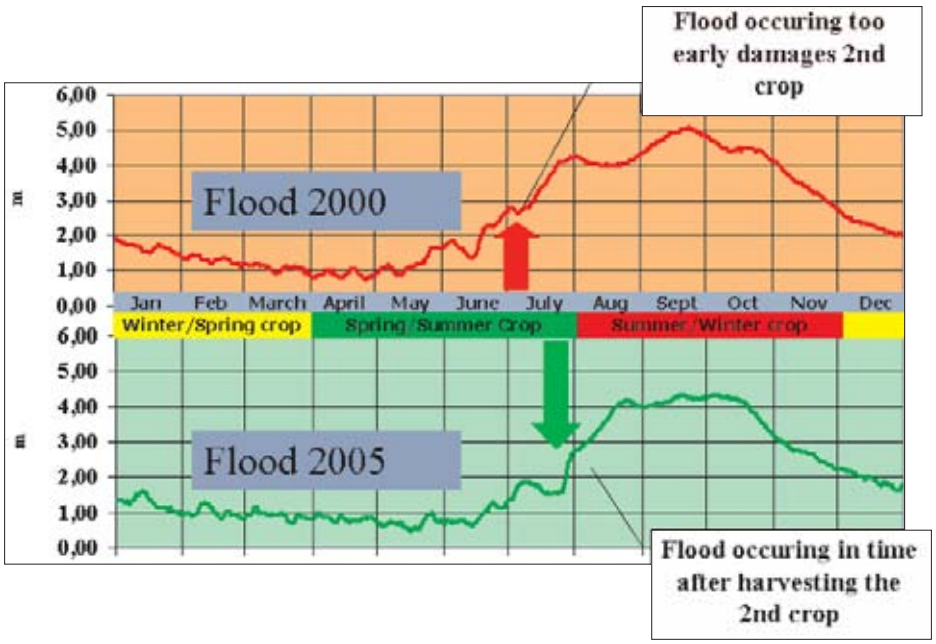


Figure 57: The relation of the flood to the second rice crop

In the Mekong Delta, a great majority of farmers (70%) have less than one hectare and often families have only 0.50 ha. This illustrates why in the lowest areas, priority is given to securing a second crop by building embankments which can retain the early flood. But in these low lands there is also great pressure to build fully protected areas enabling a third annual crop.

The Vice Chairman of the People's Committee of An Phu District, An Giang Province, explains: "Our first priority is to start the second crop as early as possible to be ready to harvest before the starting of the flood. Our objective is to raise and secure embankments so we can, at least, protect our fields against the early floods. The farmers put pressure on us to build "full flood" protection with concrete embankments so that even a third crop season could be undertaken nearly everywhere. We think that this is a very expensive solution, and one that is also questionable in terms of the environment and long term sustainability. So our objective is clearly to secure two crops but not the third one."

As an example, Figure 58 represents the percentage of land that has been cultivated with a third crop in 2005 in the province of Dong Thap (breakdown by district) . This includes both lands where a third crop is naturally possible, but also low lands which were flooded in the past and where embankments now bring enough protection. This indicator could be monitored in the future for identifying the areas of low lands that are sufficiently secured against flood.

[5]The map was drawn based on the GIS layers available at MRCS. It is based on former districts organisation and will require updating.

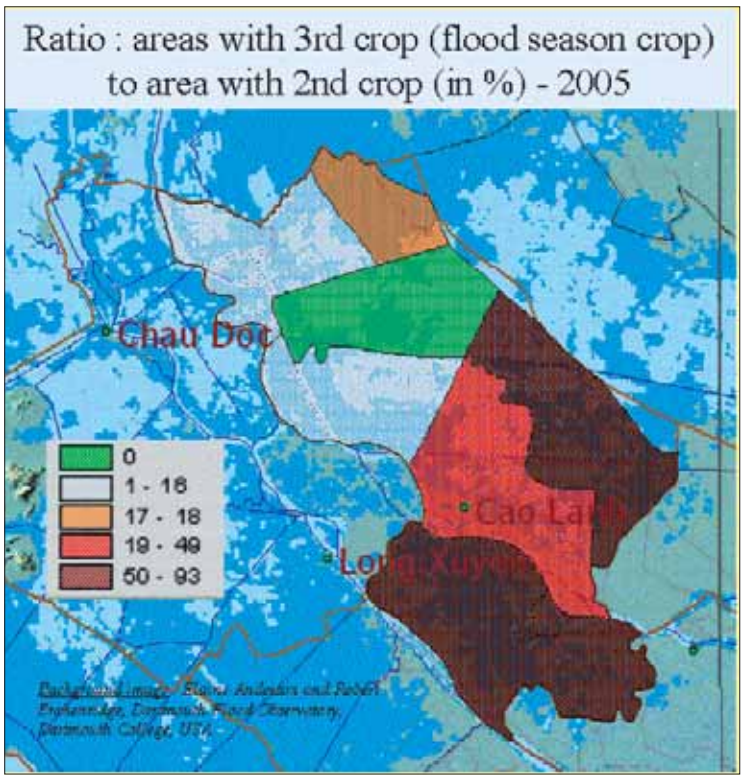


Figure 58: Percentage of third crop rice fields

Diversification from rice to other crops (including orchards) is now being encouraged as is the development of aquaculture activities (such as shrimp farming). With this approach, new concepts for balancing fully protected areas and areas that may be flooded will be necessary.

The infrastructure stake: The 2000 flood was also a starting point for reinforcements of the road network. The national roads have been raised to cope with the water levels experienced in this flood. Rural roads are still being flooded, but improvement of the weakest sections is being carried out gradually and monitored. The road network also forms an embankment network protecting the low lands against floods.

The development stake: Fish production is the second most important food production activity, but the trend is to develop aquaculture rather than relying on the natural environment. Other activities, such as sand dredging and commercial exchange (navigation) are also essential in the area. Up until now industry has been poorly developed, but efforts are now being made to attract industrial investors. With a such high density of population (over 800 inhabitants/km2 in some districts), the increase of the population will inexorably shift from the primary sector (farming and traditional fisheries) to industrial and services oriented activities. This implies development of urbanisation and industrial areas, both also needing to be "fully" flood protected by high embankments, protections against erosion and backfilled lands.



1. Some fishermen live on boat houses and as well as wild fishing activities, they raise fish in cages.

2. Sand dredging provides commercial opportunities, but the effects on possible erosion are under study.

3. Commercial exchanges are made possible by navigational improvements.



In Am Phu district, the first tentative steps for attracting industrial investors are being taken. For this reason 10 ha of land has been cleared and protected against possible inundation. Urbanisation is increasing rapidly and this will provide new challenges for all the stakeholders.

If no flood mitigation measures are taken adverse consequences may be expected. Amongst other things, safe areas will be lost for fish reproduction, for soil fertilisation, for flood diversion and, in some areas, for acidity and salinity flushing. Velocity of water in the mainstream is expected to increase with pattern changes in erosion and sedimentation. Hydrological conditions may be modified with peak flood increasing due to less water storage capacity. In addition, downstream provinces may be affected by structural investments carried out upstream for similar reasons.

The challenge for all institutions and stakeholders involved in the development of the Mekong Delta (farmers, fishermen, sailors, industrial operators, tour operators, conservation interests, populations living downstream) is huge. The challenge is how to design the most sustainable land use policy, taking into account the legitimate socio-economic development needs, while minimising adverse effects on a long-term basis.

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