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Flooding in Mekong River Delta, Viet Nam

Huu Ninh Nguyen

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Coordinator
Nguyen Huu Ninh¹

Contributors
Vu Kien Trung², Nguyen Xuan Niem³

¹Center for Environment Research, Education and Development, Hanoi, Vietnam

²Water Resources University, 2nd Branch in Ho Chi Minh City, Vietnam

³Department of Science and Technology, Kien Giang, Vietnam

1 Country background and disaster profile

1.1 Background

Vietnam is located in the south-eastern extremity of the Indochinese peninsula and occupies about 331,688 square kilometres. It borders the Gulf of Thailand, Gulf of Tonkin, and South China Sea, alongside China, Laos, and Cambodia. The country has a north-to-south distance of 1,650 kilometres and is about 50 kilometres wide at the narrowest point. With a coastline of 3,260 kilometres, Vietnam has approximately 3000 islands with total area of more than 1600 square kilometres, and more than one million square kilometres of sea surface.

The Mekong River Delta is one of the most important two rice granaries of the country, alongside Red River Delta in the North. With an area of approximately 40,000 square kilometres, the Mekong delta is a low-level plain not more than three metres above sea level and criss-crossed by a complex system of canals and rivers. Sediment is carried by the Mekong's various branches and tributaries that the delta advances sixty to eighty metres into the sea annually. It is estimated that the amount of sediment deposited annually to be about 1 billion cubic metres, or nearly 13 times the amount deposited by the Red River in the North of the country. About 10,000 square kilometres of the delta are under rice cultivation, making the area one of the major rice-growing regions of the world. The southern tip, known as the Ca Mau Peninsula, is covered by dense jungle and mangrove swamps.

The Mekong, which is 4,220 kilometres long, is one of the 12 great rivers of the world. From its source in the Tibetan plateau, it flows through the Tibetan and Yunnan regions of China, forms the boundary between Laos and Myanmar as well as between Laos and Thailand, divides into two branches - the Hau River and Tien River - below Phnom Penh, and continues through Cambodia and the Mekong basin before draining into the South China Sea through nine river mouths known as the *Cuu long* (nine dragons). The river is heavily silted and is navigable by seagoing craft of shallow draft as far as Kompong Cham in Cambodia. A tributary entering the river at Phnom Penh drains the Tonlé Sap, a shallow freshwater lake that acts as a natural reservoir to stabilise the flow of water through the lower Mekong. When the river is in flood stage, its silted delta outlets are unable to carry off the high volume of water. Floodwaters back up into the Tonlé Sap, causing the lake to inundate as much as 10,000 square kilometres. As the flood subsides, the flow of water reverses and proceeds from the lake to the sea. The effect is to reduce significantly the danger of devastating floods in the Mekong delta, where the river floods the surrounding fields each year to a level of one to two metres.

The Vietnam's "*doi moi*", literally renovation or new changes in Vietnamese, in mid 1980s and the end of the U.S. embargo in 1994, have brought stable politics, significant progress in reducing inflation and poverty levels, and strong economic growth of an impressive average

rate of 7.3% p.a. in the last recent years (World Bank, 2004; UNDP, 2004). The *doi moi* embarked on a major program of economic reform aimed at making the transition from a centralised economy to a market economy. Vietnam is increasingly becoming a magnet for foreign direct investment, while many other countries in the region have experienced a downward trend due to global and regional economic crises. The Government of Vietnam places a high priority on its reform program and on the coordination of donors and their activities with increasingly positive results.

Vietnam population is more than 83 millions, of which approximately 70% live in and rely on agricultural areas where major cash crop is rice farming. Mekong River Delta is home to 17.3 million people, spreading in 13 provinces and cities with an intensity of 435 people per square kilometres, making it the most populated area of the basin (General Statistics Office, 2005). Population growth rate has been kept at a steady 1.8 – 2 percent during the 1990s until now. Recent estimated data showed an approximate 85% of Mekong River Delta population lives on agricultural activities. The region produces and supplies 90% of national rice exports and nearly 60% of the country's total export turnover from fishery products.

Despite potentials and opportunities in socio-economic development, the country is still struggling with poverty alleviation while increasing natural disasters and climate change introduce an additional stress. At the current time, Vietnam is a relatively poor country with an estimated 19.5% of the total population living below the poverty line (ADB, 2006). The economic development, however, still relies on natural resources, particularly agriculture, fisheries and forestry. Such dependence raised conflicts and compromises by placing stresses on the environment such as deforestation, land degradation, flooding, water pollution, over-fishing and waste, creating greater difficulties for many of the country's poor (Nguyen Huu Ninh and Luong Quang Huy, 2006).

1.2 Disaster profile

Vietnam is one of the most disaster-prone countries in the world. According to the Vietnam Central Committee for Flood and Storm Control's most recent reports (CCFSC, 2005), there are about 30 tropical cyclones occurring in the Western North Pacific annually, of which 11-12 tropical cyclones land in the South China Sea, and six to eight storms and tropical depressions affect the territory of Vietnam over period 1960-2005. In some particular years, Vietnam was struck by ten or more typhoons, for instance, in 1964 (18 typhoons), 1973 (12), 1978 (12), and 1989 (10). The cyclone season lasts for about six months from June to November. Cyclone season varies in different regions of the country and lasts for three to four months. When a tropical cyclone occurs, the affected coastal area can be struck by wind velocity of 40-50m/s, especially in the Red River Delta and the Central. Torrential rain accompanied by tropical cyclones with rainfall of 100-300mm/day and total rainfall for each spell of 500-1000mm can cause flash floods, which come upon settlements unawares, and regularly submerge low-lying areas. The runoff from rains, when added to rivers already swollen by monsoon rains, creates floods which endanger river dykes and threaten to devastate millions of households. It is anticipated that the number of heavy storms and typhoons to hit Vietnam will increase both in number and intensity with climate change.

Table 1. Disasters in different geographic areas and economic zones

Disaster	Geographic Areas and Economic Zones							
	<i>North East and North West</i>	<i>Red River Delta</i>	<i>North central coast</i>	<i>South central coast</i>	<i>Central highlands</i>	<i>Southern North East</i>	<i>Mekong River Delta</i>	<i>Coastal Economic Zone</i>
Storm	***	****	****	****	**	***	***	****
Flood	-	****	****	***	***	***	*****	****
Flashflood	***	-	***	***	***	***	*	***
Whirlwind	**	**	**	**	*	**	**	**
Drought	***	*	**	***	**	***	*	***
Desertification	-	-	*	**	**	**	*	**
Saline intrusion	-	*	**	**	*	**	***	**
Inundation	-	***	**	**	-	**	***	***
Landslide	**	**	**	**	*	**	***	**
Storm surge	-	**	**	**	**	**	***	**
Fire	**	*	**	***	-	***	***	***
Industrial and environmental hazard	-	**	**	**	***	***	**	***

Key: Very severe (****), Severe (***), Medium (**), Light (*), None (-)

Source: Ministry of Agriculture and Rural Development and CCFSC (2005).

Disasters in Vietnam occur with most severe damage caused by water disasters or climate-related disasters such as tropical storms, floods, inundation, drought, salt water intrusion, storm surge, landslides, and flash floods. One reason that water disasters are so serious is that most of the population lives in areas susceptible to flooding. This is because Vietnam has developed as a nation by exploiting the low-lying river deltas and coastal lands for water-rice agriculture. Both the broad Red River and Mekong River Deltas and the narrow connecting coastal strip of the country are prone to flooding from monsoon rains and typhoon storms. The remaining three-quarters of the country are mountainous areas and suffer from flash flooding. As a result, over 70% of the population of Vietnam is at risk of water disasters.

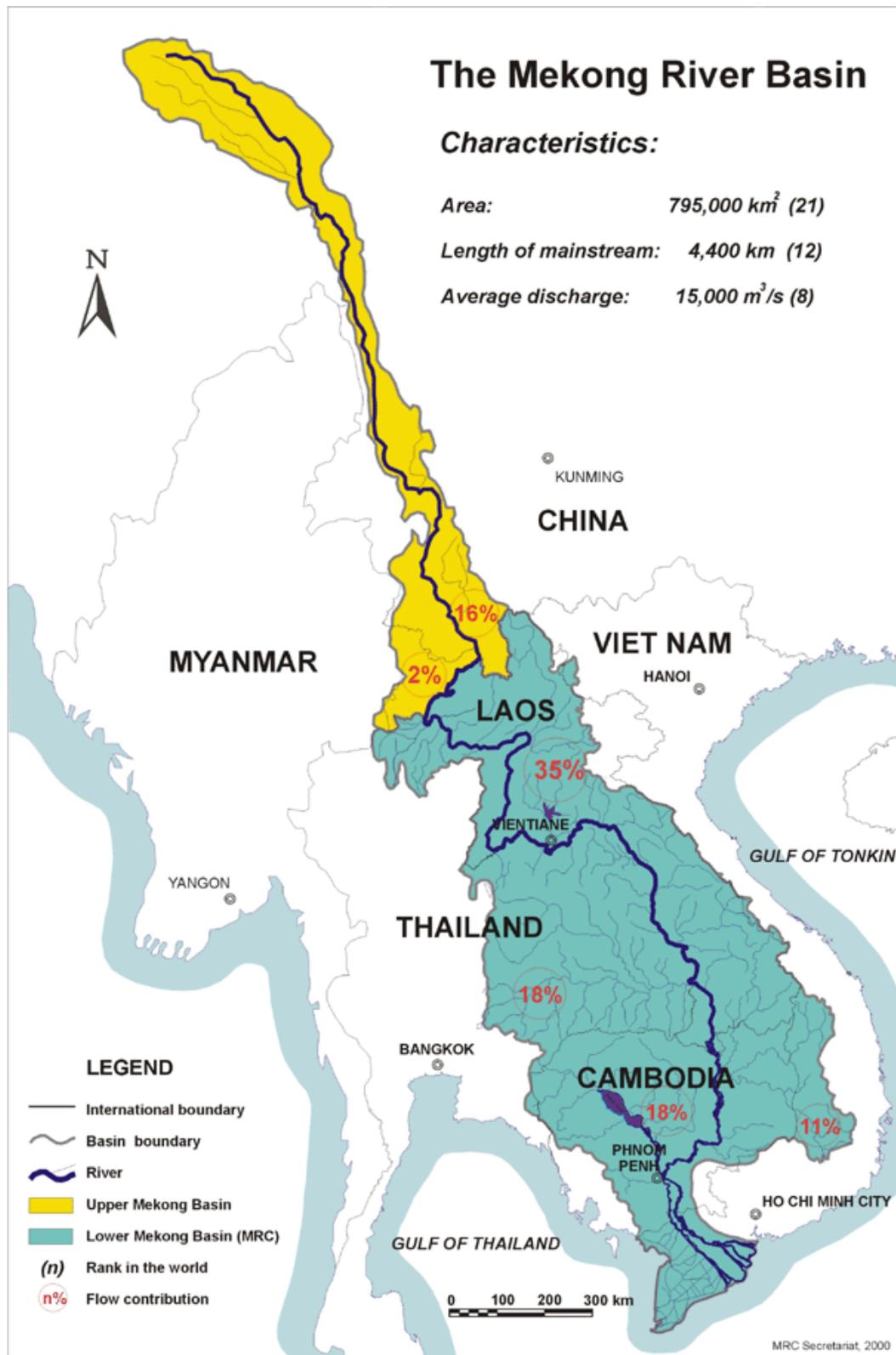


Figure 1. Mekong river basin
 Source: Vietnam National Mekong Committee (2007)

2 Scenarios and impacts of climate change in Vietnam

2.1 The impacts of climate change and floods

Vietnam is amongst the most disaster prone countries in the world. There are indications that the severity of disaster events is increasing as an impact of climate change. The floods in 1999 that hit central Vietnam were the worst in living memory. Not long before this event, huge losses occurred in the 1997 massive typhoon Linda in Mekong River Delta when more than 300,000 houses were destroyed and many more damaged. In the early 21st century, these massive floods and storms are becoming commonplace.

Annually the Vietnam coast is hit by tropical storms and typhoons and associated flooding at a rate of six to eight tropical storms. Regular disasters cause extensive and repeated damages to housing, infrastructure, agriculture and fisheries. These losses have a direct effect on the capacity of the family and the community to develop and move beyond poverty. Along with economic growth in Vietnam the levels of economic loss climbed steadily since 1985, reaching over US\$700 million by 1996.

A decade later in 2006, losses caused by Cyclone Xangsang were estimated at VND 10,375 billion (approximately US\$ 650 million), equalling the total annual losses just ten years earlier. Major progress has been made in saving lives, only 69 people died in Cyclone Xangsang, but the cost of rehabilitation is huge and largely unsupported.

Natural disasters like typhoons, floods, tropical storms, droughts, landslides, forest fires, and occasional earthquakes are constant threats to Vietnam's natural environment, its sustainable development and to its people, especially the poor. In 1999, natural disasters claimed more than 800 lives and caused US\$300 million in property damages. Later, three consecutive years of flooding in the Mekong River Delta killed nearly 1,000 people, mainly children.

Water is vital to the people of Vietnam. Much of what constitutes Vietnamese society emerged from centuries of struggle to capture annual rains to irrigate rice paddies. At the same time, water is the most destructive force in Viet Nam. In the space of a few short months, the monsoon rains saturate the earth, flood the rivers, and flow onto the broad plains of the river deltas. Coupled with seasonal typhoons that batter the coasts before moving inland, flooding is an annual occurrence. With a long coastline backed by high mountains on the one hand, and broad, flat floodplains on the other, over 70 percent of Vietnam's population is at risk from typhoons, floods, storm surges, flash floods, landslides, or mudflows.

In Mekong River Delta, flood and inundation have the most impact. The rice crop is highly vulnerable. Farmers attribute poor yields or crop losses either to floods damaging crops or to inadequate flood control structures. It is reported by local farmers that flooding has become almost an annual event. Damage from more serious floods depends upon the nature of the flooding. Floods with strong currents are characteristic of many areas in both the north central and central coastal regions. These are aggravated by dyke breach, high winds and sea surges, and are a danger to human life and property, as well as to irrigation and public infrastructure. Livestock (particularly smaller livestock such as pigs and chickens) may be drowned or washed away. Sea surges caused by storms pose a hazard to farmers whose dwellings or farmlands are near the coast.

Floods that are less violent but inundate large areas over long periods of time are less immediately devastating. However, they have severe economic and social impacts. Damage to crops and property occurs as a result of fields and houses standing in water for long periods of time. Articles for household use may be rendered unusable, and the house structure may be

weakened. Losses of food stocks stored in the house (as well as crops on the land) may threaten food security until the next harvest season. Livestock that survive the flooding may succumb to epidemics that occur following the flood.

Floods of long duration can cause severe social impacts during the flood itself. Health, particularly of the elderly and disabled family members living in poor conditions with limited food stocks, unclean water sources and poor sanitation, is a serious concern of local people. Schooling can be disrupted for long periods, especially when buildings require repairs. Children are most at risk from flooding. While more than swimming skills are needed to save even the strongest adults from strong currents, it was disturbing in the field interviews to hear of people who had died in relatively calm waters simply because they could not swim. Drought and saltwater intrusion during a drier dry season also affect the second rice crop.

The major problems Mekong River Delta is facing are increasing frequency and magnitude of flooding, sea water intrusion with high tide, contaminated soil, sea level rise, seasonal tropical storms. Annual flooding season occurs in Mekong River Delta in five months starting from July to November. Floods occur from lower part of the delta, attributable to Tien River and Hau River, which are linked by a complex system of natural and man-made canals, creating a complicated hydraulic regime. Floods also occur from the upper part of the delta, carrying much poorer nutrient sediment water. The water level in inundation area reached 1 to 3 metres. Flooding area in Mekong River Delta is home to 8.5 million people, of which 17% urban and 83% rural. 2.5 million people in this flooding area live in deep flood water area (up to 3 metres) while 3 million people in medium flooding (up to 1.5 metres).

The “beautiful” flood years supplied fresh water for irrigation and domestic use, increased fishery resources, improved navigation transport, brought about more natural fertiliser, flushed contaminated water caused by sulphate soils, transported salted water towards the South China Sea, and so on. However, damages caused by floods are considered as the cause of negative effects on economic development and to people's livelihoods. Infrastructure such as roads, houses, embankments, canals are under water. Casualties happened among the several hundreds of thousand people living for several weeks on water and a large number of the victims were children. Epidemic diseases such as marsh fever, dengue fever, diarrhoea, amongst many others also appeared when floods occurred.

2.2 Climate change predictions and scenarios

Vietnam lies in the typhoon centre of the South China Sea, which is one of the biggest typhoon centres of the world. Due to coincide of typhoon and rainy seasons, complicated topography floods and typhoons occur very frequent. It is evident that the increasing frequency and magnitude of tropical storms, accompanied by the occurrence of floods, was caused by the rapid climate change (CCFSC, 2005).

Coastal area of Vietnam is one of the most vulnerable areas being affected by climate change. Climate change scenarios revealed that if there were no dyke systems built and sea level rises of 1 metre by 2100, a vast area in the Mekong delta, estimated of 20-30%, will be effected. A large portion of the delta will be narrowed due to saline intrusion. Sea level rise will also swallow a massive area of mangrove systems.

Recent progresses in climate change modelling have included the development of regional models with a higher resolution than previously available. New and more reliable projections for regions including South East Asia are now available. The Fourth Assessment of the IPCC includes a review of the most recent regional climate projections for the South East Asian

Region and a few results of these are given here. These regional climate projections are based on the IPCC A1B emission scenario and assess the change in the climate of South East Asia in the period 2079-2098 compared with that of 1979-1998 to be as follows (IPCC, 2007):

- The regional models have predicted between 1.5⁰C and 3.7⁰C temperature increase with little seasonal variation,
- Precipitation projections have varied considerable across different models. The average result of the models is a 6% increase in annual precipitation with a variation between -3% and 15%. It is predicted that there can be very large variations in precipitation change within the region as well as within different parts of Indochina.

Vietnam's Initial National Communication to the UNFCCC (2003) provides detailed predictions regarding climate change impacts in Vietnam of which the most important are summarised as follows:

- The average temperature is estimated to increase 2.5⁰C in 2070. Inland average temperature (focus mainly on the highlands) will increase 2.5⁰C, meanwhile the average temperature of coastal area may increase 1.5⁰C. Possible effects of such increase will include a large area of the country suffer from drought, agriculture crops will be heavily lost, epidemic disease will increase and spread rapidly along the length of the country amongst other serious effects,
- Annual average high and low temperatures are also expected to increase. The number of days with temperature higher than 25⁰C will also increase. This increase will significantly affect the country's ecosystems, farming seasons, and human health,
- The North and the South regions are affected by the Southwest monsoon but the seasonal rainfall amount decreases in July and August and increases in September. October and November. In the Central, rainfall would increase with approximately 19 percent in the rainy season by 2070,
- The evapotranspiration rate will also increase due to a shift in temperature. Because rainfall is concentrated in the rainy season, rainfall in the dry season will decrease by 2070 in the Central of Vietnam and droughts will occur more frequently,
- Sea level in Vietnam has increased 5 cm within the past 30 years. Sea level is expected to rise up to 9 cm in 2010; 33 cm in 2050; 45 cm in 2070; and 1 meter in 2100,
- Over the past years, the typhoons landed to Vietnam in August in the North, in October in the Centre and in November in the South. But the typhoon season is observed to occur later and more southwardly in recent years,
- Climate change would lead to increasing the sea surface temperature in higher latitude region of Pacific Ocean. It will lead to more typhoons occurring in the northwest Pacific Ocean, affecting Vietnam, and
- In the next decades, sea surface temperature is predicted to rise, which will cause higher wind velocity in typhoons and will last for a longer period. The typhoon intensity will be stronger, especially during El Niño year.

In 2004, World Bank published the methodologies to develop Low Mekong Delta development scenarios with supports from the Decision Support Framework (DSF). Six scenarios were generated in this programme. The key model parameters are summarised in Table 2.

Table 2. Scenarios of possible changes in water flow system in Mekong River delta

<i>Scenarios</i>	<i>Domestic and Industrialised (10⁶ m³)</i>	<i>Irrigated Areas (10³ ha)</i>	<i>Hydropower dams active storage (10⁶ m³)</i>		<i>Embankment area (10³ ha)</i>	<i>Basin diversions (10⁶ m³)</i>	
			LMB	China		Intra	Inter
Baseline	1,620	7,422	6,185	-	0	0	0
Chinese Dam	1,620	7,422	6,185	22,700	0	0	0
Low development	3,109	8,316	12,443	10,300	0	0	0
Embankments	3,109	8,316	12,443	10,300	130	0	0
Agriculture	4,194	11,349	12,443	10,300	0	2,200	3,262
High development	4,194	11,349	26,778	22,700	0	2,200	3,262

Source: World Bank (2004).

This study has generated the scenarios that reflect the possible effects on flow systems, water transportation, aquatic products, floods and salinity inundation of lower Mekong River delta. It is noted that the study, though relatively comprehensive, have omitted some possible effects on the current flow within Vietnam, such as that of increasing irrigation area in Thailand or efforts put in preventing salinity inundation. Nevertheless, the study is a significant study in water resources and water use in Mekong River delta, particularly the lower part of the delta.

Global projections and downscaled scenarios have indicated that the water flow system in the Mekong River delta will alter in a complex fashion. Immediate actions, therefore, are required from national to local levels to protect the local people and regional economy from adverse impacts of the changing flow systems, especially floods and other water disasters. The next section discusses the current disaster management and adaptation strategies to improve coping and adaptive capacity to climate change impacts.

3 Current disaster management and adaptation to climate change

Vietnam has a good network of climatological observation stations as well as river level monitoring in all provinces, especially those highly exposed to climate extremes. Possible extreme event strikes are normally predicted many days in advance, but there is, however, no indication of the magnitude of the event (CCFSC, 2005). As the magnitude of the event is not predicted, people and local authority actively prepare only for routine annual events. The preparedness activities are guided by the authority, from the national to local level within the national disaster management system and, in many cases, spontaneous activities by the local groups.

Being prone to climate extremes, people in Vietnam in general and Mekong River Delta in particular are aware of the disasters that come with the seasons. Households and local authorities showed an active engagement in a series of activities at least a month before the storm and flood season. People would usually undertake repairs of residence, reinforcing infrastructure that expose to possible extremes. Bank of crop fields are consolidated to avert damage and losses. Harvested paddy is kept on elevated and safe storage. Animals are move to safer grounds. Emergency food, firewood and medicine are stocked. Local authorities, organisations, like the Women's Union and Farmers Association, and household groups may play a role in encouraging households to make such preparations.

Existing disaster preparedness plans, prepared with participation by local organisations, detailing tasks of sub-groups in addressing prevention and preparedness, response and recovery include (i) protection of agricultural and aquaculture production, (ii) protection of infrastructure, and (iii) evacuation, and search and rescue.

There was quick and comprehensive action from the authority at all levels and from local organisations, in response to the disaster. Immediate action was taken for rescue operations and food distribution by the local Committee for Flood and Storm Control (CFSC), local organisations and the Red Cross. District leaders are in charge during the whole event, organising rescue operations and food distribution. As action is urgent, more power is delegated to the District People's Committee (DPC) than normal. The DPC takes the main initiative in organising both the immediate emergency response and the longer-term efforts for recovery.

At the commune level, the CFSC sub-committees involving the People's Committee and local organisations provided rescue, evacuation, relief, assessment of damage and rehabilitation measures. At all levels, sub-committees for the Management and Distribution of Support for Flood Relief are established, with representatives of key district sections and organisations. Sub-committees for Flood and Storm Protection are responsible for the planning and coordination of disaster mitigation efforts.

The role of the village and hamlet leaders is more important during crisis than under normal daily conditions. Those leaders have the overview of all the activities undertaken by the various organisations and support directed to the village. Community decision-making is strengthened regarding the distribution of support from the district level. Village meetings are frequent in order to decide on the distribution of district level, local organisation and the Red Cross. The village-based cooperative organisations also play an important role in increasing self-reliance of the village. They build the capacity for protecting agricultural products and supplies that the village needs, organise the storage of emergency supplies, and credit funds.

The Farmers Association, Women's Union, Youth Union, Veterans Association, Agriculture Cooperative, and the Vietnam Red Cross amongst all local organisations all take part in the organisation of activities for repairing houses and infrastructure, cleaning up the environment, and replacing losses. People organise labour teams to help each other to recover the land. There are frequent village meetings on how to handle the crisis, and people in the village share labour and knowledge to support each other.

When a natural disasters affect on a large scale (i.e. commune, district, etc.), local government, organisations and community groups take actions together to handle the immediate coping strategies. However, this kind of cooperation only occurs when there is a large impact from natural disasters. Individual household crisis receive less support and often the households affected have to deal with the crisis themselves with available resources from the community. Safety nets within the community are not yet sufficiently developed and limited. Even after a community-wide crisis, many households still experience more difficulty in recovering. Many of these households, who were already indebted before the impact, are amongst the most vulnerable of the community. In such cases, coping strategies of these households often include:

- Borrowing from family and friends;
- Borrowing money privately at high interest;
- Borrowing rice at a set interest rent, per season, to be paid after the next harvest;
- Collecting minor natural products,

- Seasonal migration to work in cities or farms as physical labourers; and
- Working locally as day labourers.

Mekong River Delta, one of the two most important deltas in Vietnam, covers 40,000 square kilometres of which 24,000 square kilometres are used for agriculture and aquaculture and 4,000 square kilometres for forestry. The Government of Vietnam after *doi moi* (economic renovation) has identified the delta as a prime area for expanding the production of food, export commodities and consumer goods and is aiming for a 6.5% to 8% per annum growth rate of the region. Potentials for expansion of agricultural land is a further 2,000 square kilometres, follows by an expectation of an increase up to 50% in rice production to 16 million tonnes by 2015. At the current time, Mekong River delta produces 50% of the nation's rice and contributes to Vietnam's position as the second largest rice exporter in the world (Ti *et al.*, 2003). 60% fishery and fruit products of the country also come from the delta.

To protect and maintain agriculture development, the Government of Vietnam has put substantial supports in irrigation projects in Mekong River Delta. Recently, a total of VND 626.6 billion, mobilised from government bonds, is being invested in 12 irrigation projects in the Mekong River delta in the 2006 - 2010 period.

At local level, apart from preparedness, response and recovery strategies as discussed above, local governments and farmers in Mekong River delta have been constructing and maintaining dyke system surrounding their agricultural field in an attempt to control flood, and protect crops. Embankments are also consolidated and constructed to prevent early August flood from summer crop. This type of embankments is demolished after the harvest to welcome flood water to decontaminate and fertilise the field. Thanks to dyke and embankment system, two or three crop farms are annually cultivated in many places in Mekong River Delta. There are approximately 1,000 square kilometres of three crop rice farms, 10,000 square kilometres of two crop and 1,300 square kilometres of single crop farms. Increasing rice and fishery production has a direct demand for freshwater availability, which raises an urgent need of more effective flood control.

Floods are not always negative. During the five month flooding period, 460 billion cubic metres of water flowed through the delta each year, carrying some 200 million tonnes of alluvial, a mineral rich sediment that has high potential for soil enrichment. This type of flooding water also provides a nutrition source for fish and shrimp, while crops and livestock also benefits during flooding seasons. In terms of health care, flooding water also swipes away diseases carried to human by rats, plants, fungi and others. New dyke systems and hydraulic constructions have contributed to increasing the rice yield from 4.7 million tons in 1974 to nearly four times as much in 2005. For example, An Giang province, where the region is completely controlled from inundation, has enhanced their plantation system to three crop farms thanks to water transportation along the dykes within the province. Flooding water can be regarded as a natural resource which local people can live with and take advantage of, even contribute to lessen the poverty rate in the region, thereby reducing the level of vulnerability to disasters.

Mekong River delta, though considered as a largest granaries in South East Asia, the issues related to poverty are still being urgent concerns of the national and local governments. Reports on the households' living standard in the last decade or so have recorded significant improvement in the region. However, the number of people living under the poverty line, also those who are facing the devastating impacts of natural disasters, including floods, is still a priority to be dealt with. Details on the poverty conditions, calculated using food indicators

and general indicators, breaking down by geographical regions, ethnicity and gender, are illustrated in the following tables.

Table 3. Food poverty incidence by urban/rural residence, ethnicity and gender (%)

	1993		1998		2002		% change 1998-2002	
	<i>Vietnam</i>	<i>Mekong Delta</i>	<i>Vietnam</i>	<i>Mekong Delta</i>	<i>Vietnam</i>	<i>Mekong Delta</i>	<i>Vietnam</i>	<i>Mekong Delta</i>
Total	24.9	17.7	15.0	11.3	10.9	6.5	-27%	-43%
Urban	7.9	8.2	2.5	4.5	1.9	1.1	-26%	-75%
Rural	29.1	19.7	18.6	12.8	13.6	7.6	-27%	-41%
Ethnicity								
Kinh and Chinese	20.8	15.2	10.6	9.8	6.5	5.3	-39%	-46%
Other ethnicity	52.0	41.9	41.8	25.1	41.5	22.6	-1%	-10%
Gender								
Male	26.0	17.6	16.2	12.5	12.0	6.7	-26%	-47%
Female	21.0	18.0	10.6	6.3	6.6	5.8	-37%	-9%

Source: UNDP/AUSAID, 2004.

Table 4. General poverty by urban/ rural, ethnicity, and gender (%)

	1993		1998		2002		% Change 1998- 2002	
	<i>Viet Nam</i>	<i>Mekong Delta</i>	<i>Viet Nam</i>	<i>Mekong Delta</i>	<i>Viet Nam</i>	<i>Mekong Delta</i>	<i>Viet Nam</i>	<i>Mekong Delta</i>
Total	58.1	47.1	37.4	36.9	28.9	23.4	-23%	-37%
Urban	25.1	25.0	9.2	15.3	6.6	8.1	-28%	-47%
Rural	66.4	51.9	45.5	42.0	35.6	26.6	-22%	-37%
Ethnicity								
Kinh and Chinese	53.9	44.3	31.1	34.8	23.1	21.2	-26%	-39%
Other ethnicity	86.4	74.5	75.2	58.0	69.3	52.3	-8%	-10%
Gender								
Male	61.0	48.7	39.9	38.3	31.2	24.3	-22%	-36%
Female	48.3	41.1	28.2	31.4	19.9	20.2	-29%	-36%

Source: UNDP/AUSAID, 2004.

Strategies to reduce the level of poverty in Mekong River delta have been developed, tested and tried in various places within the delta. These strategies were established taking into account the current local adaptation, household practice in agriculture and other livelihoods, historical time experiences, and proposed five mixed agriculture-aquaculture systems specially for the rural population in Mekong River delta (Vo Tong Xuan, 2003). These project, primarily, focus on diversifying local livelihoods by taking agriculture and forestry activities along with rice farming in order to best benefit from available natural and human resources with rice production in integration with shrimp farming, livestock raising and forestry. Each model design was based on geographical and socio-economic conditions of the locality in the region. Pilot

projects of these strategies have shown positive results in improving living standard for the local population.

In order to implement these models in a large scale, small farmers need supports financially and institutionally. Local authorities all over the Mekong River delta have put efforts in developing measures of economic structure transformation, agriculture and aquaculture extensions, and financial mobilisation to materialise the projects. Local agriculture and commercial banks have also developed priority loan policies for local farmers for such projects. However, the projects can only be feasible if the water flow system is managed and controlled to favour the economic development and diversifications. The following sections detailed some pilot projects that applied such models.

The first pilot project was conducted in Hoa Thanh hamlet, Minh Hoa commune, Chau Thanh district, Kien Giang Province. The effects of changing agriculture system are illustrated as follow:

Hoa Thanh hamlet case study

Hoa Thanh hamlet covers an area of 932 ha of which 504 ha is cultivated and 109 ha is of household gardens. Hamlet's population in 2004 is 3842 people living in 702 household with a mixture of ethnic groups of Kinh, Khmer and Chinese. The hamlet is regarded as one of the poorest in the province of Kien Giang. More than 10% of the hamlet's households (82 households) have no possessions of agriculture land.

The hamlet has been implemented the National 135 Project, which focuses on replantation of its forestry land when the model was introduced to the hamlet. The mixed agriculture, livestock raising and forestry model was introduced to the hamlet from August 2002 to August 2003. The following achievement was recorded.

Effects on the economic development

- Minimising the cost of rice farming: reduction of VND 64-92 per kilogramme (summer-autumn crop), and VND 182-183 per kilogramme (winter-spring crop),
- Profit in developing livestock raising per capita: VND 6800 per capita,
- In house (family pond) fish farming: VND 1,296,190 per 1000 m²
- Diversifying plantation by cultivating additional vegetables crops: VND 1,010,000 per 1000 m²
- Profits in raising special breed of pigs (not included in other profit of livestock raising): VND 247,778 per head.
- Fruit trees plantation to improve degraded land is under way without any profit any the current time but promises profitable in a long run.
- Mushroom growing: VND 6,448,016 per 1000 m².

Environmental effects

The model introduced to the hamlet has contributed to reducing the effects of environment pollution by minimising the use of fertilisers, pesticides and making use of agricultural waste as compost.

Social effects

Through trainings, workshops on the spot have helped to raise farmers' knowledge how to reduce their poverty in their daily works, to help them to settle their own problems by themselves using available resources.

Effects of changing production

Immediate effects of the model are a significant increase in the number of households diversifying their livelihoods, (i.e. growing mushrooms, 17%; increase the area of fish ponds, 13%), and an increase in the area of fruit tree plantation as an effort to improve degraded land.

Source: Nguyen Xuan Niem, 2003.

Another project that has been implemented is Tho Son commune, Hon Dat district, Kien Giang province. Details are given as follow.

Tho Son commune case study

Four hamlets (Linh Huynh, Hon Me, Hon Dat, Hon Soc) in the commune were selected to apply the model. The total area of these hamlets is 8,095ha, consisting of three types of land: (i) alkaline land with thin level; (ii) seasonally salted land in the areas of sea-water drainage in Long Xuyen Quadrangle area with 3,522 households, 17,059 persons, among which Khmer ethnic group has 6,733 people (40%). The population are not evenly distributed while transport is difficult. The life expectancy of the population is relatively low (less than 60). Households under poverty like take up more than 20% while housing with simple leaf-roof dominates the whole area with more than 75% of houses in the region of this kind.

15 households of these hamlets carried out the model of the project. The economic effects from rice plantation with rice - shrimp farming model has brought about high profit, an average of VND 4,986,670 per ha (\pm VND 363.590 per ha) with the highest VND 5,495,000, the lowest VND 4,285,000 per ha. This means “meeting national food security”, but also reducing shrimp diseases of the following crops. This is highly important to the success or failure of shrimp farming in this area. Agriculture extensions and active involvement of local farmers have enabled the [pilot project to achieve such success. The winter crop of 2003-2004 has achieved significantly higher productivity (5.08 tons per ha compared with the planned 5 tons per ha), an increase of 42,28% compared with the plan; profit also increased (VND 4,986,000 per ha compared with the planned VND 3,951,000 per ha), increased 88,15%.

Apart from these 15 households, there were other 5 households with a total area of 14.7 ha of fish ponds. The fish are well grown, effectively harvested and sold for high price, enabling local people to further diversify their livelihoods.

Source: Luong Thanh Hai, 2004

Though the models applied in these pilot projects have revealed positive and promising results. There are other related issues, both socio-economic and environment, to be considered such as those of education, employment, health care.

The education in Mekong River Delta, at the current time, has the highest dropout of the school in the country. The reason for this is the lack of educational culture and the availability of manual jobs, even to the illiterate. Only 300 of the total 6,200 schools in the Mekong River Delta region meet the national standards and that there is only one university for every 3.37 million people against 327,000 in the Red River Delta. Only 27% classrooms in Mekong River delta are solidly build (MARD/UNDP, 2006).

The average spending on education by a Mekong River Delta household is only 63% that of its Red River Delta counterpart. It plunges to 46% of that in the south-eastern region (Viet Nam News: January 16th, 2007). For example, children’s education gets a real boost because they can stay in school longer, easier to get to school by road rather than by boat and to stop seasonal migration with their parents following work. For example, due to the rising floodwater levels in upstream rivers in 2006, a number of districts in Mekong River Delta had

to delay the beginning of the school year scheduled to be in the first week of September to ensure safety for students. In Dong Thap Province, one of the worst-hit areas in the Mekong River delta region, classroom improvements are still behind schedule. Only 600 of 1,032 classrooms have been upgraded in remote rural areas. In the districts of Chau Thanh, Lai Vung and Cao Lanh, half of the schools that need repair have not been completed. (Viet Nam News: August 25th, 2006).

Employment is also increasingly improved but there are problems to be solved. Though there are more works available accompanying higher incomes but the differences between the cost of inputs and the return has narrowed. Gap between the poor and the rich are also becoming larger. The rich is more capable of dealing with disasters and other socio-economic stresses. They can also afford a better environment, amenity, health care and education while the poor is increasingly facing issues of all aspects in life. The employment rate may be reduced by the availability of jobs but it seems to benefit the rich rather than the poor. There is a need to establish a system that favour the poor and improve their empowerment in their own employment to further enhance living standard.

Health care and relief assistance are also issues to be considered. Primarily, diarrhoea has now reduced but dengue fever still remains a significant problem. During the flooding season in 2000, diarrhoea, amoebic dysentery, typhoid, dengue fever increased suddenly. More than half of female population suffered gynaecological disease (MARD/UNDP, 2006). The Government of Vietnam put a priority in supporting the healthcare system in Mekong River delta. People can access to health facilities, take their children to be vaccinated and health care service often pay them a visit at their homes. Only 22% of poor household in Mekong River delta have at least one person with health insurance cards compared to the average 29% of the whole country (UNDP/AUSAID, 2004). Number of health establishments under provincial department of health in 2005 in Mekong River delta was 1742 compared to 2544 in Red River Delta.

Environmental pollution is suffering seriously from excessive use of fertilisers, pesticides and other chemicals used in agriculture. Farmers now have more access to chemicals such as fertilisers, pesticide and others for aquaculture than before, therefore the impacts on the soil, water and human. There is a widespread concern about degradation of soil quality revealed in the quality of agricultural products as a result of excessive use of chemicals in crops. Human health is also affected with a sharp rise of high blood pressure symptom, particularly amongst older people. The rise in blood pressure is identified by some to the increased use of pesticides.

Water resources and disasters management as well as other societal issues in Mekong River Delta have been researched and supported by the government and international community. Several governmental agencies and non-governmental organisations (NGOs) including international NGOs have been providing assistance to communities living in the region. For example, the CARE International in Vietnam have been studied in the provinces of An Giang, Dong Thap and Long An on government policies on the development of residential clusters and resettlement of flood affected households; programs implemented/assistance provided to household in the residential clusters; living conditions and facilities available in residential clusters (compared with minimum international standards); and actual or anticipated socio-economic impact of resettlement on the households (CARE, 2003).

There are some solutions that are existing in some groups of people with reverse viewpoints such as destroying dykes and embankments system to return previous natural condition (living with flood) or planning and managing regions to continue constructing the dykes

system due to controlling environment closely or coordinating with Mekong River Commission (MRC), specially with Cambodia by using Tonle Sap and low land area to storage much more flood water and regulate for dry season. The solution of anti-flood in Mekong River Delta is now a challenge for the government in an effort towards sustainable development of Mekong River Delta. Vietnam's economy is developing rapidly after joining the WTO which will soon considerably enhance living standard nationwide. Improving the lives of flood-prone area people is becoming an urgent issue. These people have a right to pursuit a better life without damaging the environment or region development. How the government and organisations have been trying to address this problem is now discussed.

4 Institutional analysis

Water resources and water related disasters, especially floods, in Mekong River Delta has long been an important concern of the Government of Vietnam. The Interim Mekong Committee (IMC) was established in 1978, followed by a more official and capable institutional body -the MRC (Mekong River Commission) - in 1995 to promote an effective management and development of water resources of the Lower Mekong Basin. Vietnam has been a member of this framework since 1978.

The “*Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin*” in April 1995 is to establish Basin Development Plan (BDP) aims to enable the Mekong River delta:

- “to cooperate in all fields of sustainable development, utilization, management, and conservation of the water and related resources of the Mekong River Basin including, but not limited to, irrigation, hydropower, navigation, flood control, fisheries, timber floating, recreation, and tourism, in such a way as to optimize the multiple use and mutual benefits of all riparians and to minimize the harmful effects that might result from natural occurrences and human-made activities.”
- “to promote, support, cooperate, and coordinate in the development of the full potential of sustainable benefits to all riparian states and prevention of wasteful use of Mekong River Basin waters, with emphasis and preference on joint and/or basin-wide development projects and basin programs.”
- “to protect the environment, natural resources, aquatic life, conditions, and ecological balance of the Mekong River Basin from pollution and other harmful effects resulting from any development plans and uses of water and related resources in the Basin.”

The concept of the BDP is also linked to the determination of the riparian countries to “*promote and assist in the promotion of interdependent subregional growth and cooperation among the community of Mekong nations, taking into account the regional benefits that could be derived and/or detriments that could be avoided or mitigated from activities within the Mekong River Basin undertaken by this framework of cooperation*” (Ti *et al.*, 2003).

The main body for co-ordinating disaster management in Vietnam is the Central Committee for Storm and Flood Control (CCSFC) with the Department of Dyke Management and Flood and Storm Control in the Ministry of Agriculture and Rural Development acting as its standing office. The CCSFC have responsibility for gathering data, monitoring flood and storm events, issuing official warnings and coordinating disaster response and mitigation measures. The CCSFC consists of representatives of the various relevant ministries, as well as the Department of Dyke Management, Flood and Storm Control, the Hydro-meteorological Service, and the Vietnam Red Cross.

Ministry of Agriculture and Rural Development (MARD) is a pivotal agency coordinating the integration of climate change adaptation into disaster risk management. However, as the five-

year plan of MARD on flood and storm control also includes the priorities from other agencies and ministries. There is an important role for Ministry of Natural Resources and Environment (MONRE) to provide information and insights on climate adaptation.

The Initial National Communication of Vietnam (2003) has identified key sectors that are vulnerable to climate change, and where adaptation is needed. Seven sectors have been identified for vulnerability and adaptation assessment, including water resources, agriculture, forestry and land-use, aquaculture, coastal zone, energy and transport, and human health.

The Vietnam Second National Communication to the UNFCCC is in preparation and forthcoming in 2007, which would be focused on water resources, coastal zone management and agriculture for adaptation.

Climate change is being recognised as a threat to long-term natural disaster risk management. The impacts of climate change are being integrated to other long-term issues into disaster risk management approaches. However, the integration of institutions engaged in disaster management, climate risk and development remains a weakness in Vietnam, though efforts have been endeavoured at all levels.

In 2006 in Ho Chi Minh City, Ministers of Cambodia, Lao PDR, Thailand and Vietnam and MRC Secretariat have signed an important agreement on the procedures governing the maintenance of flows on the Mekong mainstream (ISG Newsletter, 2006). It requires the member countries to cooperate in the maintenance of (i) acceptable minimum monthly flows in the dry season, (ii) acceptable natural reverse flow of the Tonle Sap during the wet season; and (iii) prevention of peak flows greater than occur naturally.

The Procedures for Maintenance of Flows on the Mainstream clarify the related provisions of the Mekong Agreement through further defining objectives, principles and scope of their application as well as roles and responsibilities of the various parties required for their implementation, including the MRC Joint Committee, the National Committees, and the MRC Secretariat.

In Vietnam, many legal documentations regarding to reducing natural disaster in Mekong River Delta were issued during past years such as:

- Decree of The Standing Committee of the National Assembly of Vietnam No.26/2000/PL-UBTVQH 10 dated 24/8/2000 on Dykes.
- Decision No. 173/2001/QD-TTg issued on 11/2001 by the Prime Minister on the socio-economic development of the Mekong Delta region in the period 2001-2005.
- Decision No. 1548/QD-TTg issued on 5/12/2001 by the Prime Minister on investment in housing foundations for residential clusters/dykes in deeply flooded areas of the Mekong Delta in 2002.
- Circular Letter No. 39/2002/TT-BTC issued on 26/4/2002 by Ministry of Finance to guide the management and settlement of State budget and State development credit invested in the construction of residential clusters/dykes in the Mekong Delta.
- Decision No. 146/QD-BXD issued on 28/11/2002 by the Ministry of Construction to set up a Steering Committee for the residential clusters/dykes construction program in the Mekong Delta.

At the International Support Group for Environment (IGSE) Plenary Meeting 2007 in Hanoi, Minister of Natural Resources and Environment of Vietnam concluded that climate change is a new issue which need to be carefully considered in Vietnam. In previous year, MARD and

UNDP worked out a Draft Strategy for Disaster Reducing in Mekong River Delta, which focused the main directions as follows:

- to complete drainage system against natural disaster especially on drought and flood control on boundary scale,
- to reinforce the dyke and trench systems, especially at sensitive places like living squares and fruit gardens,
- to complete coastal and estuarine dyke systems,
- to exploit efficiently and protect water resources,
- to train labour forces for anti-natural-disaster and eliminate hunger and reduce poverty,
- to deploy research projects and technologies to serve disaster control, and
- to control natural disaster in an integration system.

In order to achieve these goals, MARD will need a substantial amount of financial fund, which was estimated in Table 5.

Table 5. Capital investment for MRD in period 2006-2020 (billion VND)

No.	Preferential Programs	Up to 2010	2010-2020
1	Reinforcing the trenches, modernizing construction projects.	15,000	8,000
2	Irrigation program	8,000	10,000
3	Preventing flood and reduction natural disaster	3,000	3,000
4	Protect water sources	50	50
5	Managing water sources	30	30
6	Budget for training manpower resources	20	30
	Total	26,100	21,110

Note: US\$ 1 equal approximately VND 16,000 in 2006

Source: MARD/UNDP, 2006.

The estimated investment fund will be mobilised from the government, ODAs, provinces involved in the projects, private sectors benefited from the proposed projects, NGOs, and other potential sources. The implementation of the project will substantially improve the living conditions of local population in Mekong River Delta, protecting themselves and their production from natural resources and seasonal floods. The project will also initiate socio-economic development to maintain the Mekong River Delta one of the best rice production area in the world and diversify local livelihoods to integrate to the development trend of the country in particular and of the international region as a whole.

5 Conclusion

Climate change caused by human activities will alter climate-hydrological systems and effect on socio-economic development in Mekong River Delta in a long term. Though rich in natural resources and much potential in economic development, regional poverty is identified as the largest barrier to developing the capacity to cope and adapt to climate change impacts. The vulnerable in Mekong River Delta is most likely the agricultural, aquacultural and forestry sectors. The rural areas in the region are either more isolated or disaster prone areas due to the dependence on the natural environment. Though accounting for only 10.8% population, mostly in Red River Delta and Mekong River Delta, which would be effected by the sea level rise of 1 m in the future as an effect of climate change (Worldbank, 2007).

Lack of knowledge and education in coping with the external changes, including climate impacts (i.e. forecasting information, policy implementation, etc.) also increases the level of vulnerability of the disadvantaged and vulnerable. The integration of activities of provinces and institutions is the most important factor for better management of Mekong River Delta. However, there is still a lack of regional coordination. The National Mekong Committee and the relevant agencies need to work with provinces and stakeholders in the region to develop feasible and effective mitigation and adaptation plans to floods and its impacts. A new agency should be established in Vietnam under national or ministerial level, focusing only on Mekong River Delta disaster and flood management. Such agency should be fully supported by the government and international community to act quickly to the urgent needs of local population as well as increasing frequency and magnitude of climate impacts in the region.

Finally, the traditional approaches extending from farming practices at the local level, through informal institutions, including the self-reliance inherent, to institutions on a national scale, such as early-warning system on floods, need to be maintained and developed to empower local population to live/cope with, adapt to and in a long run, benefit from floods in particular and climate change impacts in general.

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Appendix

Mekong River delta – Pictures of people and natural resources



Source: NASA, available at <http://eol.jsc.nasa.gov/sseop/EFS/photoinfo.pl?PHOTO=STS075-721-47>



Marsh water in the Mekong River Delta, Vietnam

Source: Nile Sprague, available at <http://nilestyle.com/photography/vietnam/HCMC/enlarge.lasso?image=4404>



Aerial view of Mekong River joining Tonle Sap Lake near Siem Reap
Source: LearnNC, available at <http://www.learnnc.org/lp/multimedia/1845>



Source: LearnNC, available at <http://www.learnnc.org/lp/multimedia/1845>



People in a market in Mekong delta

Source: Panorama productions, available at www.panoramaproductions.net



A canal in Mekong delta

Source: SeaGate travel, available at www.sgtravel.com/vietnamsouthattract.html