

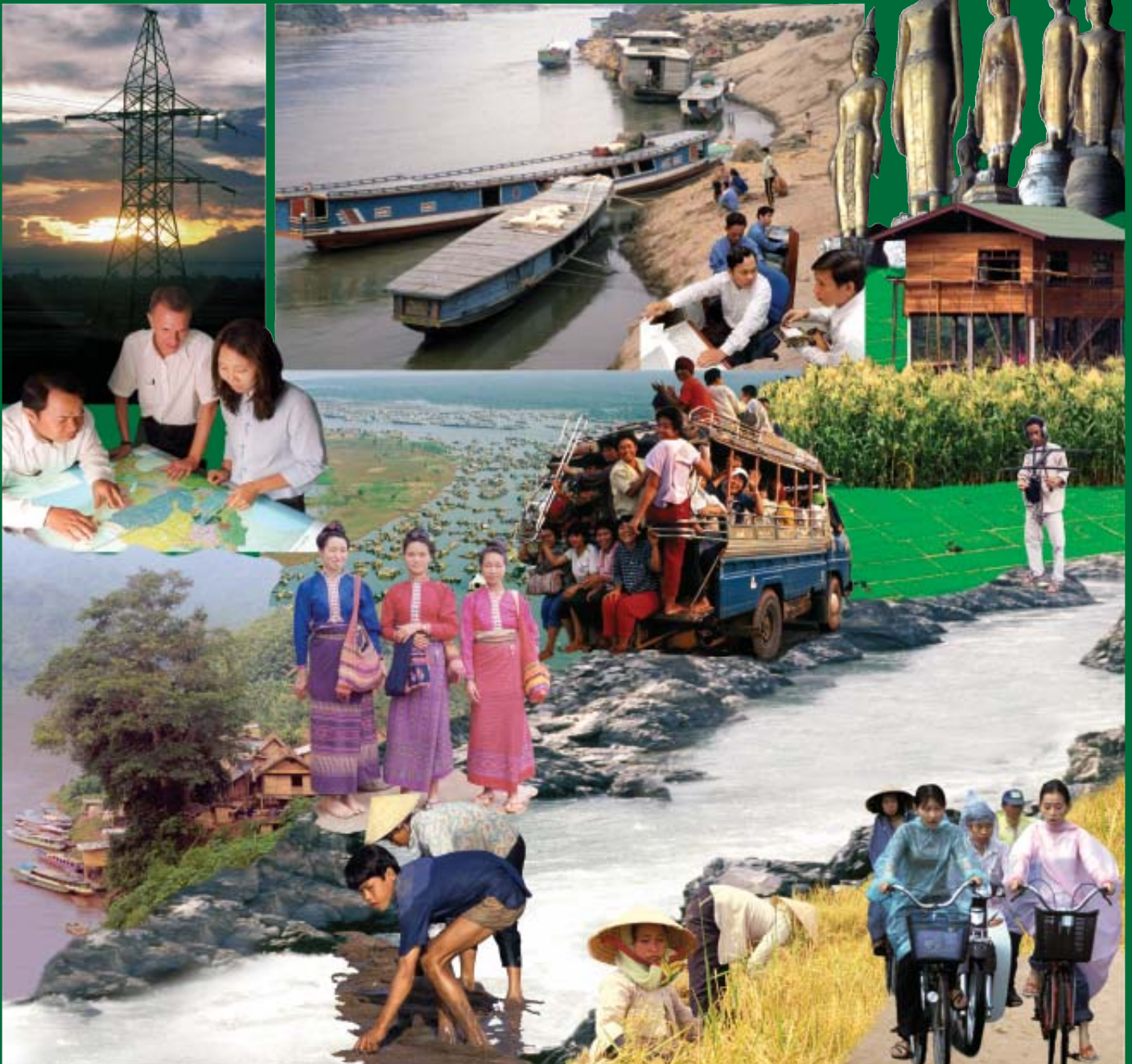


Mekong River Commission

State of the Basin Report

2003

Executive Summary



Meeting the needs, keeping the balance



Mekong River Commission

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The Mekong River Commission

June 2003

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Preface

The Mekong River and its tributaries comprise one of the largest river systems in the world. As a result of decades of war and isolation that ended just a few years ago, the Mekong's water and related resources are largely undeveloped. The volume of water flowing down the Mekong has been little reduced by dams and irrigation and, overall, water quality is good. The Mekong's fish are among the most diverse and abundant in the world.

Development of the Mekong Basin is necessary and it is also inevitable. Due to a wealth of unexploited resources, pressure from investors, and a rapidly growing population in need of livelihoods and better standards of living, the pace of development in the basin is increasing rapidly.

Although exploitation of the basin's resources could be of tremendous benefit to the peoples of the Mekong Basin, who are among the poorest in the world, it could also cause tremendous hardship if it is not properly planned, managed and monitored.

An estimated 70 percent of the people who live in the Lower Mekong Basin 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, materials and medicines. If the volume of water in the river system declines and/or the timing of the seasonal rise and fall of water changes, these wild resources may decline, along with livelihoods and food security for the millions who depend on them. Changing water levels could also adversely impact agriculture, aquaculture, navigation, and water supplies for household, commercial and industrial use.

Because the potential as well as the risks of exploiting the Mekong are significant, it is crucial that decision-makers have timely and accurate information on water-related sectors and the impact that developing them is having, and could have on the economy, environment and human welfare. In support of this objective, the Mekong River Commission is launching a series of reports on the state of the Mekong Basin.

This document summarises the key findings in MRC's first State of the Basin Report. As with the full report, this Executive Summary provides an introduction to the geography, hydrology, plant and animal life of the Lower Mekong Basin, as well as the social and economic circumstances of its peoples. It also reviews key economic, environmental and social issues related to fisheries, agriculture, forestry, hydropower, trade and transport, domestic water and sanitation, as well as flooding. In keeping with the mandate of the Mekong River Commission, the emphasis is on issues that relate directly to water resources and their management.

Since the inception of the Mekong River Commission in 1995, Cambodia, Lao PDR, Thailand and Viet Nam have been strongly committed to collaborating in the use, management and conservation of water and related resources and this report is one step in the process of reviewing the condition of the basin and how it is changing. MRC hopes that it will contribute to a better understanding and dialogue among the range of stakeholders who will determine the future of the Mekong River Basin.

MRC also hopes that readers will contribute to the success of future editions of the State of the Basin Report by suggesting topics to add, errors to correct and additional sources of relevant data. MRC's first State of the Basin Report is very much a work in progress and it is hoped that future editions will reflect the valuable advice provided by its readers.



Joern Kristensen
Chief Executive Officer
Mekong River Commission
June 2003



Introduction

There is evidence of human settlement in the Mekong Basin dating back 6,000 years, and people have certainly been living along the river far longer than that. More than a dozen sites of human habitation dating from 8,000-10,000 years ago are known in Thailand and Viet Nam, and although none are yet known in the Mekong Basin, it is probably just a matter of time before they are discovered. Indeed, it seems likely that the basin was inhabited by human ancestors such as *Homo erectus* about one million years ago.

But although the basin has an undoubtedly long history of human occupation – far longer than that for most other river basins outside of Africa, the impact of humans over the centuries was slight. Until quite recently, population densities in most of the basin were quite low, although from the time agriculture and domesticated animals were available, the region had the capacity to produce enough food to support much larger and denser populations than most other regions of the world. For example, Thailand is estimated to have been 70 percent forested in 1936, with relatively few areas cleared.

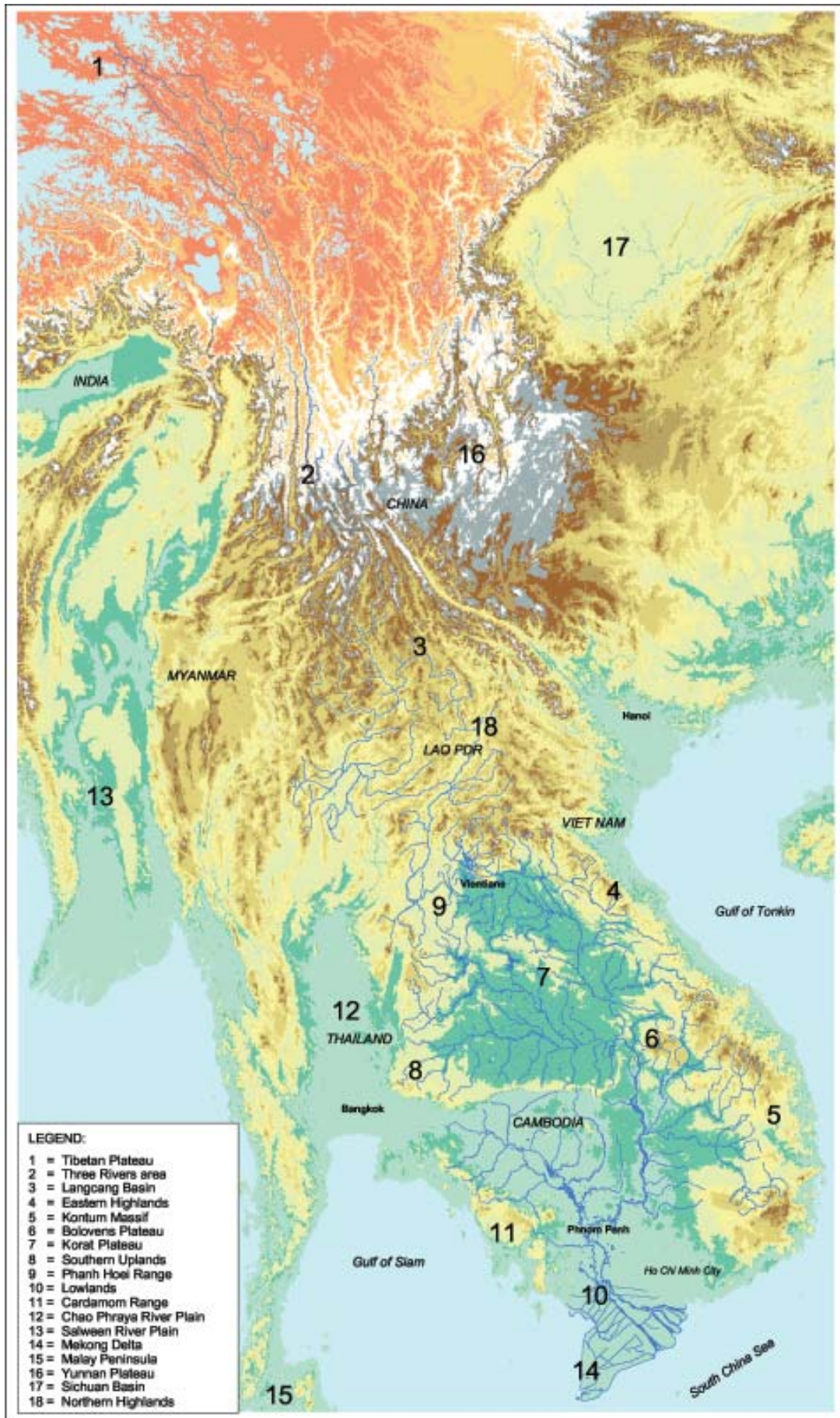
The wars fought in the 17th and 18th centuries between the various kingdoms that today would be part of Myanmar, Thailand, Lao PDR and Cambodia, were fought largely to obtain population, not land. At the time of early European accounts written during the

16th and 17th centuries, the population of the basin was relatively small and distributed in small settlements, separated by extensive areas of forest.

Only after the Second World War did the basin begin to see relatively rapid increases in population and extensive conversion of forest to agricultural land. This was particularly true in Northeast Thailand, which now has little forest cover remaining and one of the highest population densities in the basin.

Rapid population growth and industrialisation in the countries that share the Mekong Basin have meant that the basin has served as a resource “mine” for economies outside the basin. As the population has increased, and the technology available for exploiting resources has become more sophisticated, pressures on resources within the basin have become greater. Many of the people in the basin remain poor, and it is widely believed that the per capita availability of resources is declining. This has led to growing concerns within governments and civil society organisations about increased human impacts on the basin’s environment, and the consequences that this may have for its people. The challenge for the Mekong countries is how to develop and improve the economic conditions and livelihoods of their people whilst maintaining the biodiversity and ecological health of the Mekong Basin on which so many depend.

Figure 1. Topography of the mainland portion of Southeast Asia





Physical landforms of the Mekong Basin

The Mekong River Basin comprises some 795,000 km², and stretches about 2,600 km across Southeast Asia from the Tibetan Plateau to the South China Sea. It is the 21st largest river basin worldwide, incorporates areas of six countries (Table 1), and comprises six broad physiographic regions (Figure 1).

Six distinctly different physio-geographic regions

Lancang River Basin: The Lancang, as the Mekong is called in the Peoples' Republic of China, drops more than 4000 m as it flows from its source on the Tibetan Plateau down to the border between China and Myanmar.

Northern Highlands: With elevations up to 2,800 m, the highlands run from southern Yunnan Province, through Myanmar, Lao PDR and northern Thailand, and eastwards into the northern end of the Annamite Cordillera in Viet Nam.

Korat Plateau: Lying largely within Thailand, the Korat Plateau slopes gently to the east, with ancient lava flows scattered along its southern edge. The Mekong River cuts deeply into the eastern rim of the plateau, forming sheer cliffs above the river in some places, and underwater canyons up to 100 m deep in others.

Eastern Highlands: A southern extension of the Northern Highlands, these mountains extend about 700 km from Lao PDR through Viet Nam, with altitudes as high as 2,800 m. A number of the Mekong's larger tributaries flow from this part of the basin, including the Se Kong, Se San and Sre Pok Rivers.

Lowlands: With elevations just above sea level, the lowlands comprise the Cambodian floodplains and the delta. Each year, at the peak of the rainy season, floods cover vast areas of lowlands across Cambodia to the mouth of the river in Viet Nam. The Mekong branches at Phnom Penh, with the Bassac forming the western arm of the delta, and the Mekong proper forming the eastern arm. The delta area extends across some 65,000 km². In the upper delta, the river channels are lined by natural levees formed through silt deposition. Lower down within the Vietnamese section of the delta, there is an elaborate network of canals.

Southern Uplands: The southern uplands in southeastern Cambodia are extensions of the Northern Highlands and include the Cardamom and Elephant ranges in Cambodia. Both these ranges are still densely forested, with low population densities, and are considered significant areas for conservation.

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. During the flood season, water flows from the Mekong mainstream northwest to contribute most of the water that fills the Great Lake. 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 km², to up to 13,000 km². As water levels fall in the Mekong River in October and November, flows into the Great Lake reverse and much of the water flows out and down the Tonle Sap River. Through the dry season, water from the Great Lake continues to supplement the flow of the Mekong, providing some 16 percent of the dry season flow.



Table 1. Territory within the catchment of the six Mekong River countries

Description	Country or province						Mekong River Basin
	Yunnan Province, PRC	Myanmar	Lao PDR	Thailand	Cambodia	Viet Nam	
Area (km ²)	165,000	24,000	202,000	184,000	155,000	65,000	795,000
Catchment as % of country or province	38	4	97	36	86	20	
Catchment as % of MRB	21	3	25	23	20	8	100



Water in the Mekong Basin

Climate

The climate in the Mekong Basin ranges from tropical to cool temperate. Some of the higher peaks on the Tibetan Plateau are permanently snow-capped and much of this part of the basin is under snow in winter. Dry season flows downstream are maintained partly by the melting of these snows. At lower elevations in China's Yunnan Province, the climate warms and annual rainfall is as high as 1,700 mm. In the Lower Mekong Basin, the largely tropical climate has two distinct seasons – a wet season from June to October and a largely-dry season for the rest of the year. In the hottest months of March and April, average temperatures range from 30°C to 38°C, depending on location and altitude. Coolest temperatures occur between November and February. At higher elevations in Lao PDR, winter temperatures average 15°C. In the lower basin, the rain soaked uplands in Lao PDR and Cambodia receive the most rain (3,000 mm), and the semi-arid Korat Plateau in Northeast Thailand, the least (1,000 to 1,600 mm).

Water flows

Compared with other large rivers, the volume of water flowing through the Mekong each year is remarkably predictable. Between high and low flood years there is relatively little difference in volume. Although no

changes in rainfall patterns are apparent since 1950, more water has been flowing through the river during the dry season and less during the wet season. The most likely explanation is human intervention through the building of dams for irrigation and hydropower. These store water, reducing water flows during the wet season, and release water during the dry season to irrigate land and/or generate power. Concerns that dams and irrigation projects are reducing the Mekong's dry season flows seem to be unfounded

Water quality

The Mekong's water quality has been measured once or twice per month at 98 sites since 1985. Measures are taken to determine the amount of sediment in the water, its salinity, and levels of nutrients. Data indicate that water quality in the Mekong is generally good, especially when compared with many other great rivers in the world. Sediment levels are declining, as is salinity, but there have been increases in nutrients (nitrogen and phosphorus) at most sites in the delta.

Sediment

Concerns have been raised that there appear to be increased sediment levels in the river. This perception has led to worries that within a few decades, the vast

Figure 1. Rivers and water bodies in the Mekong Basin



and highly productive Tonle Sap Great Lake in Cambodia will silt up, with enormous consequences for aquatic life and fisheries. However, records dating back to 1992 show that sediment levels are actually declining. Research also shows that the sediment at the bottom of the Tonle Sap Great Lake is increasing at a rate of only 0.01 mm per year. At this rate it will take thousands of years for the lake to fill with silt. The most likely explanation for the decline in sediment is that it is being trapped upstream behind the dams that have been built for hydroelectric and irrigation projects.



Salinity

Salinity levels have been declining in both Northeast Thailand and the Mekong Delta. The most likely explanation for the decline in salinity is that the operation of increasing numbers of small-scale reservoirs is increasing dry season flows and thus diluting concentrations of salt. In the Mekong Delta, seawater intrusion has been a problem, threatening both agricultural land and domestic water supplies. Levels there have declined due to the construction of dykes that block the inflow of tidal water and/or use of increasing volumes of fresh water to flush out seawater.

Nutrients

The trend in nutrient levels in the Mekong is a cause for concern. Levels of nutrients at almost all sampling sites in Viet Nam have risen, most likely because of increasing use of fertilisers in agriculture. Levels are now approaching those that result in overgrowth of algae and negative consequences for aquatic life. The flushing action of river flows may be sufficient to reduce the likelihood of severe algal blooms, but if water velocity in the mainstream slows as a result of barriers to prevent seawater intrusion, the problems caused by nutrients could become far more severe.



Table 1 Approximate distribution of MRB water resources by country

	Country or province						Mekong River Basin
	Yunnan Province, PRC	Myanmar	Lao PDR	Thailand	Cambodia	Viet Nam	
Catchment area as % of MRB	22	3	25	23	19	8	100
Average flow (m ³ /sec) from area	2410	300	5270	2560	2860	1660	15,060
Average flow as % of total	16	2	35	18	18	11	100



Biota of the Mekong Basin

The Mekong Basin occurs at the junction between several different biogeographical zones. The northern end of the tropical Malayan Peninsula meets the southeastern extension of the Himalayas and the southern edge of the temperate region of China. This results in a great variety of ecosystem types and a wide range of species, although probably fewer than in the extremely biodiverse tropical forests of southern peninsular Malaysia and Indonesia.

Vegetation

Forests vary depending on altitude and rainfall. Wet evergreen forest occurs in the Cardamom and Elephant Mountains in Cambodia, and the Annamite Range in Viet Nam. Semi-evergreen or dry evergreen forest is widespread across northern and central Thailand, extending through Lao PDR and Cambodia in regions where mean annual rainfall is generally between 1200 mm and 2000 mm, and the dry season is 3-6 months. These forests characteristically contain mixed deciduous stands and/or deciduous dipterocarps – the most widespread forest type in mainland Asia.

Mixed deciduous forest, which includes teak, extends from Myanmar through northern Thailand and Lao PDR, in areas with 1,000-1,500 mm annual rainfall and 5-7 months of drought. Deciduous dipterocarp forest is the most widespread forest type in mainland Southeast Asia. Under heavy human pressure, the

lowland areas of deciduous dipterocarp forest may be converted to open savannah woodland.

Freshwater swamp forests occur in areas of seasonal flooding and are extensive around the Tonle Sap Great Lake.

Lower montane forests normally occur above 800-1,000 m altitude in northern Thailand and Lao PDR, where annual rainfall is above 2,000 mm, and the mean temperature of the coldest month is below 15°C. Montane conifer forests are common on drier montane sites with less than 2,000 mm annual rainfall at elevations of 800-1,500 m.

Vertebrate fauna

Although data on the vertebrate fauna of the Mekong Basin is lacking, an MRC study in 1997 estimated 830 mammal species, 2,800 bird species, 1,500 fish species, 250 amphibians and 650 reptiles.

A number of the mammals associated with the river are considered rare. These include the fishing cat, three species of otter and the Irrawaddy dolphin. Wetland and riverine birds have declined as well. Of the 35 species of bird known to have declined seriously in Lao PDR over the past 50 years, 24 are wetland birds. Worst affected are species that rely on sandbars and large rivers as breeding or feeding habitats.

Amphibians

The largest wild populations of the Siamese crocodile are thought to occur in Cambodia in the Cardamom Mountains area. Some estuarine crocodiles may still exist in the Mekong Delta, where a maximum number of 100 were estimated in 1994. Many of the aquatic or semi-aquatic turtles, snakes and lizards are hunted for subsistence or sold in local markets as food or medicine. Both snakes and many turtle species are exported illegally, and some previously-abundant species such as box turtles are now considered vulnerable.

Fishes

The freshwater fish fauna of the basin is thought to be particularly diverse. Some 481 species have been documented in Lao PDR and 500 in the Cambodian Mekong. Although the diversity of fish species in the Mekong Basin is large, it not remarkably so. The Zaire/Congo Basin in West Africa has 669 species and the Amazon about 1,200. However, other large rivers are far less rich, including the Nile in Africa with 320 species, the Mississippi in North America with 241 and the Murray-Darling in Australia with only 28.

Two recent changes in the fish fauna are the introduction of a number of species from outside the basin and the apparent decline in large fish in the basin. The giant catfish, the thicklip barb and the giant barb are now all rare, and some are considered endangered. Possible reasons include the fact that larger fish species may be more affected by loss or disruption of their habitat, that larger species may be more easily caught, and that larger species take longer to mature. Typically, fisheries deplete the larger fish species first, and then progressively focus on the smaller-sized fish. Thus the decline of the larger fish may be the first indicator of overfishing.

Invertebrates

Invertebrates, or animals without backbones, comprise most of the living things on earth and most of the Mekong Basin's biodiversity. Although limited, documentation shows that there are some 120 species



of snails and mussels, at least 11 of which are endemic to the river. This is the greatest known biodiversity of snails in any freshwater system in the world. Mobile Bay in the United States had even greater diversity but about a third of the species have been lost due to pollution and flow regulation.

Aquatic invertebrates are an important source of food in the Mekong Basin, particularly in the dry season when fish are less available. Researchers have documented 30 types of aquatic invertebrates that are consumed in Northeast Thailand.

In several areas, human impacts are obvious. Studies show that fauna below several dams differ from those elsewhere in the river system, indicating impacts of the dams. The adverse effects of elevated salinity and nutrients on fauna are also apparent at some locations.

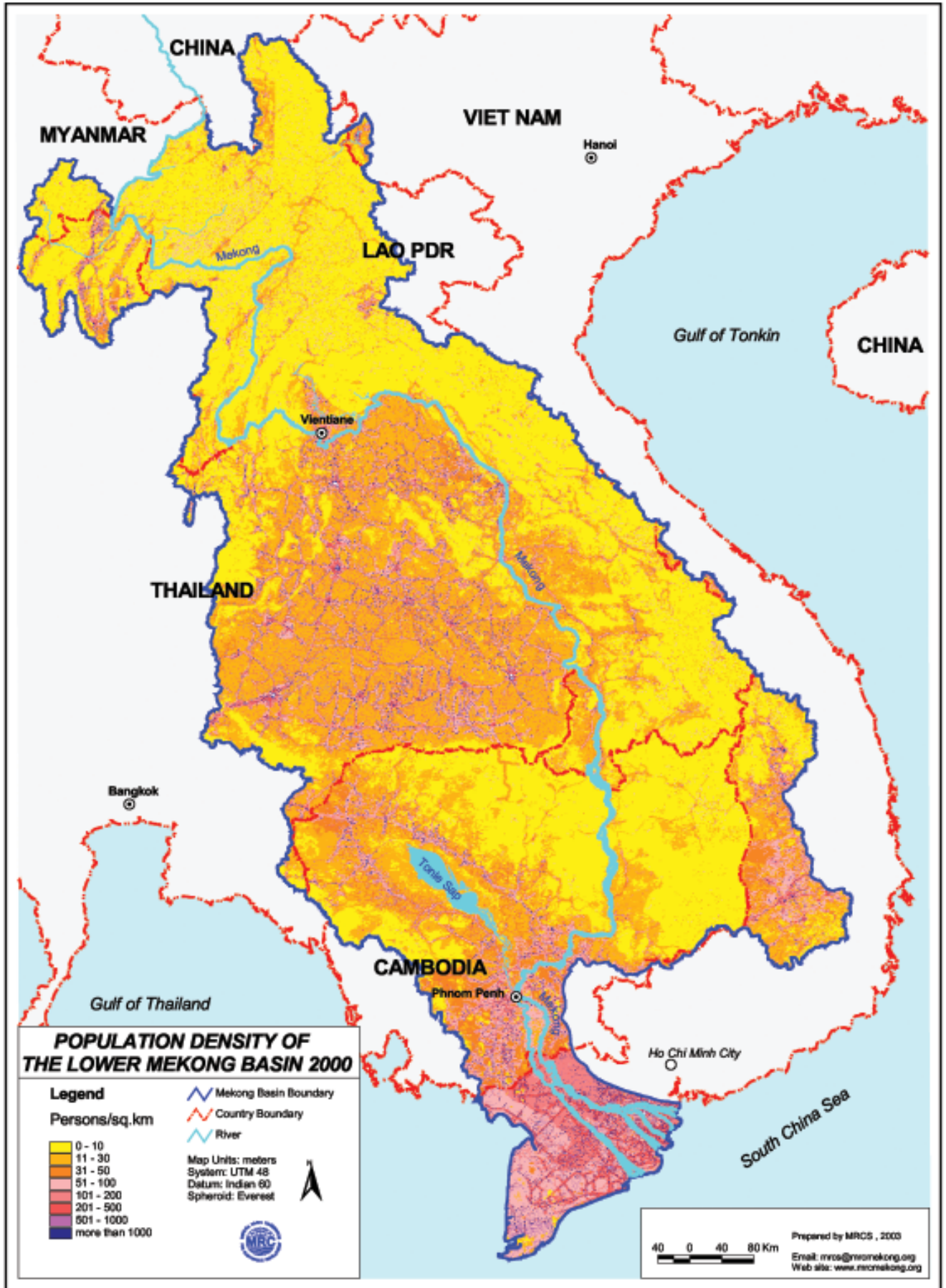
Waterborne parasites

Two parasites that have attracted particular attention are schistosomiasis or bilharzia and liver fluke. Both are caused by platyhelminth worms that use snails as an intermediate host.

Schistosomiasis is presently restricted mainly to the regions around Khone Island in southern Lao PDR and in northern Cambodia. Human infections are thought to occur mainly in the dry season when water levels are low and snail numbers are higher. If patterns of river flow change, they could influence the populations of snails, and thus human infection. Equally, improved sanitation assists in reducing the infection cycle, as does treatment of infected individuals.

Liver fluke infection appears to be most common in Lao PDR, and the route of infection is through the consumption of uncooked or inadequately cooked fish. Cooking fish properly kills the cysts, thus preventing infection. The infection is relatively easy to treat, but re-infection readily occurs because hosts cannot develop resistance.

Figure 1. Population density in the Lower Mekong Basin





Peoples of the Mekong

Geographic distribution

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 25 percent of the basin's population. The basin territory in Thailand is only 37 percent of the country but comprises 40 percent of the basin's population. In Viet Nam, the Mekong Delta and Central Highlands comprise only 20 percent of the country, but contribute 31 percent of the basin's population.

Approximately 80 percent of the basin's population live in rural areas. Population density is very low at 87 people per km². However, if the limits of arable land are considered, net densities are significantly higher, particularly in Lao PDR (465/km²) and Viet Nam (395/km²).

Ethnic diversity

The Mekong region is home to more than 70 ethnic groups, most of which practice subsistence agriculture in upland regions. In Lao PDR, ethnic minorities comprise more than 60 percent of the population. Smaller ethnic minority populations are concentrated in northeast Cambodia, northern Thailand and the Central Highlands in Viet Nam.

Migration

People move frequently in the LMB, within and between countries. Rural-rural migrations occur as people relocate from densely populated to more remote areas where they can obtain land or work. Of those who migrate to urban areas, many maintain links with their rural homes, sending much-needed cash back to their families and moving back if they lose their jobs.

Population growth and structure

The population of the basin is growing rapidly. In Thailand and Viet Nam, where women have better access to education and health services, fertility rates have dropped dramatically to near or below the replacement level of 2.1 children per family. In rural areas of Cambodia and Lao PDR, and rural and ethnic minority areas of all four countries, women continue to have more than five children. This means that working adults, particularly in Cambodia and Lao PDR, support a large population of young people.

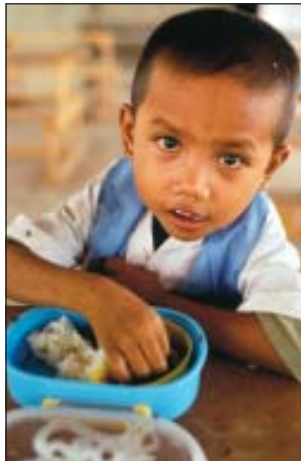
Rapid population growth will continue for the next 20-30 years, despite the fact that birth rates are falling. The large population of young people born after conflict ended in the 1980s are now reaching adulthood and having families of their own. Projected population growth rates of 2-2.5 percent per year will more than double the populations of Cambodia and Lao PDR by

2025. In Thailand and Viet Nam, population growth will be slower, but populations will still increase by 20-30 percent. Overall, the basin's population is expected to grow from 55 million today to 90 million by 2025. In urban areas, population growth will be 2-4 times higher than national rates. By 2020, an estimated one-third of the LMB population will live in urban regions.

The population of the LMB is very young and there are more women than men. Due to a post-war baby boom in the 1980s, more than half the people in Cambodia and Lao PDR are under the age of 15 years. Women outnumber men in many areas and they head more than one-quarter of households. In older age groups, particularly in Cambodia, men were killed in war and civil strife. In younger age groups, men are more likely to migrate in search of work.

Social development and gender equity

Social development varies widely within the basin. By the standards of the UNDP's Human Development Index, Thailand and Viet Nam are middle-income countries and Cambodia and Lao PDR are low-income. On the UNDP's Gender Development Index (GDI), women in Thailand and the delta in Viet Nam are generally equal to men, but their status is much lower in rural areas of Cambodia, northern Lao PDR and the Central Highlands of Viet Nam.



Life expectancy

Life expectancy is lowest in Cambodia and Lao PDR at 54 years. In Thailand and Viet Nam, life expectancy of 69 years matches the regional norm for developing countries. Women and urban residents tend to live longer. Although life expectancy has increased in recent years, poor health still reduces the number of healthy, productive years.



Mortality

Health conditions for children and women are among the poorest in the world, particularly in less developed areas of the LMB. Infant and under-five mortality rates in Cambodia and Lao PDR are, respectively, 2.5 and 3 times higher than regional norms and maternal mortality rates are 4-5 times higher than in Viet Nam and 10-12 times higher than in Thailand. Due to progress in the 1990s, mortality rates fell in many parts of the LMB, but the under-five mortality rate actually increased in Cambodia due to high child malnutrition levels (more than 45 percent). In Thailand and Viet Nam, mortality rates are much better and match or exceed regional norms. Further improvements will take place in less developed areas if women have better access to education and health services.

Public health problems

Malaria is a leading public health problem, as is HIV/AIDS. Cambodia has the highest and fastest growing rates of HIV/AIDS, although recent data suggest the situation is stabilising. Rates in Thailand have fallen due to prevention programmes. However, women in the general population and their unborn children are also at risk because so many men migrate in search of work.

Literacy

Due to advances in the 1990s, approximately 95 percent of the adult populations of Thailand and Viet Nam are literate. Literacy rates have also improved in Cambodia and Lao PDR, but remain below the regional developing country norm of 85 percent. Women, rural people and ethnic minorities have the lowest levels of literacy.

School enrolment

Primary enrolment rates have increased to 75-95 percent in LMB countries, with nearly universal enrolment in Viet Nam and in urban areas. Although equality has been achieved in Thailand and Viet Nam, in Cambodia and Lao PDR, fewer girls attend primary school than boys. Enrolment rates are substantially lower in rural and ethnic minority areas and only about half of all enrolled students complete primary school.

Secondary enrolment rates are only 40-50 percent of primary enrolment rates, and lower in rural areas than in urban areas. Cambodia has the lowest rates in Southeast Asia, and in Cambodia and Lao PDR, young women account for only 30-40 percent of secondary students. In Viet Nam, male and female enrolment is equal in urban areas, but not in rural and ethnic minority areas. Increasing enrolment and completion rates, and equity in enrolment, is considered essential for social and economic development of the region.

Access to water, sanitation and electricity

Access to improved water supply, sanitation and electricity varies across the LMB. These services are generally available in Thailand and Viet Nam, however, in Cambodia and Lao PDR, fewer than 40 percent of households have safe water or adequate sanitation. Electricity is available to 15 percent of households in Cambodia and 40 percent in Lao PDR.

Livelihoods and labour force participation

Throughout the basin, rural households grow rice and other food crops, primarily for household consumption and to sell or trade small surpluses. Lowland farmers are largely sedentary, while many upland farmers engage in shifting cultivation. Due to lack of irrigation and other inputs, productivity is generally low, with the exception of the heavily-irrigated Mekong Delta



in Viet Nam, which is the world's second-ranking rice exporter. In addition to farming and raising livestock, many rural households also catch fish and gather non-timber forest products (food, fuelwood, medicines, construction and craft materials) from common wetlands and forests. These provide food security and a source of cash income.

Most adults and young people living in the basin are economically active. Three-quarters or more work in the agricultural sector. Women's labour force participation rates are much higher than the regional average of 51 percent. They account for 50-70 percent of the agricultural labour force and, in Viet Nam, women comprise nearly 70 percent of aquaculture workers. Women make up a large part of the service sector labour force, particularly in the informal sector, and over 90 percent of LMB garment workers are women.

Unemployment in rural areas is very low, but much higher in urban areas. Underemployment is a significant, growing, but not well-documented problem in rural areas. In Viet Nam, for example, those in agriculture work an average of only 21 hours per week.

Income

Income levels vary widely across the LMB. In 1996, national data indicated that wage levels in Thailand were two and half times that of Viet Nam and five times that of Cambodia and Lao PDR. Urban incomes tend to be 2-4 times higher than rural incomes. While agricultural activities account for the majority of income, wages and profits from jobs, self-employment and home businesses constitute up to one-third of household incomes. In general, women's incomes are 60-75 percent those of men.

Poverty

Nearly 40 percent of the populations of Cambodia, Lao PDR and Viet Nam live below the poverty line. In Northeast Thailand, 19 percent of the population is poor. Between 1993 and 1998, economic growth contributed to significant poverty reduction in Viet Nam and Lao PDR. Despite economic growth in Cambodia, poverty declined only marginally. In Thailand, poverty levels in the Northeast rose by almost 5 percent after 1997 as a result of the regional financial crisis.



poverty line. The gap in incomes between rich and poor, and between urban and rural or ethnic minority areas is growing. Declines in poverty levels are mainly due to rising incomes in urban areas, to economic growth, but not to more equitable distribution of wealth.

Many households have incomes just above or just below the poverty line.

Thus, positive economic growth can readily raise people out of poverty, and economic downturns or natural disasters can push more people below the

Poverty involves a wide range of deficiencies that include: food shortages that often last for six months or more; landlessness; insecure tenure or lack of sufficient and productive land; lack of agricultural inputs (fertilisers, irrigation, equipment);

poor roads and poor access to markets and market information; and inadequate education and health services.

Table 1: Population (millions)

	LMB Country Population Data					
	Population 2000 (est.)		2020 (proj.)			
	Total	% Urban	Total	% Urban		
Cambodia	9.8	13.1	16	20.5	26	
Lao PDR	4.9	5.3	24	8.1	36	
Thailand	23.1	62.8	22	75.1	33	
Viet Nam	16.9	78.1	20	100.2	28	

Table 2: Social Development Indicators

	Life Expectancy				Child	
	LEB	HALE	IMR	U5MR	Malnutrition	MMR
Cambodia	54	47	88	125	46	473
Lao PDR	54	45	92	125	40	530
Thailand	69	60	28	33	19	44
Viet Nam	69	59	27	34	33	100
Regional	69		34	44		

Notes: LEB: Life expectancy at birth, years; HALE: Health-adjusted life expectancy, years (WHO); IMR: Infant mortality rate, per 1,000 live births; U5MR: Under-five mortality rate, per 1,000 live births; Child malnutrition: % children under 5 years underweight for age; MMR: Maternal mortality rate, per 100,000 live births; Regional: average for developing countries in East Asia and Pacific (World Bank)

Table 3: Poverty (% households)

	1993-96		1997-1999	
	Total	Total	Urban	Rural
Cambodia	39	36	18	39
Lao PDR	45	39	27	41
Thailand	11	16	3	22
Viet Nam	58	37	9	46



Macroeconomic trends in the Lower Mekong Basin

Rapid economic change in recent years

In the last 15 years, economies within the Lower Mekong Basin 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, in the 1980s and 1990s, other sectors began to develop. Thanks to pro-private sector and foreign investment policies, growth rates were double digit in Thailand in the late 1980s and early 1990s, and the economies of the other three LMB countries grew at 5 percent in the 1990s. In 1997, growth declined dramatically due to the Asian Financial Crisis, which began with the collapse of the Thai Baht. Since 2000, growth rates have improved somewhat, but are still well below pre-crisis levels.

Thailand

Although industrial development in Thailand initially occurred in the central part of the country, which lies outside the Mekong Basin, incomes improved within the basin because so many rural people migrated to the central region to work in industry and sent earnings home. Initially development within the basin area of Thailand was limited to the commercialisation

of agriculture and agro-processing, but in recent years, the government has been promoting industrial development in the Northeast, centred around Korat. Thailand's phenomenal growth stalled dramatically in 1997, with the onset of the Asian Financial Crisis.

Viet Nam

The greatest economic transformation in the 1990s took place in Viet Nam, which saw rapid development not only in light as well as heavy industry and in the development of coal and gas reserves, but also in the commercialisation of agriculture. Within the basin area of Viet Nam, economic change has largely been in the agricultural sector. In the delta, farms have been consolidated to make them more viable and irrigation, plus increasing use of fertiliser, improved seeds and other inputs have helped Viet Nam grow yields as high as five tonnes per hectare and become the world's second highest exporter of rice. Commercialisation of agriculture is occurring in the Central Highlands as well, as the government encourages lowland farmers to resettle and grow cash crops.

Cambodia

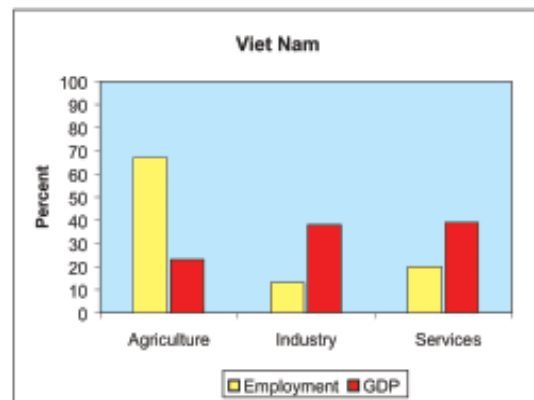
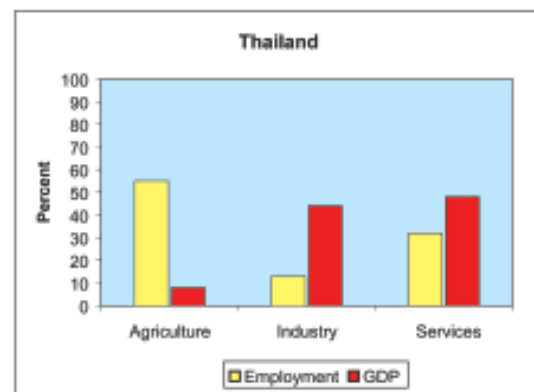
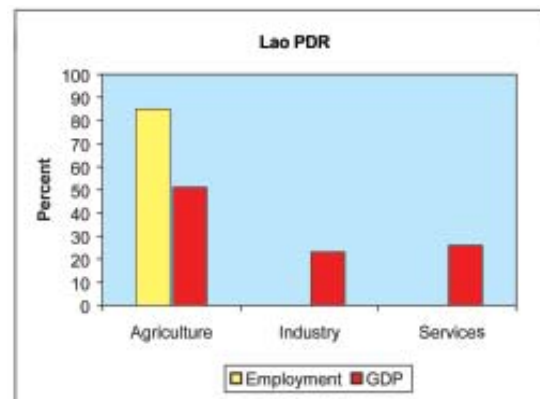
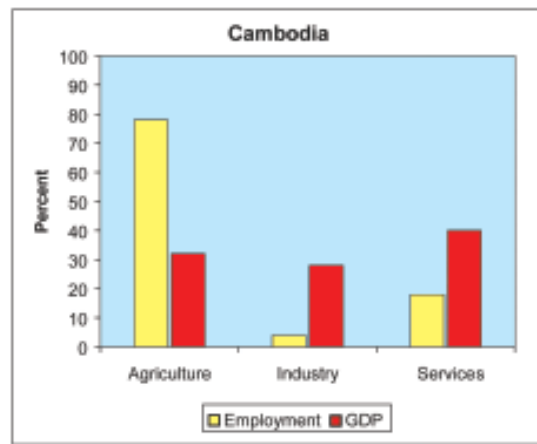
Beginning in the mid 1990s, with foreign investment and increased export opportunities, Cambodia's textile industry grew rapidly to become the country's leading source of foreign earnings. With the onset of the Asian Financial Crisis, construction of new factories declined but the industry still continues to lead exports. With free enterprise promoted, the service sector has also grown rapidly. Shops, vendors and restaurants have multiplied, along with hotels and other tourist businesses. Upgrading of the airport in Siem Reap near Angkor Wat to accommodate international flights has greatly increased tourist arrivals there. Unfortunately, due to lack of roads and other infrastructure, economic development has been largely limited to urban areas. Cambodia's abundant fishery and the marketing of fish products is worth an estimated US\$300 million, but due to the large numbers of people involved, individual earnings are generally low. So is agricultural productivity. Lack of roads, credit, access to markets and other factors mean that farmers cannot afford the inputs that have made agriculture so productive in the Vietnamese delta.

Lao PDR

Like Cambodia, Lao PDR has a significant logging industry, and like Cambodia, this has declined due to measures to protect the environment. Also, like Cambodia, industrial growth is largely limited to the area around the capital, Vientiane, and consists primarily of garment production. Free enterprise and tourism development have stimulated growth in the service sector, but in recent years the largest earnings have come from the sale of hydropower to Thailand. Because most of Lao PDR is hilly with few roads, agriculture largely remains at subsistence levels. The exception to this is the fertile lowland area along the Mekong River, where commercial agriculture is developing. As with other LMB countries, economic growth slowed with the Asian Financial Crisis but the impact was particularly bad in Lao PDR, due to strong links with Thailand's economy.

Government policies to promote economic development

The governments of all four LMB countries are promoting commercial agriculture and agro-industry in order to create jobs for poor and rapidly-growing rural populations. Thailand, which is at a much more advanced stage of industrial development, is promoting industrial development in the Northeast, but in the other three LMB countries, emphasis is on commercial agriculture and agro-processing.



Note: Employment information reflects available data for most recent years 1997-2000. Agriculture includes forestry and fisheries.

Regional integration

To encourage economic development, the Asian Development Bank's Greater Mekong Sub-region Programme is promoting regional integration. Among others, a network of roads is under construction to link all six Mekong Basin countries, river trade is being promoted and institutional barriers are being reduced to improve the flow of raw materials, finished products and workers between countries.

Prospects for future growth

With regards to future economic development, Viet Nam and Thailand are likely to continue to industrialise. Cambodia and Lao PDR will



industrialise much more slowly due to their comparatively small populations and lack of infrastructure that discourages foreign investment. Because Thailand and Viet Nam have much larger populations, they can manufacture products on a large scale, both to meet domestic demand and for export. Cambodia and Lao PDR lack such economies of scale, and with trade barriers falling, often cannot compete with cheaper goods produced in neighbouring Thailand, Viet Nam and China. There are strong prospects however for expanding tourism, growing more cash crops, and

developing rural industries such as aquaculture, livestock and agro-processing.





Fisheries

The importance of the Mekong's fishery

The Mekong's fishery is of enormous importance to the 55 million 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 are 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 Lao PDR, for example, 71 percent of rural households (some 2.9 million people) depend on the fishery to varying degrees. In Cambodia, more than 1.2 million people who live in fishing communes around the Tonle Sap Lake depend almost entirely on fishing for their livelihood. The wild fishery is particularly important for the poorest and landless rural households, making significant contributions to their nutrition, food security and income. As the population of the Lower Mekong Basin grows to an estimated 90 million by 2025, even more people will depend on the fishery. If it were to seriously decline, as fisheries have in many parts of the world, the consequences would be very serious.

Size and economic value of the fishery

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. Annual fish yield for the Tonle Sap Great Lake in Cambodia is an estimated 230 kg per hectare, a figure much higher than that for other Asian floodplain fisheries, which average about 100 kg per hectare per year.

The annual value of the capture fishery is an estimated US\$1,042 million, aquaculture an estimated US\$273 million and the reservoir fishery an estimated US\$163 million. These figures are based on point of first sale and do not include the considerable earnings from trading and processing fish.

Nutritional value

In lowland areas of the LMB, where most people live, 40-80 percent of animal protein is supplied by aquatic animals. On average, people consume about 36 kg/ per person per year. Fish are also an important source of lysine, vitamins (especially Vitamin A) and calcium. Small dried fish, eaten whole, contain more than 1,000 mg of calcium per 100 g, while dried fermented fish exceed 2,000 mg of calcium per 100 g. This is well above dietary calcium requirements of 400-500 mg per day for adults and 500-700 mg per day for adolescents.

The importance of varied habitats

The Mekong owes its abundant fishery to the varied habitats it has to offer, its vast floodplain and the extremes of wet and dry seasons. Habitat diversity is greatest in floodplain areas, and in the LMB, floodplains include flooded grasslands, forests, and an assortment of permanent and temporary river channels, lakes and pools. Fish and other aquatic animals use this range of habitats for spawning, feeding and coping with seasonal changes in water levels. Floodplains are the most highly productive part of any river system and those that expand and shrink dramatically each year, such as those of the Mekong Basin, support the highest yields. MRC studies show that fishery yields are greatest in high flood years.

The importance of migration

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 and across borders from the Mekong Delta in Viet Nam, through Cambodia to: Thailand or Lao PDR through the Mekong River mainstream; to Lao PDR through the Se Kong River; or, to the Central Highlands in Viet Nam through the Se San and Sre Pok Rivers. Also, the larvae of some species drift hundreds of kilometres from upstream spawning grounds to the floodplains where they feed and grow. Other species migrate laterally over shorter distances to spawn, feed and find refuge.

All these 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 in a complex "fish migration network". Thus, from the



point of view of migrating species, the Mekong River Basin functions as one ecological unit. Fish migration corridors connect upstream spawning habitats with downstream nursery habitats, and dry season refuge habitats in the mainstream with wet season feeding habitats on the floodplains.

Condition of the Mekong's aquatic ecosystem

The Mekong Basin's aquatic ecosystem is still in good condition, but there are a number of possible threats to the fishery that must be understood and addressed or the fishery could be decimated, as has occurred elsewhere in the world.

Possible threats to wild fisheries

Water resources development

Changes in the volume, timing and duration of water flows caused by dams and weirs built for hydropower, irrigation, and flood control can have negative consequences for aquatic habitats and fish stocks. Species that spawn in the dry season are especially vulnerable to dry season water releases from dams. They may be unable to find suitable spawning sites or their eggs may be washed away or smothered by sediment deposits. Dams and other structures across rivers and streams can block migrating fish. At times of peak migration from the Tonle Sap Great Lake to the Mekong River, at least 50,000 fish per minute swim past a given point. No existing fish ladder design could cope with these numbers of fish.

Habitat loss

The cutting of flooded forests for fuel wood supplies or their conversion to agriculture and other uses destroys crucial habitat that fish require for spawning and feeding. Aerial photo surveys conducted in 1973-1976 and 1992-1993 show that 33 percent of the flooded forest area of Cambodia as a whole and 27 percent of flooded forests around the Great Lake were cleared.

Fishing pressure

Studies show that catches per fisher have declined over time (approximately 44 percent between the 1940s and 1995). Despite this, over the same period, the total fish yield in the Tonle Sap area has increased 84 percent from 125,000 tonnes to 230,000 tonnes. Thus, catches per fisher have declined because the number of fishers has greatly increased. Increasing populations will add to the fishery pressure unless there are management interventions to restrict access to the fisheries.

River modification

Blasting of rapids, rock bars and islands, the dredging of river beds, and construction of ports and other structures to improve navigation, all modify the environment for fish, and are usually detrimental.

Deforestation

Deforestation can increase erosion and the resulting sediments can silt up deep pool habitats that serve as important dry season refuges. They can also irritate fish gills and smother fish eggs. Deforestation can lead as well to temperature changes and decrease the leaf litter needed for the aquatic food chain.



Destructive fishing practices

The use of fine mesh nets to capture catfish fry for raising in cages and ponds also nets the fry of 160 unwanted species. Only 15 percent of the total catch is kept and the rest is discarded. Fishing during spawning season, and in dry season refuge areas is destructive, as is the use of electricity, poison and explosives to kill fish.

Introduction of fish species from outside the basin

Foreign species, which are introduced for aquaculture, biological pest control and the aquarium trade, can displace indigenous fish species, reduce biodiversity, introduce disease and parasites and result in hybridisation and loss of genetic diversity.

Pollution

Water pollution is not currently a major issue for the fisheries of the LMB, although localised pollution has caused fish kills. Fertiliser run-off can raise nutrient levels in water, which in turn can cause fish-killing blooms of algae. Although not a threat to fisheries now, pesticides and fertilisers could become a concern in future as governments promote the commercialisation of agriculture and thus the use of agricultural inputs increases.

Aquaculture

The largest volumes of fish are cultured in the Mekong Delta in Viet Nam, and in Northeast Thailand, in that order. Compared with Cambodia and Lao PDR, these areas have better infrastructure, which facilitates access to inputs as well as to markets. At least two million rural households are culturing fish in the LMB. Total freshwater aquaculture production in the LMB rose from 60,000 tonnes in 1990 to 255,000 tonnes per year in 2001. This is worth an estimated US\$244.6 million.

Although people often think of aquaculture as large-scale commercial operations raising thousands of kilograms of fish or prawns, small-scale aquaculture is increasingly being promoted for subsistence households in areas where wild fish are limited. Cultured fish also provide poor households with fish during seasons when wild fish are scarce and their sale can contribute to household income.

Aquaculture encompasses a range of activities, including the production and sale of fry and fingerlings and the raising of wild or artificially produced fry and fingerlings in enclosed or semi-enclosed water bodies. Related livelihoods include the supply of inputs such as fry and feeds and the processing and marketing of aquaculture products.

Factors limiting the expansion of aquaculture

Although the expansion of commercial aquaculture could provide badly needed employment in rural areas and small-scale aquaculture could improve nutrition, food security, and cash incomes, a number of factors inhibit the expansion of aquaculture. These include: lack of seed and feed; lack of extension services; lack of access to markets; insufficient land and water; habitat degradation and the risk of disease.

A rapidly growing population means more mouths to feed. Looking across all fisheries, it appears that the total catch is probably close to being fully exploited, so further expansion of fishing will cause problems. Although aquaculture could expand and increase food security and incomes in remote areas, it can only partly substitute for wild fisheries.



Aquatic products from wetlands

The wetlands of the LMB are vital life support systems for communities throughout the region. They are responsible for providing a vast array of *goods* and *services* to the people in the region. *Services* are the ecological functions provided by wetlands such as habitats for fish and wildlife, support for the food chain, retention of water to prevent flooding, a trap for sediment, and purification and replenishment of ground water. *Goods* are the plants and animals that people harvest for food, medicine, construction, household products and so on.

The goods from wetlands are very significant for the livelihoods of people in the Lower Mekong Basin. Most of the estimated 40 million rural people concentrated along the Mekong River, its tributaries and related wetlands, are subsistence farmers obtaining their livelihoods through a combination of rice farming, fishing and foraging from nearby wetlands and forests. Besides supplementing their food supply, the harvest from wetlands provides protein during the dry season when fish are less available and ensures food security in years when the rice crop fails.

Isolated communities in the basin with limited access to markets and roads depend on locally-available flora as their primary source of edible fruits, vegetables, fodder for livestock, medicines and construction materials. Thus wetlands have been called the “poor man’s supermarket”. The abundance and diversity of species, plus their availability in different seasons, are crucial factors in providing the “safety net” that increases rural food security. However, few people outside the basin are aware of the importance of harvesting these key aquatic resources.

Aquatic animals for food

Aquatic animals, other than fish, are sometimes considered “less serious” catches. This may be because the catching is usually the work of women and children. Although catches are “low profile”, added together they provide crucial food security when other foods may be in short supply. Although primarily for home consumption, aquatic animals can be sold to obtain cash income.

Molluscs – snails, clams and mussels

At least six species of bivalves and four kinds of snails are commonly consumed in Lao PDR and other riparian countries. Abundant in the dry season and the beginning of the rainy season, snails are caught around the edges of lakes or rice fields. A typical harvest at one time is 2-10 kg, enough for 2-5 family meals. In Cambodia, *leah* (bivalves) are caught at the end of the rainy season as flood waters recede. In one study in Kampong Cham Province in Cambodia, the annual catch for 130 families was 138 tonnes, which earned each family between US\$90 and US\$180.



Shrimps and crabs.

Crabs are collected from rice fields and small freshwater shrimps from shallow water in lakes or ponds, as water recedes from November to March. The shrimp catch is about 0.5-2 kg for 1-3 hours work. On an annual basis, families catch from 15 – 600 kg of shrimp, which are worth up to US\$250 per family.

Insects - water bugs, beetles and others

Insects are an important source of supplementary protein throughout the year, and more significantly in the early dry season. At least 14 kinds of aquatic insects are known to be consumed in Northeast Thailand and other LMB countries. These include giant water bugs (*mangda*), beetles, dragonfly larvae and blackflies. Some insects are stewed with vegetables or grilled in banana leaves with spices, while blackflies are an ingredient in soup. *Mangda* are highly prized in Northeast Thailand, where they are used to flavour other foods. Due to high pesticide levels in Northeast Thailand, the catch of *mangda* has greatly declined and now several tonnes per year are exported from Cambodia for a price of about US\$90 per kg (about 100 insects).



Amphibians - frogs and toads

Several species of frog are commonly consumed in the basin. These are most abundant and easily caught at night at the beginning of the rainy season in May and June. One study in Cambodia found the average annual rainy season catch to be 20-30 kg/family/year. Tadpoles are widely consumed in Northeast Thailand, and considered a delicacy by city people. One kilogram sells for as much as US\$5 – two to three times the price of fish.

Reptiles - turtles, snakes and lizards

A number of snakes and turtles are hunted for consumption or sold for food and medicine in local markets. In the past decade, income from these animals has increased as wild stocks have diminished in other parts of Asia.



Aquatic plants as food, animal feed and medicine

At least 20 kinds of aquatic plants are commonly harvested by basin residents for food, with surpluses sold in local markets. These include the tuber, stems, and seeds of lotus, the flowers of water hyacinth, young riang leaves and water morning glory. In seasonally-flooded areas along the Songkram River and its tributaries in Cambodia, bamboo shoots are harvested for food and for income generation. In a year, the harvest of bamboo shoots is 200-500 kg/family.

Other commonly consumed wild plants include water cress, water chestnut and aquatic fern. Water fern and water cabbage are fed to ducks, cows and pigs. Medicinal uses of aquatic plants include eliminating parasites, reducing fevers and reducing inflammation. A study of one lakeside community found 35 species of wetland plants were used for medicinal purposes.



Fuelwood from wetland shrubs

The wood from wetland shrubs and trees is used extensively by lowland communities for heating and cooking, as well as for processing rice wine and palm sugar, smoking fish, making rice noodles and boiling aquatic plants with rice bran to make pig and poultry feed. Around the Tonle Sap Great Lake, 14 different aquatic plant species provide the firewood for local communities. A study of one lakeside community in Cambodia found that families saved an estimated US\$40 per year by using aquatic plants for fuel wood – a significant saving for households whose annual income is usually less than US\$300 per year.



Materials for construction, tools and crafts from wetland plants

Native plants from wetlands provide materials for house posts, floor planks, roof thatching, beam ties, as well as making and fixing fish traps and nets. A 4 x 5 metre house uses up to 15 m³ of sedge for a roof and walls, which must be replaced every two years. Stems and branches of wetland plants provide handles for knives, axes, hoes, spades, rakes, sickles, ploughs and harrowing tools.

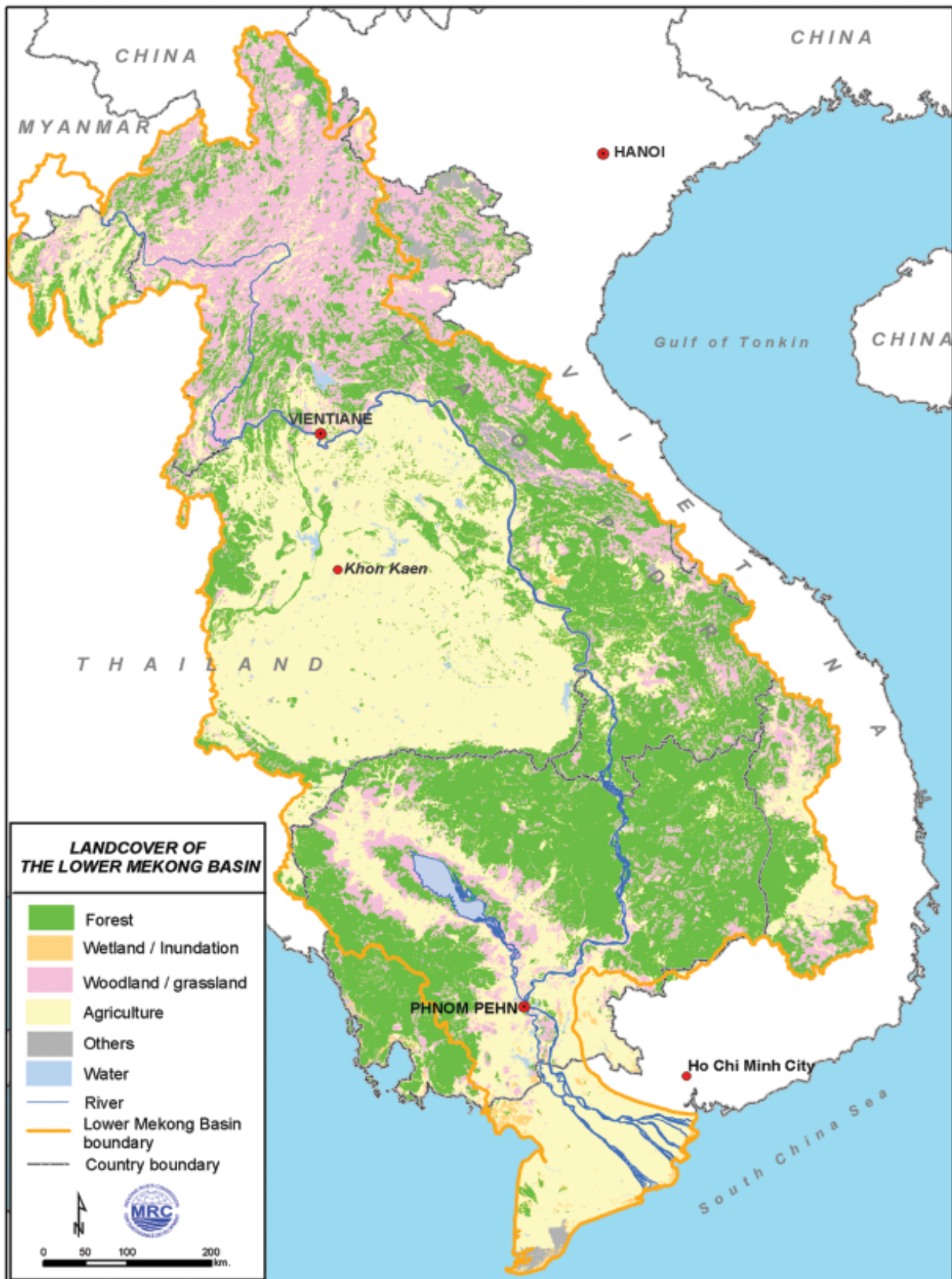


Water hyacinth and sedges are also used by many rural families to produce craft items. The softer and finer fibre of water hyacinth is woven into accessories such as hats, wallets, purses, jewellery boxes, and baskets. The durable fibre of sedge is woven to make floor and place mats. The processing and selling of these crafts provides important supplementary income for rural

women and children in the dry season. For example, the farm gate price for a 1 x 2 m mat made from sedge is US\$1-3.

While at the macro level, development of the Mekong's water and related resources could benefit national economies and the economy of the region, if not well planned and carefully managed, it could also significantly impact the harvest of fish and other aquatic products upon which rural people heavily depend, both for food security and for their livelihoods.

Figure 1. Landcover of the Lower Mekong Basin





Agriculture

The economic importance of agriculture

Agriculture is the single most important economic activity in the Lower Mekong Basin (LMB). Overall, an estimated 75 percent of the LMB population earn their livelihood from agriculture, in combination with other activities such as fisheries, livestock, and/or forestry, but the picture varies considerably between countries.

Agriculture declined in relative importance over the 1990s in all four LMB countries. The change was greatest in Viet Nam, which rapidly industrialised during this period. However, although the relative contribution of agriculture to national economies decreased between 1995 and 1999, the absolute value of agricultural output increased by 12 percent in Cambodia, 22 percent in Lao PDR, 10 percent in Thailand, and 19 percent in Viet Nam. The trend is not one of contracting agricultural sectors, but rather of agricultural growth lagging behind growth in the manufacturing and services sectors.

Agriculture in the LMB is divided into two main categories – subsistence and commercial agriculture. In order to alleviate poverty in rural areas, LMB governments are promoting the commercialisation of agriculture and agro-processing in order to increase incomes and create employment.

Subsistence and shifting agriculture

Subsistence farmers grow enough for household consumption, sometimes with a small surplus to sell or trade. To ensure food security and earn needed cash, they also catch fish and gather non-timber forest products. Farmers in upland and remote areas of all four LMB countries are limited to subsistence agriculture because they lack some or all of: water to grow crops in the dry season; affordable credit; inputs (fertiliser, pesticides, improved seeds, tools and livestock varieties); extension services; transport infrastructure to enable farmers to deliver their produce to market; and market infrastructure and market information. In Lao PDR, the 1992/3 census found that 22 percent of the population lived in areas not accessible by truck and over half were more than 10 km from the nearest market.

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. Due to population growth and loss of access to land as a result of reservoir flooding, creation of forest reserves, logging concessions and plantations, farmers have been pushed into marginal areas and now farm the same areas more frequently. This results in lower yields and can increase erosion

and landslides. To reduce environmental problems associated with shifting cultivation, in the 1990s, the Lao government required uplanders to cease shifting cultivation.

Cambodia has less land under cultivation today than it did in the 1960s before war began. Agricultural expansion is hampered by the continued presence of unexploded landmines and other ordnance. In 1995, an estimated 40 percent of arable land was mined, and although demining is progressing, it is a slow process.



Commercial agriculture

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. Farmers in the Mekong Corridor in Lao PDR, the relatively flat and fertile land that lies along the Mekong river, earn an average of US\$350-US\$360 per year, while those in upland areas earn only US\$56 per annum. On the Korat Plateau in Northeast Thailand, commercial farming of single crops such as tobacco and sugarcane has been practiced for some years. 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, in the Central Highlands in Viet Nam, lowland farmers have been encouraged to resettle there and grow cash crops such as coffee, tea and rubber. The shift towards commercialisation will be slow in Cambodia and Lao PDR because both countries still face problems with food security. The shift will also be slow as well in remote and upland areas of all LMB countries unless government or donors provide substantial assistance.

Extent of irrigation in the basin

Irrigation is increasing in the lowland areas of the basin, not only to enable a second and even a third rice crop,



and dry season or perennial cash-crops, but also to expand wet season production. However in 1998, the ratio of irrigated land to total cultivated area was only 7-10 percent, much lower than the 45 percent ratio for Asia as a whole.

In Cambodia, irrigation is largely limited to use of receding floodwaters. Only about 10 percent of the total wet season rice production area is planted with a second irrigated crop. In Lao PDR, in the 1990s, the government reported an eight-fold increase in irrigated rice farming in the lowlands. This was due, in part, to a move away from large, government-managed schemes to more numerous and small ones managed by farmers. In Northeast Thailand, where farming methods remain comparatively traditional, irrigation ratios are much lower than in other parts of the country. Large irrigation schemes have been constructed on the Chi and Mun Rivers, but local opposition to dams has slowed additional large- and medium-scale developments. Irrigation is extensive in the Mekong Delta in Viet Nam. With more than half the land flooded during the rainy season, farmers are able to store water for intensive rice cropping after the floods recede. In the Central Highlands, irrigation is limited and used primarily for rice and coffee.

Problems with irrigation schemes

Studies show that water losses, in combination with over-use, have led to construction of reservoirs that are 3-5 times larger than necessary. With systems designed largely for rice production, farmers find it difficult to switch to other crops. Financing problems include lack of mechanisms to control and measure water use, and fees that are too low to encourage efficiency and pay for maintenance. To improve matters, management of systems is increasingly being given to farmer groups.

Rice production

Rice production has increased greatly in recent years: in Cambodia, by 23 percent between 1993 and 2000; in Lao PDR, by 38 percent between 1990 and 1999; in Northeast Thailand by 33 percent between 1994 and 2001; and in the delta and Central Highlands of Viet Nam, by 27 percent between 1995 and 1999.

In the Viet Nam Delta, yields are as high as five tonnes per hectare due to irrigation. However, in Lao PDR, farmers in un-irrigated upland areas can grow only 1.55 tonnes per hectare. In 2000, the average yield for the LMB was 2.75 tonnes/ha, compared with 3.9 tonne/ha for the Asia-Pacific Region.

Non-rice crops

Although still dwarfed in importance by rice, cultivation of maize, fruits, vegetables, oil crops, fibre crops and cash crops such as coffee, tea, sugarcane and tobacco is increasing. Many of these crops can offer higher earnings than rice. In Cambodia, non-rice crops accounted for 8 percent of GDP in 1999. However, the area under cultivation (approximately 250,000 ha) is still much less than in the 1960s, before mines were laid (310,000 ha). Rubber, which is grown on approximately 40,000 ha, is Cambodia's main agricultural export.

In Lao PDR, coffee is the major agricultural export. However, due to problems with quality, prices on export are 10 percent below world prices. In response to poor international markets, tea production has declined by 23.5 percent per year and cotton by 12.2 percent. However, vegetable production has risen rapidly to meet demand from urban centres and Thailand.

Northeast Thailand, has seen the greatest shift to non-rice crops, but they still represent only 20 percent of cultivation. In lowlands, vegetables, legumes, kenaf and tobacco are sometimes farmed in combination with rice, and in uplands, cassava, kenaf, sugarcane, and legumes, such as groundnuts and mungbeans, are grown as single crops. Upland agriculture is constrained by soil quality and disease in continuously cropped areas.

In the basin areas of Viet Nam, non-rice crops are grown mainly in the Central Highlands, where production increased by 35 percent between 1995 and 1999.



Livestock

Large animals are important because they are used for tilling, hauling loads, providing natural fertiliser, dietary protein and cash income. As such, they contribute to financial security in subsistence economies because they can be sold when emergency cash is needed.

Livestock production increased substantially during the 1990s in Cambodia, Viet Nam and Lao PDR, probably due to political stability and free enterprise policies. Data for all LMB countries show buffalo have declined, and cattle, chickens and ducks have increased.

In upland Lao PDR, where potential pastureland is readily available, the government is encouraging households to switch to animal husbandry as an alternative to shifting cultivation. However, lack of fodder and animal health services and low productivity of native species remain constraints.

Environmental problems

Salinity

In the Viet Nam Delta, about 750,000 ha is affected by saline water during the dry season. Efforts to control salinity intrusion by blocking seawater can lead to other problems that were discussed previously in the section on water.

Pesticides

Use of pesticides is generally low but likely to increase as agriculture becomes more commercial. Although persistent pesticides are banned, studies have found residues of DDT, Dieldrin and others in fish throughout the basin. However, contaminant levels are still well below WHO safety levels.

Fertilisers

In Thailand and Viet Nam, farmers use respectively 100 kg and 263 kg of mineral fertiliser per hectare. In contrast, farmers in Cambodia and Lao PDR use respectively only 2 kg and 8 kg per hectare. In the Korat Plateau in Northwest Thailand and the Mekong Delta in Viet Nam, heavy fertiliser use threatens ground and surface water sources. In the delta in Viet Nam, MRC water quality surveys have found excessive levels of nutrients, and this could worsen if dams for hydropower and irrigation reduce water flows.

Acid sulphate soils

Some 1.6 million ha of soil in the Plain of Reeds, Long Xuyen Quadrangle, and Ca Mau Peninsula in Viet Nam have high levels of potentially toxic aluminium and low levels of phosphorous. Runoff from acid-sulphate soils, which have been converted for agriculture, can damage aquatic life, including the culturing of fish in rice fields. Farmers can mitigate the harm by using more water and fertilisers, but these responses increase water consumption and nutrient build-up.

National agricultural strategies and policies

All four LMB countries see the promotion of commercial agriculture and agro-processing as critical components for rural and national development. In poorer areas, the goal is to improve food security as well as increase employment. With rice failing to yield



sufficient profits, farmers are being encouraged to grow other crops. However, before they will invest in improving their land to achieve higher production, farmers need secure tenure – something that is a problem in all LMB countries.

Agricultural market issues

One of the biggest challenges in the LMB is the lack of market information and infrastructure. Unless farmers know what crops to grow and are able to market their surpluses, they have little incentive to produce them, and unless they produce surpluses, they are likely to remain poor. Therefore, improving the efficiency of agricultural marketing is a key factor in rural poverty alleviation. Key components of efficient agricultural systems include: affordable and accessible rural credit; high quality agricultural inputs such as seeds, fertilisers, pesticides, machines and related technology; extension services; market information; rural transportation systems; national distribution networks; and supportive international trade policies and relationships.



Forestry

Overview of the forestry sector

The forestry sector covers commercial logging, private and commercial gathering of fuelwood, and the harvesting of non-timber forest products (NTFPs). It contributes 5 percent of the GDP for Lao PDR, 4 percent for Cambodia, 1 percent for Viet Nam, and below 1 percent for Thailand. However, these figures understate the importance of forest resources in the economic and social lives of LMB people, many of whom draw their livelihoods partially or fully from the forests.

Legal and illegal logging

Countries in the LMB consume most of the wood they produce, but there are significant flows between them. Cambodia and Lao PDR produce a surplus and Thailand and Viet Nam import wood from these two countries. Since Thailand banned logging in 1989 after deforestation rates as high as 4 or 5 percent in the 1980s, and floods and landslides attributed to logging, pressure to log neighbouring countries has increased. Thai demand for wood is growing at an estimated 5 percent per year. Legal logging is not considered a major environmental problem, however, inefficient practices waste resources. An estimated 30-40 percent of wood harvested in Lao PDR is lost due to poor

management. Illegal logging, which is believed to be extensive in Cambodia and Lao PDR, is of greater concern. Because this logging is outside the law, it is difficult to determine how much timber is being taken. Enforcement of logging regulations is challenging due to lack of resources.

Fuelwood collection

In 1995, an estimated 95 percent of Cambodia's energy requirements for cooking and boiling water were met with fuelwood. In Lao PDR an estimated 92 percent of all wood felled is used for fuel, with similar proportions for Thailand and Viet Nam. Harvests are hard to estimate, however, because fuelwood is largely consumed by the households that collect it. Although wood taken for fuel is significant, it does not necessarily deplete forest resources because much of it comes from scattered trees in non-forest areas, or branches cut from living trees.

Non-timber forest products (NTFPs)

NTFPs 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. In Thailand, for example, an estimated five million people derive their primary income from NTFPs. Because the income earned is usually higher in upland areas than that from rice cultivation, NTFPs enhance the value of intact forests to local people and prevent deforestation. NTFPs also provide more jobs than logging. On average, collecting NTFPs from ten hectares requires 30 labourers – ten times the number required for logging.

Trends in LMB forest-cover losses

Based on an MRC study of forest losses between 1993 and 1997, the LMB as a whole lost close to 500,000 ha, or slightly over 2 percent of its forest cover in only four years. This averages out to a loss of 0.53 percent per year. This may not seem much at first glance, but over the course of the next century, this rate means that much of the LMB’s forest cover will be lost. Deforestation could also occur much more rapidly than it did between 1993 and 1997. With LMB populations growing quickly, the demand for wood products is likely to increase as well. Even at lower rates, deforestation is still a major concern because it is likely to occur in mountainous headwater areas of tributaries, where deforestation can impact the steadiness of water flow.

Patterns of deforestation

Deforestation does not occur evenly across the LMB. Rather, there are distinct “hotspots” around population centres and near roads. “Hot spots” also occur in Cambodia and Lao PDR along the Thai-Cambodian and the Lao-Chinese borders, especially where roads exist. Reducing deforestation thus requires transboundary cooperation.



Agriculture as a cause of deforestation

Although in more than 70 percent of deforested areas some form of agriculture is now practiced, agriculture does not appear to cause deforestation. Satellite data suggest that logging occurs first.

Lack of reforestation

On the whole, reforestation lags behind deforestation by a substantial margin. Viet Nam has had the most success with over one-third of deforested areas now regrowing. However, almost 90 percent of reforestation is made up of mono-culture plantations that significantly decrease biodiversity.

Table 1. Forest cover in the LMB in 1993 and 1997

Area	Forest cover 1993		Forest cover 1997		Total size	
	ha	%	ha	%	ha	%
Cambodia	9,274,703	59.4	9,092,093	58.2	15,618,908	100
Lao PDR	8,746,487	42.2	8,544,584	41.3	20,712,008	100
Thailand	3,038,772	16.1	2,990,087	15.9	18,827,978	100
Viet Nam	1,664,005	24.7	1,615,670	24.0	6,745,651	100
LMB	22,723,966	36.7	22,242,433	35.9	61,904,545	100



Social consequences of deforestation

Deforestation has serious social consequences. In Lao PDR, for example, over 85 percent of the population are estimated to be highly dependent on forest products for food, fuel and cash income. When forests are destroyed, local people who relied on them must generate more cash to buy food, malnutrition may result, and even the quality of drinking water may decline. Gathering fuelwood also becomes harder, taking time away from other activities. If farmers take over deforested land, previously common property is lost to local communities. Ethnic minority groups tend to suffer the most severely when forests are cut because they are often pushed into increasingly marginal areas where subsistence is even more challenging.



Environmental consequences of deforestation

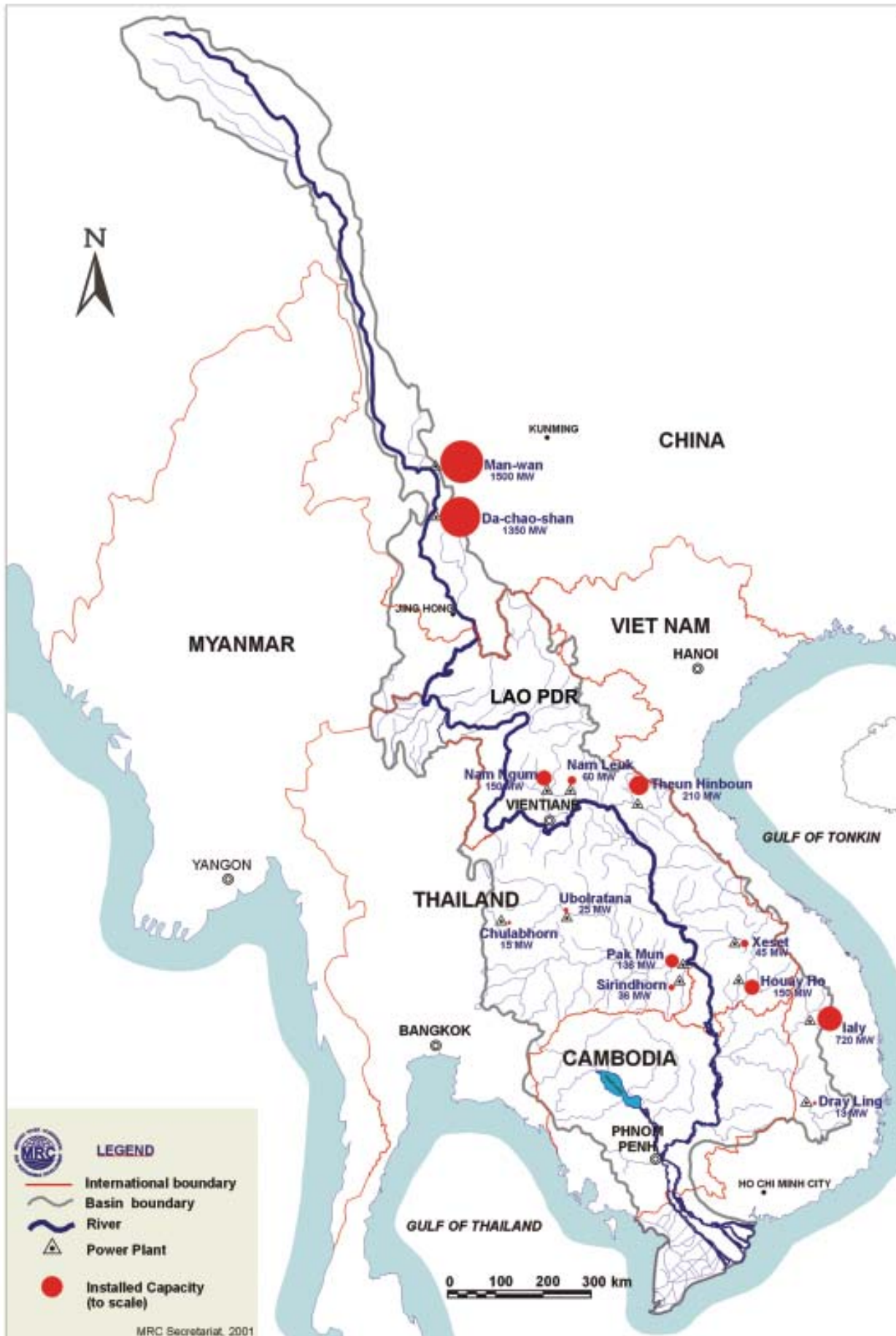
The most direct environmental consequence of deforestation is the loss of forest life. Insects and small plants are the species most frequently lost when forests are cleared. As to whether deforestation causes soil erosion, landslides and floods, studies show that impacts depend on a variety of factors. These include:

- the way the forest is removed – bulldozers cause more problems than logging methods which do not compact the earth
- the seasonal timing of removal – consequences appear greater if logging takes place in the wet season
- subsequent use of the land – young, regenerating forests take up more water than mature forest
- replacement of forest with grassland or paved areas may result in higher water flows in the wet season and lower flows in the dry season.

While research has documented all these impacts on water flows in relatively small catchments, they have not been found in large river basins – perhaps because the location and timing of rainfall varies too greatly in large tropical catchments and masks the impacts of changes in vegetation.



Figure 1. Completed hydropower projects in the Mekong Basin (10MW<)





Hydropower

The hydroelectric potential of the Mekong and its tributaries is considerable and largely undeveloped. In the 1960s, the Committee for the Investigation of the Lower Mekong Basin (known as the Mekong Committee) carried out extensive research and planned more than a dozen hydroelectric projects on the Mekong mainstream but none of these were actually built due to decades of war and civil unrest. Although war and isolation in the region ended in the 1990s, so far only 5 percent (some 1,600 megawatts-MW) of the lower basin's hydroelectric potential of approximately 30,000 MW have been developed, and these few projects are all on the tributaries. The only dams on the Mekong's mainstream are two in the upper basin in China, although more are under construction.

When the Mekong River Commission replaced the Mekong Committee in 1995, the focus changed. MRC was established as a river basin management organisation, with as much emphasis on sharing resources equitably and sustaining the environment, as on developing resources.

Evidence of this change can be seen in MRC's Hydropower Development Strategy that treats hydro

potential as one of many renewable natural resources and considers both the benefits and the adverse consequences of hydroelectric development. The objectives of the strategy are grouped into three strategic areas: consideration of integrated water use and environmental and socio-economic factors; efficient hydropower generation and distribution mechanisms; and information system and capacity building.

The state of hydropower development in the Mekong Basin

Of the total potential of 30,000 MW for feasible hydropower projects in the LMB, approximately 13,000 MW are on the Mekong's mainstream, and the remaining potential is on the tributaries (13,000 MW on tributaries in Lao PDR, 2,200 MW on tributaries in Cambodia and 2,000 MW on tributaries in Viet Nam). In the Upper Mekong Basin in Yunnan Province in the People's Republic of China, total hydro potential is an estimated 23,000 MW. The hydro projects currently built in the Mekong Basin are shown in Figure 1 and their capacity is listed in Table 1.

Concern about the development of hydropower projects in the basin has grown in recent years and civil society groups have criticised plans to develop more hydro projects.

In signing the 1995 *Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin* that established the Mekong River Commission, member countries all agreed that before any hydro project can be built on the mainstream of the Mekong, all four members must agree. Although MRC members are only required to notify each other of their intention to build a project on a tributary, the 1995 Agreement obligates members to ensure that no harmful effects will occur downstream in neighbouring countries. Increasingly, MRC has been called upon to facilitate dialogue among governments and other stakeholders to ensure that transboundary impacts are considered.

Demand for electric power

It is estimated that the electric power demand in the whole Mekong Region will increase by an average of about 7 percent annually to 2022. In order to meet such sharp growth in demand, current electric generating capacity is expected to quadruple by then.

Status of hydropower development

Most of the power generation projects currently planned in Thailand and Viet Nam will be powered either by coal or natural gas. Some hydropower projects are planned as well on tributaries of the Mekong in Lao PDR and in Viet Nam. A small-scale run-of-the-river project is under consideration for the mainstream at Khone Phapheng Falls in Lao PDR, but this does not involve damming the river. No plans are actively being considered for hydropower projects that would involve damming the mainstream in the Lower Mekong Basin, and tributary projects will be limited for reasons that include:

Difficulties in finding funds

Hydropower projects generally require high initial investment and a long payback period (the payback period for a hydro project is typically two or three times longer than that for a thermal project). In recent years, because investment costs are so high and hydro projects can have adverse impacts on the environment and on local people, international funding agencies have been much less willing to fund projects.

Undeveloped power market

Most of the hydropower potential in the Lower Mekong Basin is in Lao PDR and Cambodia, but these countries do not have a large enough domestic market (demand) to warrant developing large-scale projects. In the longer term, a regional



power network could enable Cambodia and Lao PDR to sell power to neighbouring countries with greater need for power. In the short term, only isolated hydro projects intended largely for one-way power export are likely to be developed. In these cases, developers must demonstrate that their projects are competitive with other power producers.



Environmental and social impacts

Development of the Lower Mekong Basin's hydro potential is likely to take some time because extensive investigations into the social and environmental impacts of proposed developments must be undertaken to insure that projects will not have adverse impacts. Assessing possible transboundary impacts is particularly challenging. Weighing the pros and cons of projects is difficult because too often emphasis is placed either on the economic benefits or on the negative consequences, without a balanced appraisal of both.

Negative impacts of hydro projects include: changes in the volume and timing of river flows; decline in water quality; loss of biodiversity; loss of fisheries; blocking of the flow of sediment; resettlement of populations and loss of livelihoods.

Positive impacts of hydro projects include: harnessing of a renewable natural resource; lower levels of air and water pollution than occurs when fossil fuels generate power; increasing water flows in the dry season and reducing peak flows in the flood season; generating the electricity needed for economic development and improving living standards; and increasing government revenues through the sale of power to neighbouring countries.



flow pattern, blocking of sediment and impacts on the environment have occurred. The reduction in suspended sediment concentrations resulting from sediment trapping in Manwan Dam is already apparent as far downstream as Pakse in southern Lao PDR. The next two projects, Xiaowan and Nuozhadu, will have much larger reservoirs and could also change the river's flow on a seasonal basis.

Hydropower development in China

China currently has plans to construct six dams/power stations, in addition to the two that are already operating. These are listed in Table 2.

Now that the first two dams, Dachaoshan and Manwan, have been constructed and are operating, some downstream impacts such as changing of the river's

Sharing data among countries on a common river system is crucial. On 1 April 2002, China signed an agreement with MRC to provide data on river levels at two stations located on the Upper Mekong in China. Though the information provided by China is still limited, this agreement is an important first step in establishing cooperation between China and downstream countries.



Table 1. List of completed hydropower projects (10 MW<)

Country	Name	Location	Capacity (MW)	Output (GWh/year)	Commissioning
China	Manwan	M	1,500	7,870	1993
	Dachaoshan	M	1,350	5,930	2001
Lao PDR	Nam Ngum	TR	150	900	1971-85
	Xeset	TR	45	150	1991
	Theun Hinboun	TR	210	1,645	1998
	Houay Ho	TR	150	600	1999
	Nam Leuk	TR	60	184	2000
Thailand	Sirindhorn	TR	36	115	1968
	Chulabhorn	TR	15	62	1971
	Ubolratana	TR	25	75	1966
	Pak Mun	TR	136	462	1997
Viet Nam	Dray Ling	TR	13	70	1995
	Yaly	TR	720	3,642	2000

Note: TR = tributary and M = mainstream

Table 2. List of planned and completed hydropower projects on the Mekong in China

Name of Project	Installed Capacity (MW)	Annual Generation (GWh)	Total storage C. (million m ³)	Catchment Area (km ²)	Average Flow (m ³ /s)	Commissioning
Gongguoqiao	750	4,670	510	97,300	985	
Xiaowan	4,200	18,540	15,130	113,300	1,220	2010-12
Manwan	1,500	7,870	920	114,500	1,230	1993
Dachaoshan	1,350	7,090	880	121,000	1,230	2001
Nuozhadu	5,500	22,670	24,670	144,700	1,750	2013-16
Jinghong	1,500	8,470	1,040	149,100	1,840	2012-13
Ganlanba	150	1,010		151,800	1,880	
Mengsong	600	3,740		160,000	2,020	
Total	15,550	74,060				



Trade and transport

In the Lower Mekong Basin, water transport has traditionally been the principal means of travel for much of the population. Although the 15 m high Khone Falls on the border between Lao PDR and Cambodia prevents boats from passing, on each side of the falls, boats are used to transport both people and goods for hundreds of kilometres. As the economies of the LMB countries grow, not only will river trade between them increase, but shipping beyond the lower basin will increase as well.

River transport can move people and cargo at costs that are lower than road and air transport, and river facilities are less expensive to build and maintain than road and rail networks. If proper precautions are taken to protect the environment, river transport can be more environmentally friendly than other forms of transport, both in terms of less intrusive infrastructure and with regards to fuel economy, which in turn results in less air pollution.

Importance of inland waterway transport to remote communities

More than one-third of populations living along the Mekong in Cambodia and on its tributaries in Lao PDR, live further than 10-11 km from a year-round road. For such communities, the river is the only means of transport. Some 1.36 million Cambodians are totally

dependent on inland waterways for transportation. In Lao PDR, an estimated 320,000 people depend on water transportation for most of the year. In Viet Nam about 73 percent of the region's cargo tonnage and about 27 per cent of its passengers travel by water. Thailand, which has the benefit of extensive all-season roads, makes the least use of water transport on the Mekong.

Trade benefits of river transportation

In 2001, trade valued at an estimated US\$4,700 million was transported in the LMB on the Mekong River and its associated waterways. Trade between Thailand and Lao PDR totalled US\$350 million; between Thailand and China (Yunnan Province) US\$88 million; in and out of Cambodia, US\$235 million; and in and out of the Mekong Delta in Viet Nam (excluding trade with Cambodia), US\$4,000 million. Thailand has been using the river to transport a growing proportion of its bilateral trade with Yunnan Province in China. In a single year, the value of this trade more than doubled, from US\$43.21 million in 2000 to US\$87.85 million in 2001.

In Viet Nam, some 90 percent of the export tonnage of rice and some 60 percent of the export tonnage of fruit and vegetables (fresh and processed) originates in the Mekong Delta and is transported on inland waterways.

At US\$4,000 million, the trade moved annually by water in the delta represents nearly 20 percent of Viet Nam’s foreign trade.

River navigation conditions

All sections of the Mekong River and its associated waterways are navigable during the high water season (i.e. for about eight months of the year), with the exception of a 14-km section, just north of the border between Cambodia and Lao PDR, which contains the impassable barrier of the Khone Falls. Unlike many of the world’s great waterways, the flow and depth of the Mekong is essentially unregulated with the exception of dredging in a very few locations, bank protection, port facilities and the installation of navigational aids.

Inland ports and intermodal connections

Port facilities in the LMB range from crude, makeshift landings formed by boats moored side by side against the riverbank, to concrete quays equipped with modern cargo handling technology. The most sophisticated facilities are those of the five maritime bulk-handling ports in the Viet Nam Delta. All 25 major ports in the LMB, with the exception of two between Vientiane and Luang Prabang, are connected to main (either national or provincial) roads. However, the density of road networks near ports varies widely. Roads are most numerous in Thailand, and least numerous in Lao PDR and Cambodia.

Growth and composition of inland waterway vessel fleets

Over the past five years, MRC research indicates that there has been little change in the size of the overall fleet in each LMB country. The Mekong Delta in Viet Nam has the largest number of registered vessels (some 60,000) and this is twice the number registered in 1997.



IWT traffic and modal share analysis

Although data are hard to obtain with regard to IWT’s share of cargo and passenger traffic, estimates indicate that use of IWT is declining in all LMB countries, except for Lao PDR. IWT is the dominant mode of transport only in the Mekong Delta in Viet Nam, and then only for cargo transport. IWT passenger volumes are declining for all countries, except in Lao PDR, due to expansion of road networks. However, even with road improvements in the

Viet Nam Delta, IWT is likely to remain the dominant transport mode due to its advantages in moving bulk cargo.

Cargo traffic between Simao (Yunnan Province of China) and the Thai ports of Chiang Saen and Chiang Khong has been growing at a very rapid rate (40 percent per year), but the tonnage is still only a fraction of the total volume of trade between Yunnan and Thailand. Most shipments between the two countries travel by road or rail to the coast and then by ship. Thus, there appears to be a major opportunity to increase shipping on the Mekong as costs would be lower.



Government transport policies and IWT development

Although studies conducted in the United States of America and elsewhere have demonstrated that inland barge transport is at least three and a half times more energy efficient than truck transport, and 1.7 times more energy efficient than rail transport, the LMB continues to favour road transport. In some cases, IWT operators are charged three times the applicable road transport charges for the same volume of traffic.

Despite the environmental and economic advantages of IWT, official transportation expenditures appear to favour land over water transport. In three of the four LMB countries, inland waterways attract less than 1.5 percent of total expenditures on waterways and roads, while IWT is used to carry 73 percent of all cargo tonnage in the Mekong Delta Region of Viet Nam, 45 percent of all cargo tonnage between Thailand and Lao PDR, 31 percent of all cargo tonnage within Lao PDR, and 17 percent of all cargo tonnage within Cambodia.



Potential for increased international navigation

There appear to be few institutional difficulties impeding navigation between basin countries. If all institutional impediments were removed, the port of Phnom Penh could capture a major share of international cargo traffic originating from, or bound for, countries to the northeast of Cambodia, especially China, Japan, the Philippines and the Republic of Korea, as well as to and from Singapore and Viet Nam.



Navigation and the environment

Of the four LMB governments, only Thailand appears to have and apply regulations to deter operators from discharging fuel or other liquid or solid waste into waterways or onto adjoining land. No agency can respond quickly to clean up a spill.

In Viet Nam, all new projects involving dredging or development of infrastructure, in and beside waterways, are now required to undergo an Environmental Impact Assessment (EIA). In Thailand, EIAs are required for port development projects designed to handle vessels of more than 500 DWT. In Cambodia and the Lao PDR, there appears as yet to be no requirement for EIAs to be completed for inland waterway projects.

Better monitoring, coordination and control of navigation activities can contribute significantly to a better environment by reducing shipping accidents and regulating the movement of dangerous and toxic substances. For example, the provision of specialised port facilities can eliminate the risks involved in the beach landings of petroleum tanker barges where no such specialised facilities exist. In addition, the introduction of common rules and regulations will reduce the frequency of collisions and with it the risk of pollution.





Domestic water and sanitation

If volume were the only consideration, use of the Mekong Basin's water for domestic purposes and sanitation would be of small importance. Its demands represent no more than 5-6 percent of all ground and surface water used for any purpose in the basin, and water used for all purposes is only 10 percent of the water flowing from the river's mouth. However, from other perspectives, domestic water and sanitation are of very high importance because they impact human health, productivity and efforts to reduce poverty.

Low access

Average population coverage figures for water supply for the period 1990-1996 indicate that Cambodia had approximately 36 percent coverage (ranking it 89 out of 101 countries globally); Lao PDR had 52 percent coverage (ranking it 74th); Thailand 89 percent coverage (ranking it 19th); and Viet Nam 38 percent coverage (ranking it 84th). Comparable sanitation coverage figures for the year 2000 were 14 percent for Cambodia (ranking it 97th out of 101 countries); 28 percent for Lao PDR (ranking it 78th); 96 percent for Thailand (ranking it 6th); and 21 percent for Viet Nam (ranking it 87th).

The combined global ranking for "potential exposure to polluted water" placed Cambodia 89th out of 101

countries, Lao PDR 76th, Thailand 18th and Viet Nam 86th. Although the data for Thailand and Viet Nam are for the whole country, circumstances in their LMB territory are likely to be worse, not better. Thailand appears to be only one of seven countries worldwide where sanitation coverage is higher than that for water supply.

Inequities in access

Data show that rural services lag far behind urban ones. In Cambodia and Lao PDR, for example, rural water supply coverage is half or less that available in urban areas. For sanitation, coverage in rural Cambodia is only one-sixth of that in urban areas. In Lao PDR, the ratio of rural/urban coverage is less than 40 percent. The very poor fare worst of all. In Cambodia, for example, only 1 out of 25 of the poorest 20 percent in rural areas have access to improved water supply, and even fewer to improved sanitation.

Country and basin-wide issues

Factors that impact the provision of domestic water and sanitation in the LMB include:

Drought – a problem periodically in Northeast Thailand, which could grow worse if Mekong water is diverted into the Chao Praya River system.

Saline intrusion – tidal water threatens domestic water sources as well as agriculture in the Mekong Delta in Viet Nam. If dams and irrigation upstream reduce river flows, seawater intrusion could become worse.

Deteriorating infrastructure – water and sanitation infrastructure is reaching the end of its working life in many communities, and requires extensive funding for rehabilitation.

Deforestation – logging and clearing of land for agriculture can reduce replenishment of groundwater and increase sediment in surface water.

Irrigation – extraction of water for irrigation can deplete groundwater supplies and compete for surface water.

Climate change – could increase evaporation and reduce precipitation, which could in turn reduce surface and groundwater supplies.

Contamination of water sources – there is little data available on the extent of water source contamination in the LMB, but threats to both ground and surface water quality include human and livestock waste, pesticides, flooding and saline intrusion.

Surface water contamination

Deforestation, floods, mining, and oil exploration can all increase sediment and/or pollution in surface water and with it, the costs of treating surface water. Chemical spills from shipping accidents are a threat as are algae blooms that occur when human wastes or fertilisers raise levels of nutrients in water.

Groundwater contamination

Shallow wells are more vulnerable to surface pollution than deeper ones. Threats specific to groundwater include poor maintenance, contamination during use and arsenic. Contamination is particularly serious since so many rural people rely on groundwater and contamination is slow to dissipate and costly to manage.



Monitoring and managing domestic water quality in the LMB

Testing of drinking water quality is still limited due to lack of equipment and skilled personnel. Positive trends include the recent development of national drinking water standards in Viet Nam and Lao PDR and ongoing development in Cambodia (Thailand has had standards for some years). Local monitoring of drinking water quality is increasing in rural areas, leading to early and appropriate action. There is still little systematic monitoring of impacts from arsenic, fluoride, pesticides, nitrate from fertiliser, and other chemical pollutants.

Arsenic

The areas at most risk in the LMB appear to be along the valley and floodplains of the Mekong/Tonle Sap/Bassac and deltaic areas. Exactly how arsenic is released into groundwater is not yet clearly understood, making exact predictions difficult. However, risks in the LMB could be lower than in other countries because improved wells have been developed more recently and the use of potentially arsenic-contaminated waters may have been less universal and for shorter periods. If timely and appropriate action is taken, health problems need not be as serious as they have been elsewhere.

Water treatment

Little data is available on water treatment. However, it is generally required for all surface water that inevitably becomes contaminated by animal wastes, even in areas where human waste is less of a problem. Surface water cannot, and indeed should not, be maintained at drinking water quality. However, maintaining reasonable quality is important to keep treatment costs down and to reduce the risks to people bathing, swimming, boating, fishing and laundering in water courses.



Data on diseases related to lack of domestic water and sanitation

The high frequency of gastro-enteric, worm related and other diseases in the LMB is linked with poor levels of domestic water supply, sanitation and hygiene, particularly in rural areas. These diseases exacerbate the effects of poor nutrition and the ravages of other diseases. It has been estimated that improvements in safe water supply, and in particular improvements in hygiene and sanitation, could reduce the incidence of serious diarrhoea by one-fifth and deaths due to diarrhoea by one-half. Between 1960 and 1999, Thailand reduced deaths related to gastro-intestinal illnesses 16-fold by increasing sanitary latrine coverage from less than 1 percent to over 98 percent.

Challenges in improving access

Demand for domestic water is expected to grow by 50 percent over the next ten years. With the LMB population projected to grow to as much as 90 million by 2025, and much of the population spread out in rural areas, communities will find it difficult to maintain current levels of service, let alone expand coverage. Providing coverage in urban areas, especially low-income areas, is particularly challenging because of high levels of migration from rural areas. It is clear that achieving the international target of halving the proportion of people without access to improved water and sanitation services by the year 2015 will require enormous effort within the basin.





Floods in the Lower Mekong Basin

Floods are a regular event in the Lower Mekong Basin. Flooding of the mainstream and tributaries of the Mekong River is an important contributor to the wealth of biodiversity, abundance of fish and soil fertility. Each year, flooding also results in loss of life and property, causes damage to agriculture and rural infrastructure and disrupts the social and economic activities of people living throughout the basin. Flood management and mitigation (FMM) has become a priority issue at the national and regional levels, particularly in the aftermath of the disastrous floods of 2000 and 2001.

Nature and extent of flooding

Climate, and particularly the southwest monsoon, is the immediate cause of the annual floods. The level of the Mekong starts to rise in May and reaches its peak in mid-August or early September in the upper areas of the lower basin, and in mid-September or early October in the delta region.

According to MRC estimates, 80 percent of the rural flooding and 20 percent of the urban flooding is caused by tributaries. The four major flood prone areas in Lao PDR are situated along the mainstream near large tributaries: 1) Vientiane Plain, 2) Khammoune Province (Thakhek town), 3) Savannakhet Province and 4)

Champasak Province (Pakse town). In Thailand, the principal flood-prone areas of the LMB include low-lying areas along the Mekong and tributaries in Nong Khai, Mukdahan, Nakhon Phanom and Ubon Ratchasima provinces. In Cambodia, 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 Viet Nam, flooding in the delta is influenced by tidal effects, combined with high discharge from the Mekong River and heavy rain in the delta itself. Flooding frequently inundates the entire floodplain in the Vietnamese delta, that is, up to 1.8 million ha.

Causes and factors contributing to flooding

Climate change is likely to be contributing to increased frequency and intensity of severe flooding, particularly in low-lying coastal and estuary areas. Warmer water temperatures in the South China Sea may increase the number and intensity of typhoons, in turn causing sea surges that inundate low-lying delta areas. However, climate change could also result in less rainfall in some parts of the basin and thus less flooding.

Figure 1. Extent of flooding in Cambodia and the Viet Nam Delta, 2000



Deforestation and land clearance in upland areas of the basin can result in increased volume and speed of surface run-off – circumstances which are more pronounced along tributaries of the Mekong.

Changes in flood storage capacity: the cumulative effects of many embankments to prevent floods can result in the loss of a significant volume of floodplain storage that causes increased discharge and higher flood levels, both upstream and downstream.

Reclamation of floodplains and wetlands results in the loss of floodplain storage.

Rapid expansion of urban settlements and infrastructure replaces natural vegetation with sealed surfaces such as roads, roofs of homes and other buildings. This can reduce the time between intense rainfall and peak stream flow, resulting in greater peak flows and risks of sudden floods. Roads, bridges and culverts can also contribute to flooding if this infrastructure impedes natural drainage patterns.

Channel migration and other modifications to river channels: due to erosion and sediment deposition modifications can, as at Kampong Cham, destroy flood banks that presently protect large areas of the town from inundation during annual floods. Similarly, dredging and other modifications to river channels can affect peak discharges during the flood season.

Environmental benefits of floods include:

- silt deposits that add nutrients to agricultural soils
- flushing out of pollutants that are deposited in the mainstream and tributaries during low flow periods
- refilling floodplain wetlands and recharging groundwater reserves
- maintaining of the river's ecosystem, including breeding, nesting, feeding and nursery areas for fish, waterfowl, and other wildlife and vegetation that local people rely on for food and household use.
- maintaining the physical form and depth of the river channel by flushing out fine deposited material, cleansing gravel beds and resetting the vegetation on islands.



Economic and social costs of flooding

Immediate damage and loss of life

In 2000, severe flooding affected 22 of the 24 provinces in Cambodia, with a death toll of 347 people, of whom 80 percent were children. Over 3.4 million people were affected, and physical damages totaled US\$161 million. In Lao PDR in 2000, preliminary estimates indicated that nearly 395,600 people were seriously affected in 1,200 villages in seven provinces. An estimated 10 percent of the wet season production was completely lost. Irrigation systems and rural road infrastructure were widely damaged, as well as large parts of provincial towns. Production losses amounted to approximately US\$20 million. In the Thai portion of the Mekong Basin, losses in 2000 amounted to about US\$21 million. In 2001, Udon Thani was particularly hard hit by flooding, with 2.8 million people affected, 47,350 km² of farmland inundated and 5,300 km of roads damaged. In the Mekong Delta in Viet Nam, over 500 people died due to the 2000 floods. A total of 5 million people were affected, 825,000 homes damaged or destroyed, and thousands of kilometers of national and provincial roads were damaged. The total costs of flood damage amounted to US\$285 million.



Longer term impacts of floods

In addition to these direct costs, flooding causes significant indirect and cumulative effects. In the immediate aftermath of floods, the lost production of rice and other food crops means months of insufficient food for many households. The lack of grazing lands forces farmers to sell livestock at low prices. The time required to regrow damaged fruit and plantation trees means lower incomes for several years.

Official government figures for flood damage do not include the costs to households to repair or replace their damaged housing and crop storage facilities. Transportation costs increase when damaged roads and bridges cannot be restored quickly, causing increases in the prices of some goods and services. This, in turn, undermines trade and production efforts.

Damaged hospitals and clinics seriously limit the availability of health services at a time when the risk of flood-related diseases is high. Children frequently lose many weeks of education as schools are flooded or damaged and individuals suffer increased stress-related problems. Following floods, there is often increased rural-urban migration of flood-affected people seeking work.



The impacts of flooding on the poor are particularly significant. In Cambodia, for example, rural households generally have one hectare of rice land. The loss of 350,000 ha of paddy during the 2000 floods meant that a very large number of households lost their primary asset for assuring their own food security, as well as for generating cash income. Catastrophic events such as this often cause households to sell their land in order to buy food or other essentials, with significantly higher risks that they will fall below the poverty line or not be able to get out of poverty.





Cooperation in the Mekong Basin

Cooperation is crucial

Where countries share boundaries they are often impacted by each other's actions and this is particularly true in a river basin. Water diversion upstream may reduce water availability downstream. Because fish migrate to spawn and feed, pollution in one spot may reduce the fishery throughout the river. Flood protection infrastructure in one country may exacerbate flooding in others. Barriers to stop seawater intrusion may also stop the upstream movements of fish.

If the citizens of countries that share a river basin are to live peacefully and equitably with each other, a commitment to transparency, trust and cooperation must develop between them. However, fostering these qualities is challenging in the Mekong Basin. Six countries share the basin and they have differing political, economic and social systems. Some also have a history of conflict with each other. While development of water and other resources is crucial to raise low standards of living, this may spark competition within and among countries. To ensure that resource uses are sustainable from an economic, environmental and social point of view, water resource development must be planned, managed and monitored collaboratively and on a basinwide level.

Beginnings of cooperation – the Mekong Committee

Formal cooperation between Cambodia, Lao PDR, Thailand and Viet Nam has been under way for decades. In 1957, with support from ECAFE, the Economic Commission for Asia and the Far East (now called ESCAP, the United Nations Economic and Social Commission for Asia and the Pacific), the four LMB countries set up the Committee for Coordination of the Investigation of the Lower Mekong Basin (generally known as “The Mekong Committee”).

In the 1950s and 1960s, in order to develop one of the world's great ‘untamed’ rivers, ECAFE and the Mekong Committee jointly conducted surveys of the basin's geology, hydrology, meteorology, topography, sedimentation, fisheries, agriculture and navigation. These led to the development of an Indicative Basin Plan in 1970 and identification of 181 potential projects worth an estimated US\$12,000 million. For a variety of reasons, including conflict in some of the countries in the basin, few of the Mekong Committee's ambitious projects were ever realised. However, the plan did lay the foundations for collaboration among LMB governments in natural resource planning.



The Mekong River Commission

In 1995, the four LMB governments established a new organisation – the Mekong River Commission (MRC), with a much broader mandate than the preceding Mekong Committee, and managed by the four countries themselves, rather than under the direction of the United Nations. MRC’s vision for the basin and its mission statement commit the organisation to equitably sharing resources and sustaining both the environment and human welfare.

MRC’s Vision for the Mekong Basin: An economically prosperous, socially just and environmentally sound Mekong River Basin

MRC’s Mission Statement: To promote and coordinate sustainable management and development of water and related resources for the countries’ mutual benefit and the people’s well being by implementing strategic programmes and activities and providing scientific information and policy advice

Cooperation to promote economic development

Although MRC and its predecessor, the Mekong Committee, have the longest history of promoting cooperation in the LMB, since the 1990s, other international agencies have launched programmes in the basin. Initially these focused on regional economic cooperation, but since 2000, the focus has broadened to include environmental protection, flood management and mitigation, and other important concerns.

The United Nations Economic and Social Commission for Asia and the Pacific has the longest history of promoting economic development in the Mekong Region. Under its predecessor, ECAFE, it helped establish the Mekong Committee. In 2000, ESCAP declared 2000-2009 the Decade of Greater Mekong Sub-region Development Cooperation, in order to attract international support for economic and social development in the basin.

ASEAN, the Association of Southeast Asian Nations, also fosters economic cooperation in the basin. In keeping with ASEAN’s focus on raising standards of

living and closing the gap between the original members and the newer (and poorer) ones, ASEAN inaugurated the Basic Framework of ASEAN-Mekong Basin Development Cooperation in 1996. This identifies infrastructure, trade and investment activities, agriculture, forestry and minerals, industry, tourism, human resource development, and science and technology as priorities. It also seeks to complement the development initiatives of other Mekong-related multilateral agencies.

The Greater Mekong Subregion (GMS) Economic Cooperation Programme is the largest initiative to promote regional economic cooperation. It was set up in 1992 by the Asian Development Bank to encourage trade and investment among GMS countries, resolve or mitigate cross-border problems and meet common resource and policy needs. All four Lower Mekong Basin countries are members, as well as Myanmar and Yunnan Province of China.

In its first decade, the GMS Programme focused on transportation, energy, telecommunications, human resource development, tourism, environment, and promotion of trade and investment, with loans and technical assistance totalling US\$2,000 million. For its second decade, agriculture and water resource management have been added to the list of priority sectors.



Other agencies promoting economic cooperation include the GMS Business Forum, established by ESCAP and ADB/GMS in 2000 to promote private sector cooperation and the Mekong Tourism Forum, also established by ADB/GMS and ESCAP, to encourage basin-level tourism development.

Cooperation to promote environmental sustainability

A number of international organisations have developed basin-level initiatives to promote environmental sustainability and natural resource conservation. These include the World Conservation Union (IUCN), the World Wide Fund for Nature (WWF) and the Oxfam Mekong Initiative (OMI). All of these agencies have long histories of promoting cooperation to sustain the environment in individual Mekong countries, but fostering regional cooperation is relatively new.

In the 1990s, when the coming of peace to the LMB renewed interest in large-scale infrastructure projects such as regional highways and dams, IUCN began helping governments and development agencies to conduct baseline studies in environmentally-fragile areas such as wetlands and watersheds. IUCN has also been working with local communities in fragile areas to develop sustainable livelihoods such as eco-tourism. In 2003, in partnership with MRC and UNDP, IUCN began a five-year, US\$32.6 million programme to promote regional cooperation in assessing and conserving biodiversity.

In 2002, WWF launched its five-year Indochina Strategy that encompasses Cambodia, Lao PDR and Viet Nam. The goal of this is to ensure that biological diversity is valued and conserved by current and future generations. WWF has also identified the Mekong River as one of its Global 200 Highest Priority Ecoregions and featured the Mekong as one of five “Living Rivers” in its worldwide “Living Waters Campaign”. In 2002, MRC and WWF signed a memorandum of understanding that allows the two



organisations to work together in a number of areas of common interest intended to meet the needs of the people, but at the same time ensure the long-term sustainability of the river and its related resources.

Oxfam’s Mekong Initiative (OMI) works in all six Mekong countries on four thematic issues: trade, poverty reduction, infrastructure and capacity building. At a time of rapid development with transboundary impacts, OMI works with local-level NGOs to ensure that people have a voice in planning, managing and monitoring what happens to their resources and their communities.

The initiatives of all the agencies just described are strengthening the capacity of governments, civil society groups and other key stakeholders to work together at a regional level in finding solutions to basin-wide and transboundary environmental problems, and in continuing this collaboration for the long term.

The challenge of cooperation

The Mekong Basin is a complex region politically, socially and in terms of its environment. There are many players: international organisations such as ASEAN, ESCAP and MRC, six national governments, and many provincial and local level government organisations. In addition there are development support organisations such as the World Bank, the Asian Development Bank and many national donors. Civil society organisations range from the large international ones such as IUCN, WWF and Oxfam to small local groups such as unions, cooperatives and conservation groups.



To be successful, any planning process must achieve some sort of consensus on what the basin should be. The technical aspects of planning, development and environmental management are relatively simple in comparison with the challenge of identifying preferred outcomes for the basin.

Outcomes range from that of a completely pristine basin with intact ecosystems – a kind of wilderness with almost no people – to a basin covered in concrete and factories, with a polluted river reduced to a chain of reservoirs. Neither extreme would be acceptable to most of the people in the basin. The challenge lies in achieving consensus regarding where, between these two extremes, the level of development should fall.

The six countries that share the Mekong basin have differing development goals and these are not always in accord with each other, or with those of people at the village level. Nor do the goals of government necessarily match those of civil society groups. Because of these differences, it is now recognised worldwide that successful planning must be inclusive and take into consideration the needs and aspirations of all stakeholders.

The MRC's Basin Development Plan project is one recent initiative that is working to develop an inclusive planning process. However, achieving this goal will not be easy. Even in developed countries with far greater resources, inclusive planning processes have been difficult to achieve. Usually plans leave some stakeholder groups dissatisfied, and none achieve all of their goals.



The first step towards effective planning is the building of collaborative relations across the basin, and this requires understanding, trust and breadth of vision. Fortunately, unlike many other regions in world, a start has been made in the Mekong Basin while the river is still in good condition and natural resources are still abundant.

