

Lower Mekong Basin —Existing environment and development needs—

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Abstract. 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 organisations providing development support. The six countries within the Mekong Basin have different national development goals. The visions of development held by national governments do not always accord with development visions of people at the village level. Plans of government agencies may not match the views of civil society groups. There is now broad recognition throughout the world that successful planning must be inclusive, and take into consideration the needs and aspirations of all the stakeholder groups. The MRC Basin Development Plan project is one recent initiative that is working to develop an inclusive planning process for the four Lower Mekong Basin countries. However, the achievement of that goal will not be easy. Even in developed countries with far greater resources of time and money, inclusive planning processes have been difficult to achieve. Inevitably the plans produced leave some stakeholder groups dissatisfied, and usually no group achieves all it wants. The first step in effective planning is to build cooperation across the basin. There is a need for greater understanding, trust and breadth of vision. The advantage that the Mekong Basin has over many other regions is that a start has been made while the river is still in good condition, and there are still sufficient natural resources available in the basin. It should be easier to limit degradation and loss of resources than to restore degraded systems. However, the longer we wait the more difficult it becomes. The Mekong River system is still in good condition and basin wide cooperation at all levels is crucial to ensure that it stays that way.

Keywords: Mekong, environment, development, governance

1 Introduction

The Mekong River is an international river, which runs through 6 countries from China, Myanmar, Lao PDR, Thailand, Cambodia, to Vietnam (Fig. 1). Social strife in this geopolitical region has taken heavy toll on its people from decades of cold war, the Vietnam war, the Cambodian civil war as well as some border conflicts throughout the years. As results, this region was thrown in peoples' low living standard, and social development.

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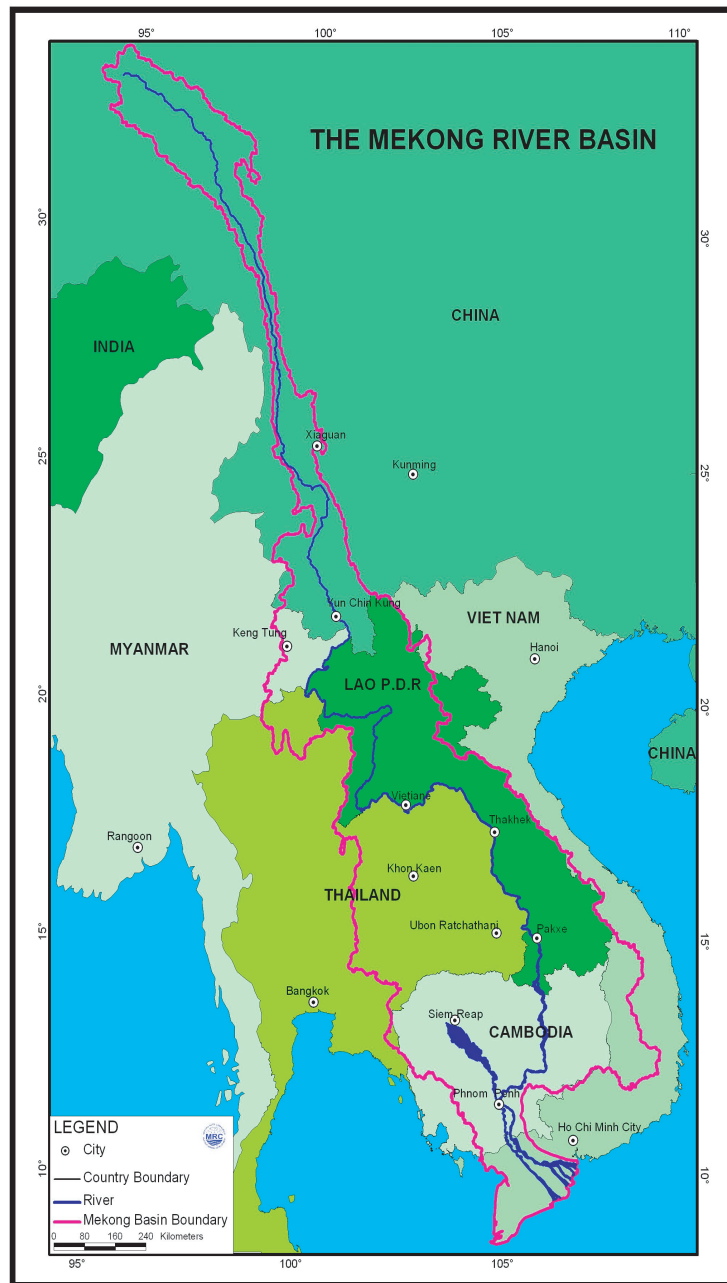


Fig. 1. Topographic Map of the Mekong Basin by Robin Johnston

This research introduces the scope of regional cooperation, the geophysical features and socio-economic situation with a focus on the four Lower Mekong Basin (LMB) countries of Lao PDR, Thailand, Cambodia and Vietnam. The sectors' development possibility (Irrigation and agricultural water management, hydropower, navigation, floods and droughts, water supply and sanitation, fisheries) and the themes for environmental concern (water quality, land and water resources, Tonle Sap Great Lake system, biodiversity, and wetlands) are also introduced. All of these constitute fundamental information for the planning of development, and also contributes to the harmony of development and conservation of the basin.

2 Mekong River Basin

The Mekong River and its tributaries comprise one of the largest river systems in the world. However, living among this natural wealth, 40 million of the Mekong people still live in poverty because of decades of war and long isolation. Yet the Mekong's water and related resources, ones of the regions' greatest assets, are far from full utilization. The volume of Mekong's natural discharge is still vast, despite some diversion for irrigation and dams, and the water quality is still good overall.

Due to these factors, development of the Mekong Basin is necessary to increase people's economic and social well being. In addition, with increasing globalization, and regional economic integration, development is coming to the region quickly and in a big way. Wealth of unexploited resources, pressure from investors, and a rapidly growing population in need of better livelihoods and better standards of living, the pace of development in the basin is increasing quite rapidly. Although exploitation of the basin's resources could be of tremendous benefit to the peoples of the Mekong Basin, it could also cause tremendous hardship if not properly planned, managed and monitored.

An estimated 70 percent of the people who live in the Lower Mekong Basin (LMB) are subsistence farmers. They supplement the rice they grow with fish and plants and animals foraged from nearby forests and wetlands. If the volume of water in the river system is significantly altered, these 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 (MRC, 2003).

3 The Mekong River Commission and regional scheme

The history of the cooperation and development planning of the Mekong riparian states dates back to 1957 when the Mekong Committee (MC) was established, under the auspices of the United Nations' Committee for the Coordination of Investigations of the Lower Mekong Basin. The MC comprised the four Lower Mekong Basin countries of Cambodia, Lao PDR, South Vietnam and Thailand. At the time, the

MC was given a coordinating role for the management of resources in the Basin, and served also as mechanism for channelling development assistance.

For twenty years, from 1975 to 1995, the Mekong Committee survived serious geo-political challenges in the region, but with limited development progress in the period. With the onset of peace and stability, the four countries were again able to move positively toward cooperative and sustainable development of the Basin. The commitment to cooperative development was formalized with the signing of the 'Agreement on The Cooperation for The Sustainable Development of The Mekong River Basin' on April 5, 1995. With this agreement, the Mekong River Commission (MRC) was established.

The MRC member countries agreed to cooperate in all fields of sustainable development, utilisation, management and conservation of the water and related resources of the Mekong River Basin, such as navigation, flood control, fisheries, agriculture, hydropower and environmental protection. Since the signing of the Agreement, the MRC, with China and Myanmar as active dialogue partners, has been able to successfully pursue the sustainable development of the basin.

4 The Greater Mekong Sub-regional Economic Cooperation Programme (GMS) and other regional initiatives

GMS was initiated in 1992 by the Asian Development Bank (ADB), Cambodia, Lao PDR, Thailand, Vietnam, Myanmar, and Yunnan Province of China. The programme covers the entire countries and not only parts that lie within the Mekong Basin. The aim of GMS is

1. to realize and enhance development opportunities;
2. to encourage trade and investment among GMS countries;
3. to resolve or mitigate cross-border problems; and
4. to meet common resource and policy needs.

Activities comprise policy guidance at ministerial level, working groups, preparation of sector master plans, and identification of coordinated projects. Priority GMS sectors are

1. transport;
2. energy;
3. telecommunications;
4. environment;
5. human resource development;
6. trade and investment; and

7. tourism.

Among other achievements of the GMS is a 'Strategic Environmental Framework' for integrated environmental and economic management. This framework was developed by ADB in collaboration with United Nations Environmental Program (UNEP) and MRC in 1998–2000. It contains technical, policy, and institutional recommendations and guidelines.

Several other regional and international initiatives to focus on the Mekong region are as follows:

- Association of Southeast Asian Nations (ASEAN: Mekong Basin Development Cooperation scheme)
- Economic and Social Commission for Asia and the Pacific (ESCAP: the 10-years Decade-of-the-Mekong Programme)
- The Global Water Partnership, which has established a Southeast Asian Technical Advisory Committee (SEATAC) to serve as a regional focal point for global exchange of knowledge about integrated water resources management
- The International Union for Conservation of Nature and Natural Resources (IUCN), which has regional programmes on wetlands conservation and protected areas.

5 Mekong Development and Environment

5.1 Water resources geophysical features

The water resources of the Lower Mekong Basin (LMB) are, still little exploited, but with extreme seasonality, and high dependence on instream use by the poor, especially on fisheries which depend on flood pulse. The characteristics of the Mekong are described in the MRC State of the Basin Report (MRC, 2003) as:

Abundance: Annual runoff averages around 475 km³/year. Per capita resources currently is at 8500 m³/person/year—compared with 2200 for the Nile; 1400 for the Rhine; 2265 for the Yangtze and 1700–4000 for the Ganges.

Low level of exploitation for extractive uses: Average annual withdrawals are estimated at 12% of total annual flows (or 60 km³), current volume regulated or stored for hydropower and irrigation is under 5% of annual flow (20km³); volume of water stored in the Lower Mekong Basin is estimated at 230 m³ per person, which is about nine times less than that of China.

High dependence on on-stream and in-stream uses (particularly by the poor): The Mekong fishery is the largest inland fishery in the world, worth at least \$US 2,000 million annually. These fisheries resources make up a major source of protein for the basin's rural poor, estimated at nearly 40 millions people. Inland navigation is also an important mode of transport for many areas where road access is limited.

Extreme seasonality: In most parts of the basin, flows in the driest three months is less than 10% of total annual flows; while flows in the wettest three months make up over 50% of total annual flows.

Importance of the flood pulse for the ecology of the floodplain and the Mekong fishery: During the wet season, 1 to 4 million hectares of floodplain is submerged, including the Tonle Sap Great Lake.

Dry season water shortages: Dry season shortages occur as a result of the rainfall seasonality, concentration of extractions in the driest period and drought events during the onset of the wet season.

Water quality: Water quality in the mainstream is generally good, and is rarely a constraint to water use. The exception is saline intrusion, acid sulphate drainage and pollution in intensively used areas of the Mekong Delta.

Groundwater: Groundwater resources are very widely used as a source for domestic and industrial supply. Use for irrigation is limited, but expanding. Groundwater systems in the flood plain are closely coupled to the river.

Mekong Basin Flows: Flows from China constitute around 16% of total Mekong flows, 2% comes from Myanmar, 35% from Lao PDR, 18% from Thailand, 18% from Cambodia and 11% from Viet Nam (MRC, 2005). The contribution from the upstream countries is higher in the dry season, when snow melt contributes a significant component of flow.

5.2 Socio-economic situation

Social and demographic features: The four Lower Mekong countries have a population of 165 million in totals. However, only 56.6 million live in the Mekong basin part of the countries. Nearly all of Laos PDR and Cambodia's population reside in the Mekong basin, but together they comprise only 19 million or one-third of the basin's population. However, most of the LMB resources lie in the two smaller countries surrounded by larger riparian countries, Thailand and Vietnam, whose whole population together stands over 140 millions, and who are experiencing increasingly scarce resources. About 21 million, or 33% population of Thailand, and 17 million of Vietnam's people (20% of the country's population) live in the Mekong Basin part of their country (MRC, 2005).

It is estimated that two thirds of the basin's population of 56.6 million live in rural areas. These rural dwellers are mostly subsistence farmers who supplement rice and farm crops with natural fish they catch, and other aquatic animals and plants for food. Many other basic needs are also covered by "direct harvest" from forests and wetlands including building materials, materials for basic household tools and medicinal plants. Nearly 40 percent of the people in Cambodia and Lao PDR live under the poverty line. The Mekong Basin part of Thailand is home to 62% of all the poor in Thailand. The number of the poor is also high in the Vietnam Delta, although the depth of poverty is highest in Lao PDR and Cambodia.

The average household size in Cambodia and Lao PDR is 5–6 persons, reflecting a common feature in rural, subsistence households in the LMB. In Thailand, the average household size has dropped from 6 to 4 persons due to declining fertility rates. A similar transition is occurring in Vietnam. Over half of the population of Cambodia and Lao PDR is children and youth below the age of 15 years. This fact reflects a high dependency ratio, meaning that each working adult must support other household members who are non-working and of non-earning age. Overall, women head

Table 1. Projected population growth of the Lower Mekong Basin.

Portion within Mekong basin	2002 population (million)	Annual growth rate (%)	2010 projected population (million)	Source
Cambodia	13.8	2.5	16.8	www.unescap.org
Lao PDR	5.1	2.86	6.4	www.unfpa.org
NE Thailand	21.1	0.87	22.6	www.nso.go.th
Vietnam delta	16.6	0.9	17.8	www.geohive.com
Total	56.6	(Average) 1.54	63.6	

about one-quarter of the households in the LMB. In rural areas, female household heads tend to be widows who lost their husbands in war, or married women whose husbands are away working as migrant labourers. In rural areas of northern Lao PDR, among older household heads, as many as 60–70 percent are women.

The projected annual population growth rates of 2.5% for Cambodia and 2.86% for Lao PDR respectively is likely to result in an additional 4.3 million people by the year 2010. Although the populations of Thailand and Vietnam will grow more slowly, each country has a large pool of young people who will start their own families. This and increased longevity mean that the overall population growth will remain high. In the year 2002 the total population living in the Lower Mekong Basin was estimated at 56.6 million. Projections suggest that the 2010 population will reach 63.6 million, which is equivalent to an overall annual growth rate of 1.54% (see Table 1).

Household incomes vary widely across the basin. In Thailand and Vietnam, there is a significant and widening gap between the incomes of the basin part and those regions outside. This is also true among LMB countries themselves. Incomes in Thailand are three times higher than those in Vietnam and more than four times greater than those in Cambodia and Lao PDR. There are also significant differences within the countries, between regions and in urban and rural areas.

Since the financial crisis in 1997, the North and Northeast Regions of Thailand have experienced significant unemployment and the return of workers who have lost their jobs in urban areas. Urban incomes in Vietnam are nearly four times higher than rural incomes. In Cambodia and Lao PDR, urban incomes are approximately twice the national average. Incomes in the Mekong Delta and the Central Highlands (in Vietnam) are, respectively, 20 and 40 percent below the national average. Income levels remain low in Vietnam, despite strong economic growth during the 1990s. This is also due to very high population densities. In addition, as a consequence of the overall high population density, there is less arable land per capita compared with other LMB countries. Also, benefits from foreign investment and exchange earnings need to be spread over a much larger population.

In general, women in the LMB tend to work at low-paying and more menial jobs. Their overall income levels are 60 to 75% of the men's incomes. Data available for Cambodia and Lao PDR suggest that non-agricultural wage levels for women are about 80 percent of those of men. In Thailand, women working in the public sector

Table 2. Socio-economic trends during the life of the Mekong River Commission (MRC, 2006).

	GDP (USD billions)		Per Capita GDP (USD)		Poverty rate (national line)	
	1995	2004	1995	2004	1993	2003
China	700.2	1,649.4	578.1	1,268.7	6.7	3
Myanmar	5.5	9.1	122.6	167.1	35	25
Lao PDR	1.8	2.4	382.1	415.7	45	33.0
Thailand	168.0	163.5	2,825.7	2,521.2	13.1	<2
Cambodia	3.4	4.4	321.1	314.1	39	36.0
Vietnam	20.7	43.9	288.0	534.8	50.9	29.0

have income levels nearly equal to men, but they earn only about 75% of men's wages in private sector, non-agricultural jobs. In Vietnam, women's wages are 72% of men's, but only 62% of men's in the agriculture sector.

Priorities for future development of water and related resources: The most pressing priority for all the countries in the LMB is to achieve higher levels of economic and social development. The proper use and development of water resources will be a basic environment to achieve this. It needs to be balanced by protection of the water resource to ensure sustainable enhancement of livelihood, environmental sustainability, and equitable distribution of "shared benefits" from development.

This will provide the base for social sustainability and mutual trust amongst the nations of the basin. In addition to the macroeconomic benefits of accelerated growth, properly managed economic development can have a significant positive impact on poverty alleviation in condition with improved governance and transparency. Although, the management of water/related resources is the responsibility of the countries themselves, regional cooperation such as the MRC has a key role in trans-boundary harmonization.

5.3 Flood and hydrology

The definitive feature of the hydrological regime of very large tropical monsoonal rivers, such as the Mekong, is that there is, in effect, just a single annual flood hydrograph in response to the SW Monsoon. On the mainstream and within its larger tributaries the vast geographic scale of the drainage systems means that the runoff responses to the individual storm events caused by monsoonal depressions tend to coalesce and therefore accumulate into a single seasonal flood hydrograph. It is therefore not generally possible to distinguish the runoff response to individual events unless the cyclonic storm system is very intense and regional scale.

Tropical typhoon incursions into the basin from the South China Sea to the east and southeast across Vietnam and southern China are the weather systems most responsible for generating distinct individual peaks to monsoonal hydrograph. These generating distinct individual peaks to the monsoonal hydrograph. These generally occur during September and October when the seasonal discharge is already high and tend to generate a second significant peak to the annual hydrograph. Historically these events have been responsible for many of the most extreme flood discharges

and water levels that have been observed within the Mekong system.

The record historical event observed for the Mekong occurred on 3rd September 1939 at Kratie in Cambodia, where the drainage area is 646,000 km². Though it is almost certain that the peak discharge of 66,700 cumecs was exceeded in 1978 when the maximum historical peak flow between 1924 and 2006 was observed upstream at Pakse. At this time, only water level observations are available further downstream at Kratie, but based on a statistical analysis of the historical joint distribution of daily flows between these two mainstream locations, it is reliably estimated that the 1978 peak at Kratie was in excess of 77,000 cumecs, which places the Mekong even closer to the global limit for rainfall generated flood runoff.

The annual flood regime of the Mekong is not geographically homogeneous in terms of its nature and magnitude from year to year. There is a significant discontinuity evident between the hydrological sub-regions upstream and downstream of Vientiane. Upstream of Vientiane the nature of the flood hydrology in any year is dictated by outflows from Tibet and China—the so called ‘Yunnan Component’ of the overall Mekong regime. Downstream, the large left bank tributaries, particularly those that lie in Lao PDR (the Nam Ngum, Nam Theun, Se Bang Hieng and the Se Kong) and the Se San and Sre Pok, which enter the mainstream from Cambodia and Vietnam, progressively mask the Yunnan Component.

It is their contribution to the mainstream flow that becomes the foremost influence on the variability of flood season conditions from year to year. Because the incidence, severity and impact of the weather systems that determine the magnitude of the annual flood, such as monsoonal depressions and typhoons, is not necessarily common between these two hydrological subregions in any year, there can be significant geographical differences in the annual flood hydrograph.

5.4 The definition of the onset and closure of the four flow seasons

1. Transition Season 1: This is a period of the year when the river is not strictly speaking ‘in flood’ but the dry season has clearly ended. Its onset is defined as the earliest date upon which the discharge rises to twice that of the minimum daily discharge observed in each year. This occurrence confirms that the hydrological response to monsoon rainfall is in progress. The arrival of this fresh runoff is extremely important biologically, most particularly as a ‘cue’ to fish migration.
2. Flood Season: This season begins when the flow exceeds the mean annual discharge.
3. Transition Season 2: This transitional period describes a short season between the end of the flood season and the start of the dry season. The annual flood has plainly come to a close, but the day to day decreases in discharge are far more rapid than those that are characteristic of the dry season itself. The rate of flow recession at this time of the year has important environmental linkages, for example with the draining of wetlands and the floodplain as well as with the timing of the flow reversal in the Tonle Sap. It is helpful that usually this

transition season never extends from one year to the next, historically the latest date for its termination being mid-December.

4. Dry Season: The second transition season comes to a close when the average day-to-day decrease in discharge becomes typical of so called baseflow conditions. The rates of flow recession or decrease that signal the start of the dry season were identified as the onset of a rate of decrease in daily flows of 1%, averaged over two weeks. This proved to be a consistent indicator along the mainstream.

The onset dates and duration of these four seasons has been remarkably consistent and unchanged over the last century, and almost certainly over the 5,000 to 6,000 years. At Kratie there is 50% probability in any year that the flood season will before week 25 (24th–30th June) and close before week 44 (4th–10th November). More generally, these figures reveal that there is a very narrow ‘window’ that defines the onset and closure of the seasons.

6 Development needs

Since 1995, the countries have undergone dramatic socio-economic change (see Table 2). Economic growth in Thailand has surpassed the other three countries, as witnessed by its high GDP. Although there was prolonged contraction due to the 1997 crisis, Thailand seems to have finally surpassed economic levels achieved prior to the crisis. Vietnam has been growing rapidly over the last decade as illustrated by the tripling of its GDP. Although Vietnam’s per capita GDP lags behind Thailand, it has experienced the most dramatic drop in poverty from over 50% to 29% in 10 years, from 1993 to 2003. Cambodia and Lao PDR have lower economic development and have made less progress in reducing poverty.

All four LMB countries have seen much increased integration with global and regional economies with the increase in international trade. This has created fundamental shifts in these countries. In this context, human resources capacity building, awareness building, and institutional arrangement should be considered. In addition, developing eco-tourism would constitute an avenue for increasing the economic development of the Mekong Basin. There is a strong recognition in the Mekong Region that continued strengthening of regional linkages are of mutual benefit based on the complementary relationship of resources, markets and opportunities.

Irrigation and agricultural water management: Nearly 75% of the region’s population is employed in agriculture, fisheries and forestry. In macroeconomic terms, agricultural production is a significant contributor to and driver of economic growth in the riparian countries. Water is, of course, an essential input into the production process. While there is significant development of irrigation in the basin, much potential for new development still exists.

Significant crop production occurs in the major sub-basins including the Tonle Sap Great Lake in Cambodia, the Xe Bangfai River in Lao PDR, and the Mun River in Thailand. There are two priority areas for irrigation management: expanding pro-

ductive irrigation in areas that need it and improving efficiency of water use where irrigation exists. Improving efficiency of irrigation includes rehabilitation and modernization of existing systems and implementation of improved management techniques. Expanding irrigation will most often only be economically justified in relation to crop diversification (high value crops), mitigation of risks from price fluctuation in the world market and maintaining competitive edge in the global economy.

Agricultural water management issues often relate to water use, salinity, water logging, flood risks and water flow/quality in relation to cropping patterns. A change in crop type induces a change in timing of water use, possibly increasing water demand at times of low river flow. General problems faced by agriculture in lowland areas, in Vietnam, include salinity intrusion from the sea affecting agriculture and biodiversity, and acid sulphate soils in Cambodia and Vietnam, and soil and water contamination from inappropriate use of manufactured chemicals in all the countries.

Other reasons that small farmers may not benefit significantly from irrigation include low return and high production cost, and risk aversion. Irrigated rice requires intensive inputs—both labour and cash (to buy seeds, pesticides, fertilizers). Dry season production is for cash income, so net benefits are important. Low price of rice makes the profit margin very small. For the delta in Vietnam and NE Thailand where rice is a major export, the farmer's income is quite small. (When farm gate price is set at 0.08 \$/kg, total rice production is valued at 80 \$/person in VN, 38 \$/person for NE Thailand, \$27 for Cambodia and \$34 for Lao PDR).

Avoiding risk is important to LMB small farmers—who survive on subsistent farming or very low income. Rice farmers are normally the poorest, and trade in rice grain is minimal in Lao PDR and Cambodia where most farmers barely survive on their annual production. Farmers wishing to change farming systems to improve their income need to take into account a number of factors: land suitability for new system, marketability of the products, market price, storage, potential yields, pest and the diseases, capital costs, labour availability, and technical and finance support. Most importantly, the farmers must make room for risks that these factors may change before and after they adopt a new system. The majority of small farmers cannot afford the risks of being in debt, nor food insecurity in the following year if this investment fails. As a result, there is low use of irrigation facility in most LMB regions.

Because of these factors, increasing/expanding irrigation systems cannot readily be equated with poverty reduction, nor improving income of the mass poor. In contrast, it is the bigger farmers and wealthier and large land holders who benefit from irrigation because they can enjoy “the economy of scale” from farm investment, and can afford up front cash, with modern farm machines and inputs (MRC, 2003).

Irrigated agriculture benefits can reach small farmers only when the obstacles above are overcome through credit for investment, extension service, low irrigation cost, control over irrigation scheme operation, market price guarantee etc. Without removal of the obstacles, irrigation cannot be assumed to reduce poverty. Indeed, the poor cannot achieve food sufficiency by their own production. In many instances, there is insufficient land to produce the food that people need.

Hydropower: The Lower Mekong River Basin has an estimated potential for

hydropower development of about 30,000 MW. However, only a small part of this potential has currently been developed (2000 MW or 7%). It is estimated that the hydropower potential of the Lancang basin (up-stream Mekong in China) amounts to 23,000 MW, of which 13% (3,000 MW) are currently developed. Altogether, the Mekong Basin has an overall hydropower potential of 53,000 MW with an estimated development level of 9.4%.

Hydropower plays several important roles in the development of the basin. First, provision of a reliable and sufficient power source is an essential ingredient in building a favourable investment climate that can serve as a platform for rapid economic growth. Second, a reliable power supply system can bring significant benefits to rural households when connected and made affordable. Third, hydropower plants with their scale economies provide a source of revenue for governments from which they can fund poverty alleviation activities (if desired). This aspect is particularly relevant to the situation of Lao PDR. Much work has already been done to assess potential hydropower development in the Mekong Basin, both on the mainstream and in the tributaries.

Hydropower issues are mainly related to the existence of dams and reservoirs from which water is released on a regular basis. The most persistent effect of dams is the change of the natural flow regimes. During the rainy season the flood peak may be attenuated, and dry season flows increased to even out the hydrograph downstream. This allows for drought management and development of irrigated agriculture. Under the global climate change, flood and drought are said to be extreme. In that context, dam reservoirs can be a positive solution. However, changes in the volume and timing of river flows simultaneously bring bad impacts in case without good management and outreach effort.

Careful operation of dam gates is necessary especially in emergency. And also following impacts have to be taken into consideration as well: decline in water quality, changing the flow temperature, loss of biodiversity, loss of fisheries, blocking of the flow of sediment, resettlement of populations and loss of livelihoods. Hydro-energy is the asset of rural region, and should not be exploited only for urban centre. It should be planned in balanced way between rural and urban development.

Navigation: River transportation provides an efficient means for the people of the basin to access different areas of the basin, and to move goods from production around, and to link with regional and global markets. The last ten years have seen a tremendous rise in trade in the region. A key aspect of successful trade development is having low transaction costs. In developing countries, poor transportation capabilities are often cited as a prohibitive barrier to increased trade. Improved transportation capabilities brought about through river navigation improvements can also serve to connect isolated areas and improve livelihood opportunities. In general, waterway navigation can serve as one critical element in improving the lives of the basin's people and alleviating poverty through employment and trade opportunities.

Key activities in this kind of development include improvement of ports, river works and regional waterways. Harmonization of "supportive software" to go with physical infrastructure is necessary for navigation to succeed. These may include

border regulation, navigation aids, navigation rules, pollution control, certification, monitoring, and statistics. Finally, morphological management, including river bank protection and dredging using available expertise in the region, includes China. Improved waterway navigation should be conducted in cooperation with regional initiatives to improve road and rail transportation.

Improving the navigability of a river often involves removal of obstructions to navigation and improvement/construction of port facilities, which can have significant impacts on the river ecosystem. Removal of rocks and rapids, and channel dredging, can cause permanent alteration of fish habitat, as well as reduce ecologically important habitat complexity and diversity. Some rocky areas, as well as rapids and shallows are critical for life cycle of some species, for example providing important areas for spawning and rearing.

Flood: In 2000, more than 800 people lost their lives due to excessive flood, and the economic damage was assessed at more than US\$ 400 million in Mekong Delta, i.e. in Cambodia and Vietnam. In 2001, about 300 people lost their lives, and the economic damage from the flood was assessed at more than US\$ 100 million. And in 2002, flood devastated large areas in the four LMB countries. In all of these years, 1–8 million people were affected by floods, either by need for evacuation, or by loss of crops and livestock, or by being prevented from going to work or to school (MRC, 2003).

Efficient flood management is an important precondition for poverty alleviation in the Lower Mekong Basin. Taking into account that 40% of the population, predominantly rural in Cambodia, Lao PDR and Vietnam, live below the poverty line, serious floods have negative impact on the fragile social and economic systems. They pose a major threat to people's lives and property. People in flood prone areas are accustomed to living with floods. However, population pressure and increasing severity of floods due to natural and man-made factors have significantly increased the damage risk.

Improved flood management and mitigation remain indispensable and will in the future be more in demand than ever. The complex flood problems of the Lower Mekong Basin not only require an integrated and holistic floodplain management approach but also attention to trans-boundary and regional issues. The large floods of the Mekong are regional in character, MRC recently implemented real-time water level monitoring, and the flood forecasts published daily on the Internet are widely applied. The flood forecasting programme will cover the entire basin both upstream and downstream. More intensive data collection needs to be made to serve these purposes and have direct impacts on the local people.

Drought: The impact of droughts is also widespread throughout the basin. Thailand faces a "chronic shortage of water." Droughts can negatively impact agricultural production, the availability of water shortage for domestic uses, the quality of water, and the ecology. Drought management is an emerging issue for the region. Potential areas for action include modelling and policy design for improved water management options to mitigate drought impacts.

Water supply and sanitation: Less than 40 percent of households in Cambodia

and Lao PDR have access to safe water; less than 30 percent in the rural areas. In the urban area, the presence of piped water supplies increases the availability of safe water. In Cambodia, however, during the dry season, the number of households with access to safe water declines in both urban and rural areas, compared with the rainy season. In Thailand and Vietnam, access to safe water supplies is generally more widespread. In the Mekong Delta; fewer than half the households have access to safe water. Thailand has recently embarked on an ambitious programme to provide safe drinking water for all villagers in the country by the year 2008. The Millennium Development Goals target a reduction by half in the proportion of people without access to safe water by 2015.

Fisheries: About 40 million people are engaged in the Mekong's Fishery. It has been estimated that the value of the Mekong's annual fish harvest is about US\$ 2 billion at point of first sale. There is no doubt that the Mekong Fishery is important to both the livelihoods of the basin's people and broader economic growth. However, increasing population pressure and economic development are increasingly threatening the sustainability of the Mekong Fishery. It is thus very important to protect this vital resource for the people and economic growth.

Several priority areas in the development of water resources of the Mekong include protection of the capture fisheries, with specific emphasis on co-management of the fisheries involving local communities. There will also be an increasing need for development of reservoir fisheries and aquaculture; in particular, small scale aquaculture for rural households and aquaculture of indigenous Mekong species.

Recently, governments have emphasized aquaculture as part of their rural development/poverty reduction strategy policy. Thus, efforts and budget are focused on aquaculture. Given the management regime of wild capture fisheries, the rate of natural fish loss cannot be offset by gain in aquaculture fisheries in total. In terms of distribution of benefits, poor farmers are less able to enter substantial fish culture as it involves high cost and intensive management and know-how, neither can they easily afford to buy this cultured fish. Unless wealth increases in LMB in the near future, most culture fish will be exported for luxury consumption elsewhere—outside the basin.

Thus beneficiaries of the farming and fisheries sub sector could be a rather different set of people in society. Consideration needs to be given to social groups at whom the water resource development is aimed. There are particular concerns to be accounted for if we are to allocate water to those who are more in need, have fewer options and could be badly affected by new allocations of water—if construed by economic gain alone.

7 Environmental protection needs

Water quality: The water quality of the lower Mekong River generally is of a good standard. However, at a localized level there appear to be three commonly identified water quality issues: sediment in the water, salinity, especially in Northeast Thailand and the delta in Vietnam, and eutrophication in the delta.

Other changes which can be expected to directly impact on the river will be increased development of hydropower schemes, increased demand for irrigation water, and increased generation of waste water to be treated and discharged. Pollution of water is an important concern particularly in the vicinity of large urban centres.

Land and water resources: An Integrated Water Resources Management (IWRM) approach to water resource development is founded upon the knowledge that water is but one element of a healthy environment, and preservation of the environment requires a holistic approach to management. Watershed management allows planning and development to “specialize” on the unique characteristics of sub-catchments. This allows for greater and more effective public participation and more realistic options.

Priority areas for involvement are the development and promotion of watershed-related knowledge, awareness and attitudes among the stakeholders and decision-makers. Other identified needs include integrated spatial planning at local, national and basin levels. This may include pilot studies to develop improved agricultural practices in upland areas, in terms of direct livelihoods improvement, and studies to support sustainable commercial forestry, agro-forestry and traditional forest-related livelihoods e.g. reforestation and greening schemes. Finally, there is a need for appropriate management of important fish and aquatic habitats, including zoning, restoration and protection schemes.

Increased salinity of water and land is a serious problem in some parts of the Mekong basin and its delta area. Saline water from the sea extends tens of kilometres into delta areas of Vietnam, reaching a maximum during the dry season when water levels in the river are low. A further reduction in flow (resulting from upstream activity) is likely to affect salinity levels of land and water and consequently the productivity of the resources. Expanded storage capacity through hydropower projects, however, has the potential to mitigate this effect. This has to be traded off against consequences for natural fish reduction and related livelihoods.

Increased levels of nutrients, causing eutrophication in the delta area is a big concern (local concern) because agricultural production systems are intensifying, using high amounts of fertilizers to produce more rice for a growing population, and compete for rice export share in the world market.

Tonle Sap Lake: known as the Great Lake or simply Tonle Sap, is situated in the central plains of Cambodia and is the largest freshwater water body in SE Asia. Its flow reversal system makes it unique at the global scale and is of considerable significance for Cambodians. It is estimated that almost half of Cambodia’s population benefits directly or indirectly from the Lake’s resource. The Tonle Sap River connects Tonle Sap Lake to the Mekong River which it joins at Chaktomuk junction near Phnom Penh. The water flow from the Mekong River to Tonle Sap Lake occurs during the flood season (June–October), when the rising water in the Mekong forces the Tonle Sap River to change its flow backwards into Tonle Sap Lake. The incoming water causes massive flooding that extends over a vast floodplain, covering forest, shrub land and rice fields.

The Lake acts as a natural reservoir for the Lower Mekong Basin by regulating the

floods downstream from Phnom Penh during the wet season and makes an important supplement to the dry season flow to the Mekong Delta in Vietnam. From December to February, the Lake provides approximately 50% of the total inflow to the delta. In the wet season, the Lake increases 6 fold in area coverage, and 10 fold in depth when compared with the dry season; from an area of 2,500–3,000 km² to 10,000–16,000 km² and a depth of less than one metre to 9–10 metres during the peak of the flood season. Similarly, the water volume of the Lake increases over 60 fold, from about 1.3 km³ up to 60–80 km³ depending on the flood intensity.

As a result, the size of the Lake also expands from 160 km long and 35 km wide, to 250 km long and 100 km wide. The bottom of the Lake lies approximately 0.5–0.7 m above the mean sea level (AMSL). Hence during the year the surface of the Lake varies between 1.3 and 10.3 m AMSL (Chadwich *et al.* 2008).

Concerns about accelerated sediment filling the Tonle Sap Great Lake due to increased erosion rates remain unproven. 80% of the labour force of Cambodia is directly reliant upon this seasonal flooding and the benefits it creates. As stored water flows out of the Lake back to the mainstream, there substantial benefits in terms of irrigation water availability as well as the enhancement of the low flow regime to minimise saltwater intrusion.

Biodiversity: The diverse ecosystems of the Mekong Basin are exceptional in their productivity, and the benefits its people derive from this. The maintenance of high biodiversity represents not only the biological integrity of the ecosystems but also the range of natural resources and products available to both urban and rural populations.

Large numbers of the population of the basin derive at least some part of their livelihood directly from wild resources. Many, especially rural poor in Cambodia and Lao PDR have no alternative or substitute for this yet, if they were to lose this life base due to macro—economic development.

Impacts of land use and hydrological changes which can threaten biodiversity, through habitat degradation, fragmentation and loss also have severe impacts on human populations, the rural poor in particular. Conservation of biodiversity means both the maintenance of the productivity natural systems and security of access to those resources (including the genetic resources) by current and future generations of the basin. Sustainable development is reliant on conservation of biodiversity to support diversity in economic activities.

The conservation of biodiversity requires continuity of species, populations, habitats and ecosystems from one human generation to the next. The persistence of biodiversity is an indication that development is sustainable; a decline in biodiversity is a warning that development is unsustainable.

Wetlands: The biodiversity and productivity of the Mekong Basin is in large part represented by its wetlands. Wetlands in the LMB include lakes, rivers, rice fields, marsh, swamps, flooded forest and estuaries to name but a few. The wetland area of the LMB is itself highly seasonally variable with large areas of Thailand, Cambodia and the Vietnamese Delta flooded annually. Wetlands are home to common species of plants and animals which the people utilize daily, such as rice, vegetables, fruits,

fish, bamboo and timber, and to rare and globally—threatened species like Irrawaddy Dolphin, Siamese Crocodile, Giant Catfish, Giant Ibis and Sarus Crane, etc.

These natural and human wetland systems are both highly diverse and productive, and support many of the basin's people, both directly and indirectly. Products harvested in the basin are also exported, providing a highly significant and diverse income for local populations, and contributing to industry and economy within the wider region (e.g. fishery exports from Cambodia to Thailand).

In addition to the 'products' derived, the services provided by the wetlands of the basin are often overlooked and under-valued. Wetlands, such as canals, provide vital transport linkages within the LMB and have done so for centuries. What is rarely acknowledged is their contribution to flood mitigation and the savings made in otherwise necessary maintenance to road transport, buildings and other infrastructure.

Water treatment and sewerage disposal are other vital services provided by wetlands and under considerable pressure in urban areas. In towns and villages wetlands traditionally provide flood control and water treatment, and whilst development demands an increase in this capacity, it usually results in a loss of wetland area. Urban wetlands also provide a vital source of protein and income from the collection of wetland products for the urban poor. Other undervalued services include nutrient and sediment retention, groundwater recharge and carbon sequestration (often greater than forest systems).

A small change in water level in a wetland at a critical time may have wide ranging impacts on both the ecosystem and the human use and value. Finally, the trans-boundary nature of wetlands of the LMB pose a major challenge for good governance and sustainable development of the Mekong River Basin, not only in terms of habitat management, regional planning and decision making, but also with respect to traditional utilization, management and conservation of the water and its related resources, environmental education and public awareness activities.

8 Conclusion

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 organisations providing development support. The six countries within the Mekong Basin have different national development goals. The visions of development held by national governments do not always accord with development visions of people at the village level. Plans of government agencies may not match the views of civil society groups. There is now broad recognition throughout the world that successful planning must be inclusive, and take into consideration the needs and aspirations of all the stakeholder groups.

The MRC Basin Development Plan project is one recent initiative that is working to develop an inclusive planning process for the four Lower Mekong Basin countries. However, the achievement of that goal will not be easy. Even in developed countries with far greater resources of time and money, inclusive planning processes have been difficult to achieve. Inevitably the plans produced leave some stakeholder

groups dissatisfied, and usually no group achieves all it wants. The first step in effective planning is to build cooperation across the basin. There is a need for greater understanding, trust and breadth of vision.

The advantage that the Mekong Basin has over many other regions is that a start has been made while the river is still in good condition, and there are still sufficient natural resources available in the basin. It should be easier to limit degradation and loss of resources than to restore degraded systems. However, the longer we wait the more difficult it becomes. The Mekong River system is still in good condition and basin wide cooperation at all levels is crucial to ensure that it stays that way.

The author used to work for Lake Biwa in Japan, which is Japan's largest lake, where the national objective of increasing water resources to serve rapidly industrializing cities downstream led to massive public works projects (including dam construction) which over three decades radically changed the landscape and lifestyles of the lakeshore. But simultaneously, central and down stream local governments took account of the concerns of the people who lived in the upstream lakeshore. Because of this, the lakeshore district became one of the richest areas in Japan. Not only this, but also gathering worldwide experiences and wisdom, we wish the Mekong River Basin prosperous future¹.

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¹The authors worked in the Mekong River Commission's Basin Development Plan from 2001 to 2004 (Muanpong until 2005), carrying out holistic study of Mekong River Basin with the concept of harmonized development. This paper draws on that experience. Almost all information is from MRC studies but, of course, the opinions and views of this paper are ours, and not the official views of MRC.