

# The Challenges of Integrated Management of Mekong River Basin in Terms of People's Livelihood

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## Abstract

Mekong River Basin is a life for many people in six south East Asian countries. The river basin is very productive and has crucial activities like: fishing, agriculture, hydroelectric power, transportation, biodiversity and so on. However, due to mismanagement, political intentions and one way interest only for development, the river basin has already started experiencing complications. The major challenges found out were, huge hydroelectric dam constructions and other projects, high population pressure, lack of cooperation among riparian states (especially upper Mekong region and lower one), and lack of proper management system. This leads to inequitable resource use, impact on water quality, biodiversity loss, and disasters like flooding. It is a high time to make a joint venture among riparian countries for sustainable use of the resource. Multi lateral cooperation and commitment among user countries by consulting all stakeholders will benefit all to use this precious resource equitably without major ecological impacts on the river basin.

**Keywords:** Challenges, Ecology, IWRM, Livelihood, Mekong River, Sustainability

## 1. Introduction

Mekong River is one of the great river systems of the world draining 795,000 km<sup>2</sup> covering a distance of 4800kms. Its Annual discharge is about 475 billion cubic meters. The river basin includes parts of China, Myanmar and Viet Nam, nearly one third of Thailand and most of Cambodia and Lao PDR [1].

In Southeast Asia, it is the region's largest river basin and widely praised as the "Mekong Spirit". The climate of the Lower Mekong Basin is governed by monsoons. Agriculture is a predominant economic sector in the Mekong River Basin. The large portion of water use in the river basin is for irrigation with rice as the main crop under irrigation and fisheries are a significant water user in the Mekong Basin. A large majority of the population earns their living from agriculture and fishing [2].

The great majority of the lower basin's inhabitants are farmers and fishers, relying quite directly on the natural resource base. Integrity of the basin's ecology is vital to their social, cultural and economic well-being [3].

The source of the river's great productivity is its seasonal variation in water level, and the range of wetland habitats inundated. Wet season river levels are up to 8-10

meters higher than dry season ones, creating a rich and extensive series of wetlands in the four countries of the Lower Mekong Basin [4].

The biodiversity of the Mekong River Basin is immense, and of truly exceptional significance to international biodiversity conservation even in comparison with other parts of tropical Asia. The river and its numerous tributaries, backwaters, lakes, and swamps support many unique ecosystems and a wide array of globally-threatened species. The diversity of the river fauna itself is surpassed only by that of the Amazon and the Congo, with between 500 and 1,300 species of fish inhabiting the main channels, tributaries, and associated wetlands [4].

The heavy reliance of the Mekong Basin's inhabitants on the river, especially for agriculture and fisheries, presents a number of complex, interrelated issues for trans-boundary governance and sustainable development. In the lower basin, which cuts through four countries, 70 percent of the inhabitants are subsistence farmers. Traditional rice cultivation goes hand in hand with fishing and the gathering of forest products [5].

Moreover, high levels of human population and usage have led to increasing unplanned development pressures within the basin, causing many direct threats to most of the important ecosystems and endangered species for

which the region is renowned. This poses a significant threat to biodiversity and environmental sustainability and thereby to the livelihoods of the Mekong peoples [5].

Only 1.3% of the biodiversity-rich Mekong Delta now remains in a semi-natural condition and the few remaining wetland species are wholly reliant on these remnant patches. Degradation of wetland habitats and hydrological regimes poses perhaps the greatest threat to the viability of one of the most important freshwater fisheries in the world. Widespread hunting and over-fishing, inflated by a massive illicit wildlife trade, has brought many species to the brink of extinction, and development of river infrastructure is believed to have caused the extinction of a number of endemic fish species [5].

These problems have been exacerbated by sociopolitical issues, including widespread poverty, high population growth, a history of conflict and which caused by the weak governance structure. The growing need for integrated basin management to address food insecurity, rural poverty, environmental degradation, threats to biodiversity, and tensions among multiple users makes the river basin a good choice for the Challenge Program on Water and Food [6].

Therefore, the objective of this paper is to identify the major challenges of Mekong River Basin management and evaluate its impact on biodiversity issues in particular. Eventually feasible recommendations for effective and sustainable management of the river basin will be forwarded.

## 2. Challenges in Mekong River Basin Management

### 2.1. Challenge Induced by Development Projects

Tens of millions of people in the Mekong Basin rely on traditional uses of the water of the river system to provide them with their primary source of nutrition and income for their livelihood. Yet, as population numbers increase, these traditional uses and benefits are being threatened. With a relatively low level of development the natural capacity of the river system to supply goods and services may be pushed beyond acceptable limits, as often experienced at the local level. Developing the economic potential of the Mekong system for domestic use, for hydropower, navigation, irrigation and drought management is the key to fighting poverty and increasing people's welfare [7].

Today this development is still in its early stages and the Mekong offers a high potential for balanced and sustainable socioeconomic development. However development must carefully take into account the environmental impacts. Independent planning should be replaced by jointly planning which based on regional cooperation and yield better management results. The challenge is not only

to attract significant investments, but also in ensuring that development avoids the risks of environmental degradation, social inequity and international disagreement [7].

Economically and technologically, Mekong's riparian states were not well-equipped to undertake large-scale exploitation of its waters so far. However, recent developments in the five riparian countries' economic and political conditions and the region's increasing demand for energy, is bound to change this picture. This together with considerations of climate change and renewable sources of energy and the rising importance of regional trade and investment flow have stimulated a new era of hydropower development in the basin. In response to market demands, a broad range of developers are now investigating a large number of potential projects. In the last ten years, more than 100 large dams have been proposed on the river. Western companies and donor countries are vying for contracts to build dams on the Mekong through international lending institutions with high hopes for substantial profit [8].

Hydropower generation potential and energy demand are geographically imbalanced, thus highlighting the importance of and opportunities for an emerging regional power market. This regional dimension is the driver behind most of the current projects with bilateral agreements being established for the export of electricity [8].

During construction of dams: it submerged a lot of forest land (including cash crops), agricultural land, pastoral and waste land. A lot of people were displaced from the inundated area to the inland from river bank. Some of them were moved out to faraway places [8].

The livelihoods of these displaced were depend on agricultural cultivation. Such as: Cash crops like fruits are the main income sources of the local people. Most of the farmlands are located at the alongside of the River. This region has rich resources of water, soil and favorable climates. Depend on these unique natural resources; the people living in the region can produce enough grains for their own consumption as well as for sale. With the reform of the rural economy, the agriculture production in this region had made great progress. However, the new farmlands received by these displaced farmers because of the dam construction are less productive, some of them placed in hilly area (prone to irrigation), and some of them even didn't get any compensation at all [8].

Hence, people who had received new lands are facing the problem of food shortages because of their low productivity cultivation. The living conditions of most of the immigrants are getting worse year by year. Many young people have moved out to work in construction sites as cheap labor. Because of poverty, children are facing the threat of dropping out of education; whereas adults are facing the threat of diseases. There are families that have broken down, with the wives and children leaving home for other provinces. To speak from the perspective of the

local people, the operation of the dam is also the beginning of a disaster for them. However, the company has been denominated as one of the production unit in the Chinese electricity system for five years. Only by the year 2001 the company has got annual profit of around 35 million euro [8].

When comparing the lives of local inhabitants and the benefits to the enterprise and governments, the discrepancy is obvious. The main reason for this gap is that information in resettlement policies and decision-making was not disseminated openly enough to the public. The construction of project was started before the immigration, which provide the investors and local governments an opportunity of cutting down the expenses of resettlement to meet the escalating construction costs. The plan of resettlement neglected the rehabilitation and development of immigrants. The estimations about the number of people need to be resettled and their property losses were severely lower than the realities [9].

The other problems being experienced by riparian countries especially by those found downstream of the Mekong River Basin due to the continued dam construction and commercial navigation plan are: suffering from the Mekong's abnormal floods, signs of such stress in erosion, siltation and changes in water currents. There is also some reduction in fishery resources, impediments to river transportation and exceptional flooding. Its impact might scale up to dry the Tonle Sap ending the famous river fishing industry and causing widespread flooding; and eventually the home of endangered fish species would be destroyed. A study to look at the downstream impacts is urgently needed for the sustainability of resources management in the Mekong. Of course, some preliminary researches show that the change of flow regime is a critical factor in the annual flood levels that sustain the region's fisheries, traditional livelihoods and biodiversity [9].

There was an agreement being signed among riparian countries found in the LMB (lower Mekong River Basin) in 1995 in order to utilize the river sustainably. This agreement has been hailed as a landmark achievement, adopted by the four lower riparian states in the "Spirit of Mekong Cooperation." It seeks to promote "sustainable development in the utilization, 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." However, the agreement is incomplete since China and Burma didn't sign on the document. The attempt to apply more stringent rule will normally make more difficult to secure cooperation from all the relevant states. The Agreement has also failed to attract the participation of China and Burma, and this failure is perhaps the biggest setback that stops MRC's initiatives from becoming truly regional in scope [10].

The challenges in the field of water governance, especially the implementation of water efficiency programs, its impact on people's livelihood and the environment require a global and joint approach to resource management, organized at the natural and relevant level of local, national or cross-border river basin districts. In the Mekong River use, It is clear that China's participation is particularly important because not only it's engaging in many large-scale hydropower projects on the Mekong which have important downstream trans boundary implications but also because of its dominant role in trade and development in the region. Therefore, the agreement theoretically needs to include all users for maximum and sustainable use of the river basin without significant deleterious effect on the environment [10].

In general, from those projects that are already accomplished, China still intends to develop a number of big hydroelectric power plants and to make Mekong mainstream navigable from Yunnan to the South China Sea, a distance of some 2,500 kilometers. This poses unprecedented environmental and social problems for the downstream countries Myanmar, Laos, Thailand, Cambodia and Vietnam. Severe ecological deterioration of the Mekong River is a foregone conclusion if this plan proceeds. And of course the impacts will not be limited to the river [11].

The downstream countries will be forced to undertake exhausting and largely futile efforts to protect themselves and make up for the damage to their agriculture, fisheries, forests, and way of life. Cambodia and Vietnam, the two countries farthest downstream, will benefit little and will experience the worst negative impacts from the scheme. Particularly at risk are Cambodia's Great Lake and Vietnam's Plain of Reeds and Mekong Delta. China itself will not be immune to adverse impacts. Of particular concern will be sedimentation of the Lancang hydropower dam reservoirs. Sediment in the Lancang mainstream, already great, is likely to increase due to larger and more frequent landslides and other effects brought about by the dams and their reservoirs. The useful lifetime of China's Lancang cascade of hydropower dams is likely to be only about thirty years rather than the one hundred years foreseen by project proponents [11].

## 2.2. Deforestation

It is a major issue in the Mekong Basin. The impacts of deforestation on the biodiversity are obvious. Forests have the important role in stabilizing the river's flow and protection of watershed. However, due to various reasons, forests are decreasing dramatically. In Vietnam, for example, the reasons of deforestation are inappropriate economic development policies. In total, Vietnam's forest cover has declined from 67% in the 1940s to the current 26% [12].

### 2.3. Challenge on Population Pressure and Institutional Management

The Mekong River Commission (MRC) has been established for the sustainable development of the Mekong River Basin to broaden the scope of cooperation in all fields of basin development and resource management, river navigation, flood control, fisheries, agriculture, power, production and environmental protection to prevent and turn the potential conflicts to a mutually beneficial cooperation and sustainable development of the river basin among member states. And the potential area of conflict is how to ensure use and development of water and related resources to be consistent with the needs to protect, preserve and enhance environment and aquatic conditions, and maintenance of the ecological balance for future [2].

The 1995 agreement on the cooperation for the sustainable development of the Mekong River Basin has focused on the activities that must have aim for a balance between the economic, social and environmental dimensions of development in the basin because the aquatic and terrestrial environment of the basin supports the livelihood of the majority of the people especially the rural poor. Use of water resources for development purposes in one country can have negative effects for other countries, unless potential impacts are properly considered during planning. Obviously, environmental management and related socio-economic factors must be understood as integrated in a development process that helps to sustain existing livelihoods and promotes the alleviation of poverty, while reducing the risk for conflict over the use of resources within and between countries [2].

Within the riparian countries there is a challenge to integrate management between government agencies both “vertically” between national, provincial and local government levels and “horizontally” between ministries and sectors. It has been pointed out by Campbell (2005) that there is a disparity in institutional capability across the riparian countries and in countries such as Cambodia; many of the institutions are relatively undeveloped and need strengthening. And community input is an important aspect to evaluation of basin wide development strategies if management policies are suppose to reflect aspirations of communities.

The Mekong Basin has diverse social and cultural system and if community participation is to be effective then it must be carried out on a country by country basis in a transparent and flexible manner. This is a challenging task and the National Mekong Committees (NMCs) are, therefore, required to play a key role to address this aspect as they are well placed in respective countries to coordinate with national organizations while still working within the basin wide perspective provided by the MRC [13].

The development of a water utilization procedure and the realization of an agreement to adopt this in practice

by the basin countries involve so many complexities that a truly rational comprehensive decision making approach may be impossible. However, a significant input of resources is required if MRC has to achieve an outcome that is acceptable to all the MRC member countries. The implementation of comprehensive integrated resource management policies across the basin will not be possible unless and until the basin wide planning is complete enough to provide a framework for action and agreement is reached on fundamental issues such as water use, sharing of resources in times of scarcity and sharing of benefits [13].

There is another big challenge of greater pressure on water resources from a growing population in Mekong River. This demands for clean and adequate water, food and energy supplies to support economic development without causing serious damage to the environment and ecological system. Integrated water resources management leading to sustainable development is yet to be achieved in the Mekong River Basin. Effective coordination and management of water and related natural resources across the basin is yet to be instituted. Basin wide evaluation, development planning and strategy formulations are in the process. Critical challenges like the understanding of how the basin functions as a system, integrating institutional management, forging community participations and securing resources for building capabilities and competence are identified [13].

There is certainly a need for a systematic approach to integrated water resources management. Apart from the requirement of equitable distribution of water among the stakeholders, governance, economic performance and environmental quality are the crucial challenges facing water resources management. Water resources management must inevitably involve multi-objective tradeoffs in a multi-disciplinary decision making process. However, under the present institutional framework, several departments or agencies are dealing with the water resources development according to their own requirements, without much integrated effort towards basin-wide planning and management. A collaborative and coordinated effort is needed among all the stakeholders involved in order to address the issues and challenges of water resources management [13].

In the past most countries did not pay attention enough to the management aspects as the resource was abundant compared to the demand and easily obtained from river, lakes, and canals and from rainfall. With the growth in demand over the years, many regions are facing shortages of water, particularly in the dry season, and, frequently, excess of water during the wet season. These concerns result not only from the scarcity or excess of water, but also from the lack of appropriate water management policies and institutional structures to utilize the national water resources effectively. With the promotion of the concept of integrated water resources management,

an appropriate shift in the water management paradigm is needed, considering three important elements of an enabling environment, effective institutional structure, and appropriate tools and technologies. This should be viewed as a flexible framework to be adapted within the economic, strategic and social dimensions of each country concerned [13].

## 2.4. Challenges Regarding Pollution and Water Quality

Water quality is one of the key factors affecting the environmental health of the Mekong river system. As the livelihoods of most of the 60 million people who live in the Lower Mekong Basin (LMB) wholly or partly depend on aquatic resources, the environmental health of the river is a major concern to the governments of the countries in the basin. In 1985, the Mekong River Commission (MRC) established the Water Quality Monitoring Network (WQMN) to provide an ongoing record of the water quality of the river, its major tributaries, and the Mekong Delta [11].

Three main categories of water-quality indexes (WQI) were used: 1) for the protection of aquatic life (WQIai); 2) for human impact (WQIhj); and 3) for agricultural use (WQIag). Each WQI category is subdivided into classes according to the number of chemical parameters (DO, pH, etc.) that meet guideline thresholds. Based on the classification and index the quality of the river and its use for different purpose has been tried to be assessed [11].

In the mainstream and tributaries, the WQIai is mostly High Quality. However, in the Delta from the total 8 stations four are Moderate Quality, and one is Poor Quality. Signs of significant human impact on water quality are observed at stations in the uppermost part of the LMB and downstream of Phnom Penh. The lower index values at the downstream stations reflect higher population densities, particularly in the highly populated and intensively farmed Delta. In addition, one of the Delta stations of the WQIhi is classed as Severely Impacted. Moreover, some stations on the Cau Mau Peninsular of the Delta were under the class of Severe Restrictions [11].

## 2.5. Major Sources of Mekong River Water Pollution

### 2.5.1. Municipal Waste Water

The two largest urban areas (Vientiane in the Lao PDR, and Phnom Penh in Cambodia) are of concern as they lie on the banks of the Mekong. Currently, Vientiane, a city of less than 500,000 inhabitants, discharges its municipal sewage into the That Luang Marsha wetland that dis-

charges into the Mekong River some distance downstream of Vientiane. This discharge is small at this time and is not thought to pose any immediate risk to the mainstream of the Mekong. However development and population growth it may pose greater threats to the mainstream in the future [11].

Phnom Penh approximately with 1.7 million inhabitants also discharges much of its urban sewage into a series of wetlands that drain into the Bassaca tributary of the Mekong. In addition, certain industrial and municipal discharges as well as storm-water runoff discharge directly into the Tonle Sapa tributary of the Mekong [11].

The MRC reports in 2007 about local pollution of an industrial nature in the Tonle Sap at Phnom Penh. There are also a number of floating villages on the Great Lake of Cambodia. These populations discharge domestic sewage directly into the water column. However, the loading and significance of these discharges are not known. Using population statistics and data on urban sanitation coverage' for year 2000, the total discharge from urban areas was found 150,000-170,000 tones /year of BOD, 24,000-27,000 tones/year of total-N, and 7200-8100 tones/year of total-P [ibid]. These values indicate that it is by far very strong and concentrated waste that can affect the aquatic ecosystem of the river and consequently biodiversity and human livelihood in the long run [14].

### 2.5.2. Industrial Wastewater

Industrial development has the potential to increase substantially the pressure on aquatic resources. For example, in the upper Mekong region especially the Yunnan Province in the People's Republic of China, located immediately upstream of the Chinese/Lao border, is reported to have inspected 1042 industrial enterprises in the basin in 2000 (CIIS, 2002). Among them the dangerous one like the Lanping Lead-Zinc Mine has been built on the banks of the Lancang (Mekong) River which could have a tremendous impact on the LMB. In general at present there is no much information and strong evidence available on industrial discharges to the river because of limited research work on this specific section [11].

### 2.5.3. Agriculture

Agriculture sector has also its own pollution potential in the river basin. Based on available data suggest, a loss of about 225,000 tons of Nitrogen and 37,000 tons of phosphorus per year. There is some evidence for transboundary transmission of pollutants from the Upper Mekong Basin into the LMB. There is no sign of any significant basin-wide trends for any parameter regarding pollution status from agriculture. However, with the continuing development of both, agriculture (increased use of fertilizers, pesticide) and urbanization there will be a threat in the changes of water quality in some tributaries [11].

### 3. Principal water Quality Issues in the Lower Mekong Basin

**Salinity:** High salinities caused by saltwater intrusion are nearly ubiquitous in the Delta (but not on the main-streams of the Mekong and Bassac Rivers). Fifty-four of the stations analyzed have a maximum conductivity greater than the threshold of Some Restrictions in the WQI<sub>agi</sub> (for general agricultural use). For nine of these sites located in on the Ca Mau peninsula of the Delta, the WQI<sub>agi</sub> is at the level of severe restrictions [11].

**Acidification:** When exposed to air (oxygen) sulphate soils in the Delta produce sulphuric acid, which leaches to the canal system. The most severely affected area is the Plain of Reeds, but similar effects are recorded in some areas in Cambodia. The situation in the Plain of Reeds seems to improve in the western parts of the canal system that are close to the Mekong. Further east, there are still times of the year when extremely low pH-values are measured [11].

**Eutrophication:** There is a significant increase in the total-P concentrations at the mainstream stations, while no such difference is found for the tributaries. Although the concentrations of nitrogen and phosphorus generally are lower than the threshold values for WQI<sub>a1</sub>, there is a possibility of an effect on algae, and floating aquatic vegetation. In general, due to the greater discharge of Mekong River the possibility of eutrophication seems unlikely [11].

### 4. Challenges on Biodiversity

Biodiversity in the Mekong River Basin is fundamental to the viability of natural resource-based rural livelihoods of a population of 55 million people living in the Lower Mekong Basin-equivalent to more than 90% of the population of the entire Mekong River Basin [4].

Biodiversity loss is a major problem in Mekong River Basin. For instance, fish species diversity in the basin is currently estimated at 1200 species, and could be as high as 1700 species. The difference clearly shows there is a very rapid biodiversity loss in the river basin. Besides the anthropogenic impact on biodiversity loss the dynamic nature of floodplain ecosystems also drives fish to migrate, often very long distances, contributing to both genetic mixing and isolation of populations. Although only a fraction of migratory species have been studied, in only modest detail, to date, a high proportion of these are thought to have distinct populations within the Mekong Basin [15].

A serious decline in biodiversity is an indicator of unsustainable development. And in this regard, the fisheries are unquestionably of paramount importance. Maintain-

ing biodiversity must be a key goal in the quest for sustainable development of the Mekong. Fisheries as a threat to biodiversity because of widespread over-exploitation of stocks, the use of destructive fishing gears, large by-catches (killing unused species) and general mismanagement of resources which leads to biodiversity loss especially for some endangered species [12].

But still the degree of diversity is large due to the complexity of the Mekong river ecosystem. The river and its tributaries originate high in mountainous areas and flow through a wide variety of landscapes as they wind their way to the sea. Variation in climate, geology, terrain and water flow results in river habitats of almost unlimited variety. Seasonally-flooded forest represents a type of habitat that is particularly rich in life. The pressure of the riparian communities and their fishery demand is one of the big challenges for Mekong River Basin. According to Mekong River Commission the Lower Mekong fishery supports up to 40 million people and two third of the population of the lower Mekong Basin are actively involved at least part-time in the fisheries. The average catches per fisher, although tend to low in rivers, but participation in the fishery is very high [16].

There are a number of factors influencing the biodiversity of the River. However, two types of activities, which frequently mentioned are over exploitation and environmental degradation. While the former considered bringing less adverse impacts to the basin, the later raises special concern of the environmental actors. Regarding the extraction of fish in the basin, the use of destructive fishing methods (explosive, poisons and electrocution) is mentioned as a big threat and need to be ban completely. Considering the environmental degradation, the expansion of agriculture and aquaculture are taken into account. For example, in Vietnam, inland fisheries production is expected to rise from 310,000 tons (1992) to 600,000 tons in 2000, due mainly to increased aquaculture production. This practice has resulted in the clearance of thousand hectares of forests [12].

Problem with the release of farm-raised native species are well documented in the rivers, particularly for highly migratory species (as occur in Mekong River Basin). Therefore, the determination whether a particular animals are exotic to a certain area can only be made by considering diversity at the genetic level, not at the species level. However, it is not always easy to measure the change in genetic of any species in a short time. Hence, the evaluation of biodiversity at Mekong River is really a big challenge [12].

Although over exploitation is a problem in rivers, it has yet to lead to collapses of fisheries (with the exception of certain vulnerable species). Environmental degradation is the threat instead. As nearly 75% of the region population is employed in agriculture, fishery and forestry [16]. The intensification of agriculture in the Delta is reliant on increased use of agrochemicals. Un-



fortunately the management of chemical use in agriculture and in many other sectors is a difficult task and not always success, impact on the environment due to over use of chemical becomes uncontrollable. For instant, the Mekong Water Quality Monitoring project (1989) has found the presence of organ chlorines in water and fish tissue [12].

Rice cultivation is a good example of how agriculture activity causing the environmental degradation in the region. Regard to Vietnam case, the Mekong Delta is crucial as it's "rice bowl", producing half the rice and 40% of total agricultural output, making it the richest agricultural zone in the country [12]. Increased agriculture production has fuelled economic "renovation" or "doi moi" and the Mekong delta has been instrumental in this continuous process. And especially, Mekong Delta is considered as a main source both of food security and export income, contributing significantly to the GDP of the country. However, as mentioned earlier, rice production might be increase the risk for environmental degradation due to the overuse of pesticides.

## 5. Impact of Flooding and its Management

Flooding is a way of life along the lower Mekong River in Vietnam and Cambodia. Every year between August and November, monsoon rains fill the rivers of Southeast Asia, and the Mekong River Delta broadens well past its dry season levels. The annual floods carry nutrient-rich silt to farmland around the river and provide the moisture needed to grow vast fields of rice. Vietnam is the second largest exporter of rice in the world behind Thailand, and the Mekong River Delta is one of two primary rice-growing areas in the country [17].

In Thailand, some local residents and environmentalists told IRIN they suspected Chinese dams and the destruction of small Mekong river islands to clear passage for Chinese cargo ships had aggravated flooding in the region. They also blamed the Mekong River Commission for failure to warn people about the flooding [18].

Due to the fact that flooding has become annually expected dangerous event in the basin, the Mekong River Commission is conducting Flood Forum every year for better understanding, early preparation, forecast and mitigation. The forum provides an opportunity for managers, planners, practitioners and scientists from riparian states, international organizations, and civil society organizations to meet and exchange experiences and information addressing flood issues and to identify ways to improve flood management using a balanced regional and holistic approach [19].

In fact the Mekong floods play an important role in the development of the country as they carry and distribute fertile silt into the floodplain for agriculture production,



**Figure 1. Flood inundated area, 2002 (Source:<http://www.mrcmekong.org/programmes/flood.htm> and 6<sup>th</sup> annual flood forum).**

feed the food chain for fisheries, provide water supply for people living along the river side, provide navigation routes and necessary environmental functions, but extreme floods usually cause severe damage and suffering, especially to people living in low lying areas. It is, therefore important to find ways how to get the maximum benefits and the minimum risk or damages from floods. To achieve this more effort and commitment as well as coordination and cooperation between institutions and people concerned are needed. Problem regarding forecasting has been observed especially in Cambodia and needs to be strengthening in a more scientific base and more efficient technical staff for better and accurate flood forecasting. Not only countries found in the lower Mekong River Basin that are affected but also China has frequently been hit by floods and suffered from flood disasters [20].

## 6. Conclusions and Recommendations

Integrated Water Resources Management (IWRM) is a process, which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and future generation. However, the management of Mekong River Basin is not following this natural balance and equity. This is due to high population pressure, development and technological advancement and less political commitment and cooperation to use the resource equitably without harming the environment [13].

Management of the Mekong River Basin and its natural resources need to be integrated due to the complexity of various socio-economic, cultural and environmental issues in the basin. An appropriate approach should take into account the combination between physical, biological, institutional, political, social and economic interests. At all level, the approach needs to consider the implications of development in one sector on the well-being of other sectors, both on-and off-site.

Regarding the biodiversity conservation at the Mekong Basin, in one hand, it needs to be considered in the relation with the livelihood development of the riparian communities and the development of the riparian countries. On the other hand, any development policies should

take into account the adverse impact on the Mekong Basin, in both sustainable use of natural resources and conservation of biodiversity. The integrated management of Mekong Basin requires also providing of adequate knowledge on sustainable use of natural resources to various stakeholders. It also requires a closely and effectively collaboration among different stakeholders in order to share equally benefits and responsibility as well as risks in the management of the Mekong Basin.

For optimal and equitable development of the Mekong's water resources require collaborative planning and joint identification of investment priorities, referring to basin-wide strategies in each water-related sector.

This may also be usefully supported by multi-sect oral analysis and the simulation of various development scenarios and their effect on the river flow regime. In conclusion, the Mekong River Basin needs the attention of all riparian countries with full commitment and motivation to use it equitably without serious impact on it. This multilateral cooperation also needs the involvement of all stakeholders to meet the need of the poor in front. Moreover, development projects needs to have impact assessment of the current and future generation and the environment as a whole. Development shouldn't be under the cost of the environment. The MRC has to influence the upper basin countries like China to join and sign the agreement for better utilization of the basin with common understanding among the riparian countries.

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