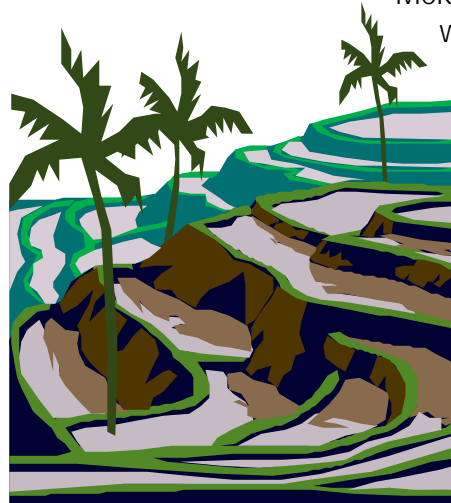


RESOURCE USES IN THE MEKONG RIVER BASIN¹

The Mekong River Basin (MRB) has a vast and diverse array of natural resources. The fish, forests, water, wildlife and fertile soils found in the Basin interact to form a highly stable and productive natural environment. Many of these resources are of great value to the people living in MRB riparian countries. Natural resources are the foundation of local, regional and national economies.

AGRICULTURE

The MRB has large reserves of arable land, totaling close to 18 million hectares in the Greater Mekong subregion (which also includes Myanmar and Yunnan Province in China). Agriculture is the dominant sector in the economy of the Lower Mekong Basin (LMB). Some countries, however, have more arable land per capita than others. Cambodia, for example, has a relatively small area of the country under cultivation, as the soils are considered generally of poor quality. Cambodia also faces the problem of land mines in nearly 40 percent of its arable land, leading to the cultivation of marginal lands that are relatively unsuitable for crop production. Regions of the MRB that have limited land suitable for crops must practice careful management of their cropland or risk food shortages.



Rice is by far the dominant agricultural crop in the MRB. Some countries, though, are growing different crops. Vietnam has been diversifying its agriculture for the past 30-40 years, now growing large crops of beans and sugar cane in addition to rice. Farmers in northeast Thailand grow maize and cassava.

The region has three major types of agricultural zones:

- The plains located around the Great Lake in Cambodia, characterized by rice paddies irrigated by rainfall and seasonal flooding.
- Flatlands in southern Cambodia and at the mouths of tributaries of the Mekong River in Lao PDR, which are subject to flooding. In this region, the rising waters are used to grow rice during the wet season. During the dry season other crops are produced, as the soils have high moisture retention properties.
- The river deltas of the Song Hong and the Mekong in Vietnam.

Two rice crops can be grown annually, using the delta creeks for both irrigation and drainage.

Fluctuating hydrologic conditions can cause a number of problems for farmers, such as insufficient rainfall on the plains during the dry season, deep

¹ Information provided in this lesson text is extracted in part from MRC (1997).

and prolonged flooding during the rainy season, flooding, acid water, and saltwater intrusion into low-lying deltas. Lack of adequate irrigation in many areas allows for the production of only one rice crop per year. Food shortages often result for a few months of the year.

While many areas of the LMB have sufficient arable land to feed the people, sustainable management of agricultural land will be necessary in order to reduce degradation of the natural environment. Current agricultural practices resulting in significant environmental impacts to natural ecosystems are briefly examined in the following section.

Slash and Burn Agriculture

Slash and burn agriculture involves the rapid conversion of forest into farm land. Intense logging pressure often leads to the clearing of land otherwise not suitable for crops. It is a fairly common practice in the MRB and results in erosion of topsoil and sediment deposition in waterbodies. Land on steep slopes, with highly erodeable soils and low soil nutrients may be placed under cultivation shortly after clearing. The first year's crop may be good, but heavy applications of fertilizer are often required if the soil is of poor quality. Soils will erode quickly from steeper slopes, with more fertilizers being applied to supplement the nutrient loss. Eutrophication, or excess nutrients, and siltation of receiving waterbodies often results, leading to degradation of water quality and fish habitat.

Use of Agricultural Chemicals

Insect pests are a major problem for the farmers in the LMB, particularly in

high-yield rice paddies. The over-use of pesticides may be common in the region, and the type of chemical used is also of concern. Rice farmers often use organophosphate and carbamate insecticides; these chemicals tend to be less persistent in the environment, but many are acutely toxic to birds, fish and aquatic insects. Organochlorines like 2,4-D and lindane are used as well. These chemicals are toxic and highly persistent in the environment, posing a threat to aquatic organisms, farmers and consumers of the crops. Highly toxic chlorinated hydrocarbons like DDT, which are banned in most developed countries, are still in use in the region because they are cheap, available, and effective.

The extent of the impacts of pesticide use in the MRB is difficult to assess, but long term effects on the aquatic environment are potentially serious. Hazards are likely to arise from:

- Acute toxicity, resulting in fish and invertebrate kills
- Chronic toxicity, leading to reduced reproduction or deformities in offspring
- Accumulation of chemicals in body tissues; risks to human health, and other top predators, can result.

The increased use of fertilizers in the MRB can also contribute to degraded water quality in the region. Run-off of agricultural drainage water can lead to eutrophication, which is a process of nutrient enrichment (usually by nitrates and phosphates) in aquatic ecosystems. Sewage disposal and urban land drainage can also cause eutrophication. The rapid increase in nutrient levels stimulates algal blooms. On death, bacterial decomposition of

the excess algae can seriously deplete oxygen levels, thereby reducing oxygen available for fish and other aquatic life and causing fish kills.

FISHERIES

The LMB is one of the most productive areas in the world for fish, with more than 1,300 fish species identified. However, the biology, life cycle, migration and food sources of many of these species are poorly understood. The Mekong River fishery sustains millions of people; fish is the main source of animal protein in some areas and fishing is the basis of many local economies.

Capture Fisheries

The capture fishery can be divided into three segments:

1. Large-scale and fully commercial, based on leased lots. Extended bamboo fences and the installation of dais (large set nets approximately 25 m wide by 12 m deep, with a 80-100 m net funnel) are the primary capture methods of the commercial fishery.
2. Medium-scale commercial fishing based on licensed gear. Capture methods include seine nets, drift nets, gill nets, hook lines, various traps, lift nets and scoop nets.
3. Small-scale, semi-commercial and subsistence fishing. Certain areas within the large commercial lots may be reserved for subsistence fishing. Small gill nets and traps are common capture methods.

Some of the more important fish species of the capture fisheries include:

- Species that are associated with smaller streams and tributaries of

the Mekong River, as well as with the Great Lake. This group includes species from families of marine origin that migrate from brackish to fresh water. Families include: *Clupeids*, *Sciaenidae*, and *Soleidae*.

- Species that are mainly associated with the larger streams and the Mekong River itself. They are commonly called 'white fish' and migrate between home streams and flooded areas during the rainy season. Families include: *Cyprinidae*, *Siluridae* and *Notopteridae*.
- Species that are able to survive under more adverse environmental conditions, such as lower dissolved oxygen and higher acidity. They tend to stay in swamps and flooded plains year round and are termed 'black fish'. Members of this group are carnivores or detrital feeders, and some are able to migrate over land, as they have organs for oxygen uptake from atmospheric air. Families include: *Clariidae*, *Bagridae*, *Ophicephalidae* and *Anabantidae*.
- Species that are smaller, fast growing, prolific and opportunistic. They use the flood period for quick reproduction and growth. This group mainly consists of small *Cyprinidae*. Due to their biology, they can exhibit very high abundance in a distinct seasonal pattern. These fish are mainly used for feed for caged culture fish, or to make fish paste and fish sauce.

Threats to fisheries in the MRB include habitat destruction, biological and chemical pollution, constraints to fish migration, exotic fish species, and over-fishing or illegal fishing methods.

Concerns are heightened that due to increasing fishing pressure, some species are decreasing (both in size and quantity).

Aquaculture

Fish culture in floating cages is an age-old cultural practice in the MRB. Wild surplus fish are kept in bamboo pens and cages. The cages are used to transport the fish to market. In general, fish are cultured in pens during the dry season, when water levels in the Basin are low. The fish are then transferred to large floating cages at the onset of the rainy season.

Pond culture is also very prolific and successful in the Basin. Catfish are often cultured in ponds, particularly by smaller-scale farmers. Water is exchanged periodically through a screen, which prevents the entrance of predacious fish. This culture method is similar to cage culture, but fish density is generally lower.

The flourishing aquaculture industry brings new environmental threats to the natural fisheries of the region. Water quality degradation is common to fish aquaculture operations. Latrines are sometimes hung over the fish ponds, and fish are often fed with community wastewater effluent. The wastes from large-scale fish culture operations include uneaten food, faeces and ammonia. Chemicals used for disease treatment may also be released into the natural environment. These chemical and biological pollutants can cause dissolved oxygen depletion, increased biochemical oxygen demand (BOD), which further reduces oxygen available for fish, high turbidity and excess nutrient loading.

The Endangered Giant Catfish

The Giant catfish (*Pangasianodon siamensis*), a native of the Mekong Delta, is receiving international concern about its continued survival. While capture of the fish is illegal in Cambodia, Giant catfish are known to still be harvested.

In 1999, the Fisheries Department of Cambodia introduced a buy-and-release program for captured Giant catfish in order to determine how abundant the fish were.

A Giant catfish hunt is held each year at Chiang Khong, located between Lao PDR and Thailand. Sperm and eggs are stripped from the captured fish and used for the Thailand Department of Fisheries' breeding program. In 1992-1993, more than half a million Giant catfish fry were produced for stocking rivers, for farm operations and for additional breeding experiments. Currently, about 100,000 fry are expected from one pair of Giant catfish caught just before spawning. Breeding remains dependent on the capture of wild stocks, as the production of broodstock in captivity has not yet been possible.

The development of a hybrid by fish farmers, called the Big Sawai, or just 'Big Y', is also an issue of concern. The hybrid is a cross between the Giant catfish and a similar catfish species, the Pra Sawai. Hybrid fingerlings are known to have escaped into the Chao Phraya Basin. So far, the hybrids have not been found in the Mekong Basin, where the dwindling population of Giant catfish remains. However, it may be only a matter of time before the Pla Sawai hybrids reach the Mekong.

The hybrids are known to breed well with Giant catfish. At this point we can only speculate on the consequences of the mixing of wild Giant catfish with the hybrids. The genetic purity of the wild Giant catfish may be forever altered or lost.

Exotic fish species are often preferred in the aquaculture industry. The risk of escape of exotic species is great. Many countries are faced with escaped exotics that flourish in the natural environment, displacing native species and reducing ecosystem diversity. Alternative, economically viable culture systems for indigenous species are needed in the MRB. However, culture of native species can also threaten regional biodiversity if not properly managed. Unintentional release or escape of hatchery-reared fish may affect local wild populations by genetic contamination. Hatchery-reared fish that have been bred for more commercially-valuable traits may lose some of the traits necessary for survival in the wild. Hatchery fish and wild fish in different parts of the Basin may breed, creating entirely separate hybrid populations. Massive stocking of hatchery fish into local waterbodies may increase fishing pressure, further endangering the wild genetic stock.

Coastal Shrimp Aquaculture

Mangrove coastline of the MRB is frequently cleared for the installation of shrimp aquaculture operations. Loss of mangroves combined with intense culture operations has the potential to reduce the availability of wild shrimp for stocking the ponds. Loss of shrimp broodstock and water quality deterioration also result from intensive aquaculture operations. In addition, the following environmental impacts should be addressed when assessing future shrimp aquaculture operations:

- Water pollution due to release of pond effluent
- Sedimentation due to release of solid material from ponds
- Interruption of water flow patterns

- Higher incidence of disease among stock due to limited movement of the shrimp
- Mortality among natural shrimp and fish stocks due to the release of toxic material
- Product contamination due to indiscriminate use of chemicals.

Migration Routes

Fish migrations in the Mekong River are significant elements of the Basin's ecology. They are also intimately related to the lives and cultures of local people, for many communities depend on the seasonal return of migratory species for food and income. For example, the Trei Riel (*Henichorhynchus siamensis*) is a small fish that is very important as a food source in Cambodia. Nearly 60% of the dai (large set nets) fishery is Trei Riel. This species is caught from December to February when it migrates out of the Great Lake.

The Trei Riel spawn upstream of the Tonle Sap and return to the Great Lake from May to July, at the start of the rainy season. The fish are known to travel upstream into Lao PDR and Thailand, and downstream into Vietnam, covering a total of more than 1,000 km. There they enter tributaries, canals and flooded areas and form the basis of important regional fisheries.

Human activities within the MRB, however, can seriously impact or cut off migration routes. Migration routes within the Basin must be kept open to enable fish species to return to the upper Mekong River, Tonle Sap River and the Great Lake. Activities such as dam and reservoir construction, stream channelization and construction of irrigation canals can restrict or reduce

water flow along migration routes. Populations of migratory fish are effectively cut off from important habitats necessary for the completion of their life cycles.

FORESTS

Forests are central to the livelihood of the people in the MRB. The forests of the Basin provide a wide range of important and beneficial ecological functions. They protect rich tropical soils, stabilize watersheds, and regulate water flows and local weather systems. They also help prevent both flooding and drought, which are serious problems in the area.

They are home to the remarkable number of species that make up the vast biodiversity reserves of the region. Forests are also of immense spiritual and cultural importance to the people of the MRB.

Yet even with all these recognized values of the region's forests, this resource is rapidly being depleted. The forests of the MRB are one of the region's primary natural resources harvested for sale. The forests are facing ever-increasing environmental degradation, primarily due to commercial logging, much of it illegal. Shifting cultivation, frequent uncontrolled forest fires and local demand for fuelwood also impact the forests.

Revenues from legal and illegal logging in the region are immense. Estimates from timber sales for Cambodia were in excess of US\$130 million per year in the late 1990s.

The list of environmental impacts resulting from clear-cutting is long and potentially devastating to the people and wildlife of the MRB. Landslides are

increasingly common along many sections of rivers and streams, often destroying homes and sometimes killing people. Rapid deforestation deposits heavy sediment loads to waterbodies. This leads to flooding in areas where it is generally not known to occur. In addition, the shallowness of the streams and rivers causes them to dry up more quickly; storage volume is reduced, and the forest vegetation is no longer present to slow water loss. There have even been reports of unexpected storms occurring in interior areas of the region, as forests are no longer there to act as natural barriers against strong winds.

Forest cover in the LMB was estimated at about 50% in the 1970s; now, it is less than half the original estimate. Loss of *Melaleuca* forests in the U Minh swamp (i.e., a significant source of freshwater fish in Vietnam) and the destruction of coastal mangroves are believed to have negatively affected regional fisheries. Erosion and sedimentation from the deforestation on the Khorat Plateau and upland areas in Lao PDR and Thailand also impact downstream fisheries.

Recent logging around the Great Lake and along the Mekong River has led to some disturbing impacts on the local fisheries. During the rainy season, the flooded forests normally provide shelter and abundant food to a multitude of fish species. Without these trees, fish numbers dwindle. Reduced fish numbers can have serious consequences for the local people who depend upon the fish for food.

Deforestation is also causing serious water shortages in some parts of the region. Water shortages are a serious threat to the rice crops, many of which are already in need of improved irrigation.

WILDLIFE AND BIODIVERSITY

The extensive variety of native flora and fauna within the LMB is coming under increasing pressure from activities such as logging, continued clearing of land for agriculture and urbanization.

Impacts from the agricultural sector result from changes in patterns of traditional land use, commercial agriculture operations and use of agricultural chemicals.

Agricultural pesticides will have an increasing impact on the natural ecosystems of the region, and thus can harm the resident species. Some chemicals, like methyl parathion, are banned in Lao PDR, yet produced in Thailand and sold illegally to Laotian farmers. As mentioned earlier, DDT is still used in some areas of the MRB, primarily by rice farmers. These chemicals are used with lack of training, not only on crops, but also to poison aquatic resources as a harvesting method. In many villages cropland is physically adjacent to or linked through food webs to terrestrial and aquatic habitats. Without adequate protection measures, continued use of these toxic chemicals will cause degradation of habitat and loss of resident species diversity.

Impacts from urbanization are primarily related to rapid growth coupled with inadequate sewerage systems. Many streams and tributaries of the Mekong and Tonle Sap rivers drain urban areas, carrying raw or improperly treated sewage. Water quality degradation can cause a reduction in the number and abundance of native plant and fish species, paving the way for domination by less sensitive and exotic species.

Hunting and harvesting of wildlife products are also on the rise in the MRB, and can lead to a reduction in native biodiversity. There is a long tradition of hunting in the region, and rural communities are often dependent on hunting and the harvesting of wild products to supplement seasonal rice harvests. Portions of many wild animal species are also used for medicine and trade.

Commercial hunting and trade in wildlife products is increasing as prices have risen and access to some remote areas within the Basin has improved.

Exotic Species in the Mekong River Basin: The Water Hyacinth

The invasion and success of water hyacinth (*Eicornia crassipes*) in the MRB serves as a reminder of the impacts of human disturbance on aquatic ecosystems. Water hyacinth is a native of South America, but it has been introduced into many tropical ecosystems of the world. The plant is believed to have arrived in Southeast Asia in the late 1800s to early 1900s.

Water hyacinth is considered one of the worst weed pests in the world, for it is very productive and forms dense, almost impenetrable, mats that interfere with navigation, irrigation and hydro electric power generation. The mats competitively exclude native submerged and floating-leaved vegetation. Low oxygen conditions develop beneath the mats, creating an unfavorable environment for fish. The reduced water flow caused by the mats of hyacinth creates an ideal breeding ground for mosquitoes.

Water hyacinths grow over a wide variety of wetland and aquatic habitats, including lakes, ponds, canals, ditches and backwater areas. The plant tends

to colonize recently disturbed areas where the natural hydrologic regime has been altered, or in waterbodies with high nutrient content. Large water hyacinth infestations are often a clear indicator of nutrient-enriched water and could be expected in the receiving

waters of agricultural drainage or raw sewage effluent.

Threats to natural resources and the traditional way of life in the MRB as development increases, as discussed in this lesson, are summarized in Table 1.

Table 1 Natural resources and ecosystems at risk in the MRB

PHYSICAL RESOURCES	ECOLOGICAL RESOURCES	HUMAN USE & QUALITY-OF-LIFE VALUES	DEVELOPMENT
Deteriorating surface water quality due to both point and non-point sources of pollution	Aquatic ecosystems are being degraded by development activities	Subsistence economies in areas of limited natural resources threaten sustainable environmental quality and sustainable quality of life	Development of waterway and road transport, pipeline and electricity transmission links may negatively impact resource use and sustainability
Changes in hydrological regimes due to development projects	Fish are adversely impacted by development activities and overfishing	Water-related diseases are degrading public health	Increased logging and land encroachment degrade watersheds and affect resource use and sustainability
Sedimentation is critical and intensifying	Flooded forests are threatened by increased exploitation of biological resources and development activities	Rural women have low social position, poor work skills, and lack awareness of methods for sustainable use of natural resources	Development activities which impact fish habitats and increased fish consumption are decreasing fish populations
Soil quality is expected to further deteriorate	Wildlife, particularly waterbirds, is adversely impacted by development activities and unsustainable exploitation.	Environmentally sound cultural heritage, which contributes to the stability of socio-ecological systems, is being lost.	Urban and industrial wastes threaten downstream resource use and sustainability
			Irrigation development in saline soils and improper rock-salt exploitation on the Korat Plateau and Vientiane Plain adversely impact downstream resource use and sustainability
			Agricultural intensification and improper use of agro-chemicals is degrading water quality
			Intensive salinity control in the Mekong Delta causes adverse impacts on resource use and sustainability
			Irrigated agricultural intensification and expansion decreases water availability for other uses.