

Regional definition

This section describes the boundaries and the main physical and socio-economic characteristics of the region in order to define the area considered in the regional GIWA Assessment and to provide sufficient background information to establish the context within which the assessment was conducted.

Boundaries of the Mekong River region

The Mekong River and its network of tributaries form the vast Mekong River Basin, draining parts of six riparian countries: Cambodia, China, Lao PDR, Myanmar, Thailand and Vietnam. The river is an international water body which flows from its source in the Tanggula mountain range in Qinghai province, China (MOC/China 2004) for 2 161 km through Qinghai province, the Tibet Autonomous region and Yunnan province of China, and another 2 719 km through countries of the Southeast Asian peninsula to the south of Ho Chi Minh City in Vietnam, where it discharges to the South China Sea (MRC 1997a). Its total length is about 4 900 km.

The boundary of the Mekong River region includes the entire Mekong River Basin (MRB) and the coastal area adjacent to the Mekong Delta (Figure 1). The total catchment area is about 795 000 km², producing a run-off of approximately 475 000 million³ during the rainy season (MRC 1997a). The part of the MRB within China and the eastern end of Myanmar is known

Figure 1
Boundaries of the Mekong River region
(Source: Elevation based on USGS 2003)



as the Lancang or Upper Mekong River Basin (UMRB), and the lower part, the Lower Mekong River Basin (LMRB). The UMRB is predominantly mountainous, whereas lowlands and floodplains prevail in the LMRB. The LMRB covers about 70% of the whole basin and is its most important part both environmentally and economically. Its population is largely rural and employed mostly in agriculture or related activities, with rice as the major crop (Chu et al. 2003).

Physical characteristics

The Mekong River Basin comprises a large network of tributaries, forming many sub-basins. While the watersheds of the UMRB are contiguous (Figure 1), those of the LMRB are much more complex with around 125 small and large watersheds (MRC 1997a). Watersheds with areas of more than 10 000 km² are shown in Figure 2 and their areas listed in Table 1. The watersheds harbour large areas of forest, paddy fields, streams and creeks forming a complex, rich and diverse ecosystem supporting over 65 million people.

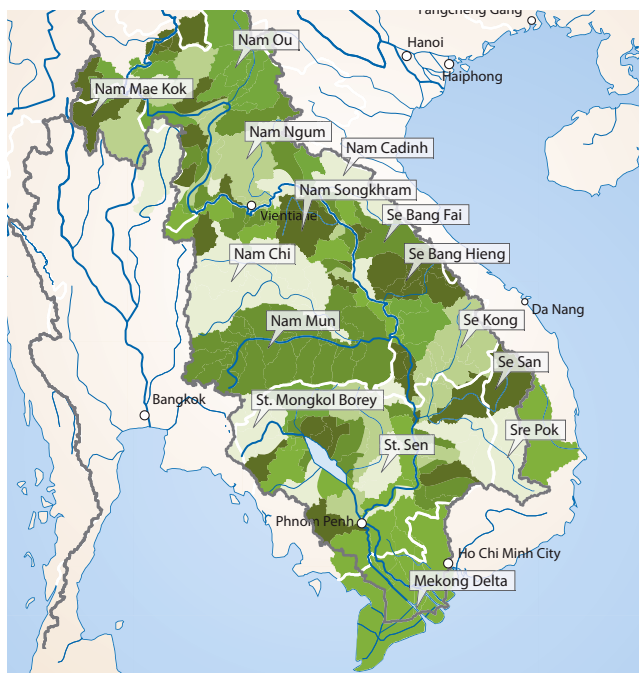


Figure 2 Major watersheds in the Lower Mekong River region
(Source: Redrawn from MRC 1997a, MRC 2004)

The Mekong River Basin is divided into six bio-geographical zones or landforms as shown in Figure 3 and Table 2:

- Lancang River Basin (UMRB) (parts of Qinghai province, the Tibet Autonomous region and Yunnan province in China);

Table 1 Areas of the major watersheds in the Mekong River region

| Name of watershed | Area (km ²) | Name of watershed | Area (km ²) |
|---------------------------------|-------------------------|-------------------|-------------------------|
| Lancang River (Yunnan province) | 89 320 | Nam Mun | 70 900 |
| Nam Ou | 25 830 | Se Kong | 28 710 |
| Nam Mae Kok | 10 780 | St Sreng | 10 380 |
| Nam Ngum | 17 170 | Se San | 18 710 |
| Nam Cadinh | 14 860 | St. Mongkol Borey | 11 350 |
| Nam Songkhrum | 13 090 | Sre Pok | 31 11 |
| Se Bang Fai | 10 240 | St. Sen | 16 250 |
| Nam Chi | 49 100 | Mekong Delta | 49 520 |
| Se Bang Hieng | 19 340 | | |

(Source: Hirsch & Cheong 1996, MRC 1997a, Puustjarvi 2004)



Figure 3 Bio-geographical zones of the Mekong River region
(Source: MRC 1997a, MRC 2004)

Table 2 General statistics relating to the Mekong River Basin

| | |
|---|---|
| Basin (catchment) area (2004) | 795 000 km ² |
| Area above 3 000 m altitude (2004) | 62 000 km ² (7.8% total basin area) |
| Mean annual run-off (2004) | 560 mm |
| Discharge volume (2004): Rainy season Dry season | 475 000 million m ³ 78 800 million m ³ |
| Major cities in the MRB (2004) | Phnom Penh (Cambodia); Vientiane (Lao PDR); Luang Phrabang (Lao PDR); in Vietnam: Cao Tho, Nong Khai and Khon Khean |
| Loss of original forest area (up to 1998) | 69% |
| Deforestation rate (1998) | 16% |
| Eroded area (1998) | 21% of total basin area |
| Large dams (>1 500 MW) in operation (2003): UMRB LMRB | 4 0 |
| Small dams (<1 500 MW) in operation (2003): UMRB LMRB | 4 11 |
| Wetlands (1998) | 9% of total basin area |
| Protected areas (1998) | 5% of total basin area |
| Population density (1998) | 78 people per km ² (average for entire MRB) |

(Sources: ADB/UNEP 2004, WRI 2004)

- Northern Highlands (parts of Yunnan province in China, Lao PDR, Myanmar and Thailand);
- Korat-Sakon Plateau (parts of northern Thailand and southern Lao PDR);
- Eastern Highlands (parts of Lao PDR and Vietnam);
- Southern Uplands (part of Cambodia); and
- Lowlands (parts of Cambodia, Lao PDR and Vietnam including the Mekong Delta and its associated coastal area).

Lancang River Basin

The watershed of the Lancang River is typified by high mountains and deep gorges. The northern part of the river valley lies at some 2 000 m and is flanked by mountains of 3 500 to 5 000 m (MRC 1997a). The central part of the catchment comprises medium-sized mountains and wide, fertile valleys above 1 000 m. This is the most habitable and populated part where relatively large-scale agricultural, industrial and urban development has taken place. The southern part of the catchment is characterised by medium to low mountains and valleys below 1 000 m, with limited arable land and small population centres. The high flow relief of the Lancang River (average 6.5 m/km) provides potential for hydropower development (Hirsch & Cheong 1996, MRC 1997a).

Northern Highlands

The Northern Highlands cover parts of southern Yunnan in China, eastern Myanmar, northern Thailand and northern Lao PDR (Figures 1-3). The MRB here is characterised by high mountains with several peaks

rising to over 2 000 m and valley floors more than 600 m below the mountain crests. The rough terrain is largely uninhabitable, thus human population is sparse. Agricultural activities are limited to rice production in the narrow valley floors and shift cultivation on the mountainsides. The greatest development potential of this area is for hydropower. Some large-scale hydropower schemes are already established in Myanmar, Thailand and Lao PDR (Hirsch & Cheong 1996).

Korat-Sakon Plateau

The Korat-Sakon Plateau extends over northern Thailand and the floodplains of southern Lao PDR. It is surrounded by the northern and eastern highlands in Lao PDR and the Petchabun and Phnom Dangrek mountain ranges in Thailand and northern Cambodia (MRC 1997a). The plateau is drained mainly by the Nam Mun, Nam Chi and Nam Songkhram rivers (tributaries of the Mekong River) in the north of Thailand (Figure 2). These rivers are generally incised several meters below the predominantly sandstone plateau. The Plateau is the driest part of the MRB. It has low rainfall and most of its soils have a poor capacity for moisture retention (Hirsch & Cheong 1996). Despite low soil fertility agriculture is extensive and there is potential for further agricultural development by installing flood controls, drainage and irrigation as well as taking measures to reduce salinisation (MRC 1997a).

Eastern Highlands

The Eastern Highlands cover the mountain ranges extending over eastern Lao PDR and central Vietnam, spanning an area of approximately 300 km long and 50 km wide (Hirsch & Cheong 1996, MRC 1997a). Networks of tributary rivers draining the Highlands are numerous, the large ones are the Nam Cadinh, Se Bang Fai, Se Bang Hieng, Se Kong, Se San and Sre Pok (Figure 2). Rainfall is the highest in the MRB with its tributaries contributing about two-fifths of the total water volume in the Mekong River (Hirsch & Cheong 1996). It is the most heavily forested area of the entire MRB and rich in biodiversity. Rotational farming is the commonest crop production method practiced by a wide range of indigenous communities in this area (Evans 1992). The upper part of the Highlands, generally of high relief, has a high potential for hydropower development; several large projects are already underway or imminent in the Laos and Vietnamese sections (Hirsch & Cheong 1996).

Southern Uplands

The Southern Uplands are extensions of the Northern Highlands and include the Cardamom and Elephant ranges in southeastern Cambodia (MRC 2003). They are drained by the Tonle Sap River which flows northward into the Tonle Sap, the great lake of Cambodia (see below), and by the Prek Thont River into the Basaac River (Hirsch & Cheong

1996). The uplands, including the mountain ranges, are still densely forested. They have low population densities and are considered significant areas for nature conservation.

Lowlands

The Lowlands cover a large part of the northern half of Cambodia and areas in southern Lao PDR, eastern Thailand and southern Vietnam, as well as the Mekong Delta and its associated coastal area (Figure 3). The Mekong River flows from the highlands of the Korat-Sakon Plateau to the northern part of this vast lowland area where it is broken by the Khone Falls (Figure 3), which form an obstruction to navigation. Surrounding habitats have great aquatic biodiversity significance (Hirsch & Cheong 1996). Two landforms of great importance in these Lowlands are the lake Tonle Sap on the floodplain in Cambodia and the Mekong Delta mainly in Vietnam. The Tonle Sap is the largest lake in Southeast Asia. It serves as a natural reservoir storing flood waters from the surrounding watersheds and regulating river flows in the dry season, thus helping to relieve droughts in southern Cambodia and the Mekong Delta (MRC 2003). The lake's area can increase from 250 000 to 300 000 ha in the dry season to as much as 1.3 million ha in the rainy season (MRC 1997a, MRC 2003).

The Mekong Delta is a triangular area at the southern tip of the Lowlands (Figure 3). It covers around 49 520 km² with 74% of this area in Vietnam and the rest in Cambodia (MRC 1997a). The Delta is historically the most densely populated area of the MRB with large areas of fertile agricultural lands (Snidvongs et al. 2003). It can be divided into three sections: upper, middle and lower. The upper section has strong natural levées – embankments built on either side of the river by accumulated deposits of silt. Behind the levées there are wide depressions. The middle section includes well drained arable land as well as poorly drained areas. The lower section is formed by the river distributaries and their associated sediments (Tuy 2004). The coastline along the Delta is around 650 km in length of which around 350 km borders the

South China Sea and the remaining 300 km flanks the Gulf of Thailand (MRC 1997a). The coastal area is characterised by large estuaries, sand dunes, tidal marshes and mangrove forest (MRC 1997a).

The Mekong Delta has three major water and land resource problems. Acute flooding occurs during the wet season when flood waters can rise more than four metres in much of southern Cambodia and the upper Delta (Hirsch & Cheong 1996). Another problem is the occurrence of acid sulphate soils in several areas, making them unsuitable for agriculture. Actual and potential acid sulphate soils, covering an area of about 1.6 million ha, occur mainly in the Dong Thap Muoi and Long Xuyen quadrangles (Cao 2004). The third problem is that of saline water intrusion. During the dry season, the river flows are so low that sea water intrudes the lower reaches; this produces brackish water conditions that are unsuitable for rice production (White et al. 2004).

The climate

The climate ranges from cold temperate and tundra in the UMRB to typically tropical monsoonal in the LMRB. In the UMRB, the peaks of the higher mountains in the catchment of the Tibet Plateau are almost permanently snow-capped. The climate is cold without any clear summer season and rainfall is generally low (Liu 2004). At lower elevations in Yunnan province, the climate is predominantly sub-tropical with higher rainfall (as high as 1 700 mm annually) and clearly demarcated seasons (Chu et al. 2003). Elsewhere in the LMRB, the climate is largely tropical monsoonal. The southwest monsoon usually begins in the latter half of May and continues to early October. The northeast monsoon starts in early November and continues to early March.

In the LMRB the southwest monsoon brings high rainfall resulting in the onset of the rainy or wet season while the northeast monsoon has low rainfall and forms the dry season. Air temperature is remarkably uniform due to the area's maritime influence and generally low elevation. High temperatures occur except during part of the northeast monsoon when

Table 3 Key characteristics of the various bio-geographical zones

| Bio-geographical zone/landform | Rainfall (mm/year) | Type of vegetation & land | Population density (person/km ²) | Main economic activities | Environmental problems |
|--------------------------------|-----------------------------|---|--|---|--|
| Lancang River Basin (UMRB) | Variable: 600-2 700 | Mountain brush, meadow, pine forest, mixed evergreen & broad-leaved; some arable land | Low to moderate: 7-145 | Agriculture (frequently shifting) | Erosion, forest degradation and natural disasters |
| Northern Highlands | Wet: 2 000-2 800 | Hill evergreen and mountain forest; grassland | Low: 8-15 | Agriculture (frequently shifting) | Erosion and forest degradation |
| Korat-Sakon Plateau | Relatively dry: 1 000-1 600 | Scrubs; grassland & arable land | Moderate: 80-160 | Agriculture (irrigated and rain-fed) | Limited water resources, floods, drought, salinization and low soil fertility |
| Eastern Highlands | Wet: 2 000-3 200 | Upland savannah & rain forest | Low: 6-33 | Agriculture (shifting) | Erosion, soil degradation, forest degradation |
| Lowlands | Variable: 1 100-2 400 | Arable lowland and dense upland | Moderate to dense in Lowlands: 10-570 Very low in Upland: less than 8 | Agriculture in Lowlands (rice cultivation) Small development in Upland | Flooding, acid-sulphate soils, salinity intrusion, drought in lowland and forest degradation in upland |

(Source: Snidvongs et al. 2003)

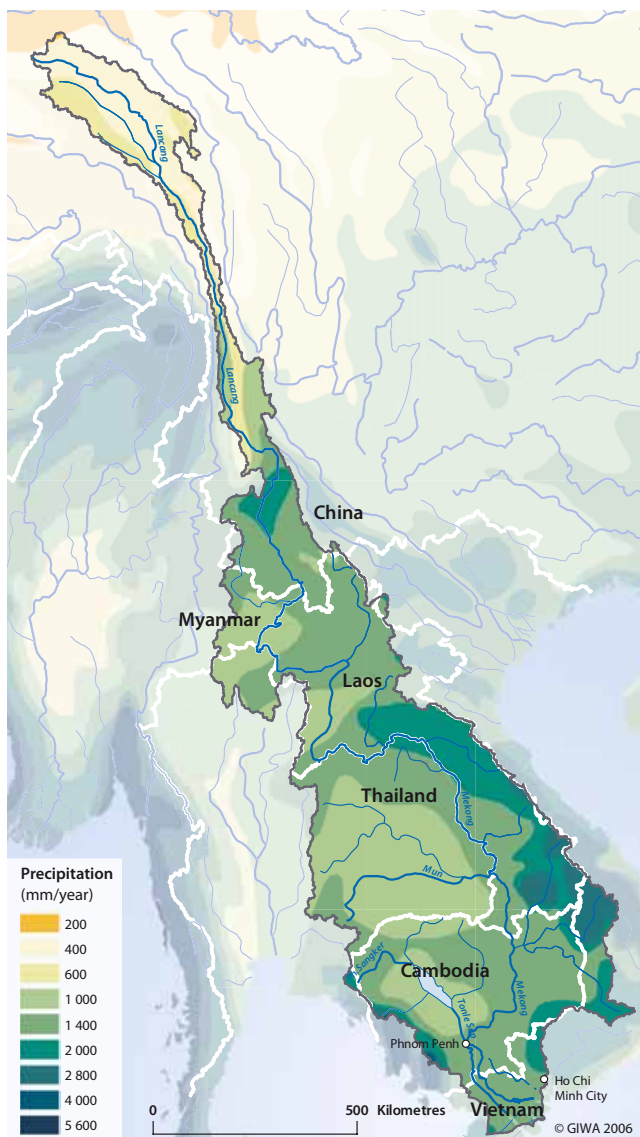


Figure 4 Precipitation in the Mekong River region
(Source: ESRI 1997)

cool winds blow from Central Asia. Lowest temperatures occur between November and February (MRC 2003). The hottest months are at the beginning of the dry season with average air temperatures of 30-38°C.

Precipitation in the region varies with location. Rainfall is low on the Tibet Plateau and increases southwards through the MRB, being the highest in the Mekong Delta (Figure 4). As indicated in Table 3, rainfall ranges from 600 to 3 200 mm per year. Cyclonic disturbances during the rainy season may cause widespread rainfall of long duration during July-September, resulting in flooding (Chu et al. 2003). With the onset of the southwest monsoon in May, the level of the Mekong River rises reaching its peak in mid-August or early September in the upper part of the LMRB, and in mid-September or early October in the Delta (MRC 2003). Flooding in the Cambodian and Vietnamese parts of the MRB is usually disastrous with up to 4 million ha of Cambodia's lowland areas and up to 1.8 million ha in the Delta inundated annually.

Water resources

The total water catchment area of the region is large (795 000 km²). The Lao PDR catchment accounts for 25% of this total, Thailand 23%, Yunnan 21% and Cambodia 20%, while Vietnam accounts for 8% and Myanmar 3%. The region's catchment produces abundant surface water resources with discharge amounting to approximately 475 000 million m³ in the rainy season and 78 800 million m³ in the dry season (Table 4). About 17-19% of this discharge is contributed by the Cambodian catchments, 32-35% by Lao PDR's, only around 2% by Myanmar's, 15-17% by Thailand's, 10-11% by Vietnam's, and 16-25% by Yunnan's. Discharges in the dry season are 4 to 7 times lower than those in the rainy season (Table 4).

The availability of surface water resources in terms of the amount internally renewable annually also varies widely by country. Around 97% of the land area of Lao PDR and 86% of Cambodia as well as

Table 4 Contribution of discharges to Mekong River Basin

| Description | Riparian country/province | | | | | | MRB |
|---|---------------------------|---------|---------|----------|----------|---------|---------|
| | Yunnan, China | Myanmar | Lao PDR | Thailand | Cambodia | Vietnam | |
| Catchment | | | | | | | |
| Area (km ²) | 165 000 | 24 000 | 202 000 | 184 000 | 155 000 | 65 000 | 795 000 |
| Contribution to MRB total (%) | 21 | 3 | 25 | 23 | 20 | 8 | 100 |
| % of total area of country/province | 38 | 4 | 97 | 36 | 86 | 20 | |
| Average discharge (million m ³) | | | | | | | |
| In rainy season | 76 128 | 9 416 | 166 195 | 80 732 | 90 193 | 52 350 | 475 014 |
| In dry season | 19 032 | 1 419 | 24 929 | 12 110 | 13 529 | 7 852 | 78 871 |
| Average discharge as % of total MRB: | | | | | | | |
| Rainy season | 16 | 2 | 35 | 17 | 19 | 11 | 100 |
| Dry season | 24.1 | 1.8 | 31.6 | 15.4 | 17.2 | 9.9 | 100 |

(Sources: ENSIC 1999, Ringler 2001, MRC 2003)

Table 5 Availability of water resources and withdrawals

| Riparian country or province | Availability* | | | Withdrawal | | Withdrawal to availability in 1995 (%) |
|------------------------------|------------------------------|-----------------------------------|---|------------------------------|-----------------------------------|--|
| | Total 1995 (m ³) | Per capita 1995 (m ³) | Estimated per capita 2020 (m ³)** | Total 1995 (m ³) | Per capita 1995 (m ³) | |
| Yunnan province, China | 2 800 000 | 2 292 | 5 171 | 500 000 | 407 | 18 |
| Myanmar | 606 000 | 13 024 | 13 366 | 4 000 | 86 | 0.7 |
| Lao PDR | 270 000 | 55 305 | 20 345 | 1 000 | 205 | 0.4 |
| Cambodia | 88 000 | 8 585 | 4 811 | 1 000 | 98 | 1 |
| Thailand | 210 000 | 3 559 | 2 392 | 33 000 | 559 | 16 |
| Vietnam | 318 000 | 4 479 | 1 647 | 65 000 | 915 | 20 |

* Availability refers to the amount internally renewable annually (** Sokhem pers. comm.). (Source: ESCAP 1998)

large areas of Thailand and Vietnam derive their water needs from the Mekong River Basin. In Yunnan province, China, the major source of supply comes from the MRB, but Myanmar is not dependent on basin waters (Table 5). As indicated in Table 5, in 1995 Lao PDR had the largest per capita availability of water resources while the availability in Yunnan province was the lowest. At the same time, Vietnam had the highest per capita withdrawal rate of the MRB's water resources, followed by Thailand and Yunnan province. Vietnam also has the highest ratio of withdrawals to availability, followed by Yunnan province, while low ratios were observed for Lao PDR, Myanmar and Cambodia (Table 5).

There are believed to be extensive groundwater resources in the region although these have not been adequately assessed (MRC 1997a). Aquifers of recent alluvium flank the mainstream Mekong River in northeast Thailand and the Mekong River Delta. These aquifers are recharged mainly through rainwater seepage. More than 6 000 groundwater wells are reported to have been drilled in these aquifers and in other parts of the MRB since 1980. Total potential capacity of the groundwater resources in the region is estimated to be around 60 million m³/day (Chu et al. 2003).

Biodiversity, critical habitats and land cover

The Mekong River Basin possesses immense biodiversity of exceptional international significance, including many unique ecosystems and a wide array of globally-threatened species (GEF 2004). These include new genera of large mammals (*Pseudoryx*, *Megamuntiacus*, *Pseudonovibos*) discovered in the past decade and many bird species identified as globally threatened or globally near-threatened, including

the famous Eastern saurus crane (*Grus antigone sharpii*), Giant ibis (*Pseudibis gigantea*), White-shouldered ibis (*Pseudibis davisoni*) and Bengal florican (*Eupodotis bengalensis*) (Friederich 2004). Aquatic biodiversity is also high. A recent study by IUCN lists the MRB as one of the nine richest habitats for fish biodiversity globally, with 298 recorded species, including the endemic Giant catfish (*Pangasianodon gigas*), the Giant Mekong barb (*Catlocarpio siamensis*) and several species of giant stingray (*Dasyatis* sp.). More recent estimates have raised this to over 480 species (Coates et al. 2003). The LMRB is considered a biodiversity hot-spot for molluscs, with 160 endemic species. The river also harbours an endangered population of Snubfin dolphins (*Orcaella brevirostris*) and the Siamese crocodile (*Crocodylus siamensis*).

Aquatic living resources represent significant biological value in terms of species composition and diversity (MRC 1997a). Fish represents the major aquatic living resource in the MRB with 1 200 to 2 000 species, the majority of which are freshwater species (Ringler 2001). Many of these are migratory and may travel far in search of food and spawning grounds. For instance, the Giant catfish (*Pangasianodon gigas*) (Figure 5) has been reported to migrate from Cambodia to its spawning grounds in Yunnan province (McElwee & Horowitz 1999).

The MRB's wetlands play a critical role as staging posts in the flyways for migratory birds. The Tram Chim National Park in Vietnam hosts almost the entire world population of Eastern sarus crane during the dry season. The freshwater wetlands are also important for migratory egrets and shorebirds, and the intertidal coastal areas, for shorebirds from northeast Asia (Friederich 2004). The total area of wetlands in the Cambodian part of the MRB is around 36 500 km², in Lao PDR 2 200 km² and in Thailand 2 000 km². The wetlands in the Mekong



Figure 5 Mekong Giant catfish.

(Photo: Suthep Kritsanavarin/U.S. Newswire Photography, 2005)

Table 6 Types and areas of land-cover in the Mekong River region

| Type of land-cover | Area (km ²) | | % of total MRB area | |
|--|-------------------------|---------|---------------------|------|
| | 1992-1993 | 2003 | 1992-1993 | 2003 |
| 1. Forest land | 340 620 | 242 475 | 42.8 | 30.5 |
| 2. Grassland, savanna & shrubland | 140 754 | 136 740 | 17.7 | 17.2 |
| 3. Wetlands – rivers & lakes | 11 643 | 69 165 | 1.5 | 8.7 |
| 4. Crop land or agricultural land | 227 518 | 323 565 | 28.6 | 40.7 |
| Non-irrigated cropland | | 277 455 | | |
| Irrigated cropland | | 23 055 | | |
| 5. Dry land or semi-desert land | 70 644 | 6 360 | 8.9 | 0.8 |
| 6. Urban & industrial centres | 438 | 16 695 | 0.1 | 2.1 |
| 7. Tundra (treeless plain with frozen subsoil) | 3 383 | - | 0.4 | - |
| Total | 795 000 | 795 000 | 100 | 100 |

Delta in Vietnam cover an area of 20 000 km². Within the UMRB, the largest known wetland is the 250 km² Er Hai lake in Yunnan province (ADB/UNEP 2004).

Forest coverage in the MRB has declined from over 70% to below 30% in the past fifty years due to destruction by logging, uncontrolled shift cultivation, the encroachment of forest reserves for human settlements, uncontrolled farming and infrastructure development (MRC 1997a). Types of land-cover and changes over the period 1992/3-2003 are shown in Table 6 and Figure 6.

Socio-economic characteristics

Population and health

The Mekong River Basin had a population of approximately 65 million people in 2000, of whom about 55 million live in the LMRB. In 2000, the average proportion of the MRB's population living in urban areas was around 29%, an increase of about 6% over that in 1990. This proportion is likely to increase significantly due to rapid urbanisation over the next decades. The great majority of the MRB's inhabitants are farmers and fishermen, as illustrated in Figure 7 by the high population densities in arable lands. About 80% of the MRB's population live in rural areas. There are 71 large cities with populations in excess of 100 000 (IUCN 2004b). The average population density is generally low, around 59 person/km² for UMRB and 88 person/km² for LMRB. The density is highest (260 person/km²) in the Vietnamese part and lowest in Lao PDR, around 24 person/km². In 1995, life expectancy, at 49-50 years, was lowest in the Cambodian and Lao PDR areas, but higher, at 64-67 years, in the Thai and Vietnamese areas.

The region is characterised by a rich cultural diversity with more than 70 ethnic groups living in localised communities and having their own languages and traditions. These ethnic groups use knowledge, traditions and land use systems that are closely interwoven with the surrounding local environment and natural resources to sustain their daily life (MRC 2003).

Health conditions for children and women are among the poorest in the world, particularly in less developed areas of the LMRB. In 1993, infant mortality rates in Cambodia and Lao PDR were high, about 3-4 times higher than those of Thailand and Vietnam. Due to economic growth in the 1990s, infant mortality rates fell in many parts of the LMRB and there will be further improvements in less developed areas if women have better access to education and health services (MRC 2003). In the MRB,

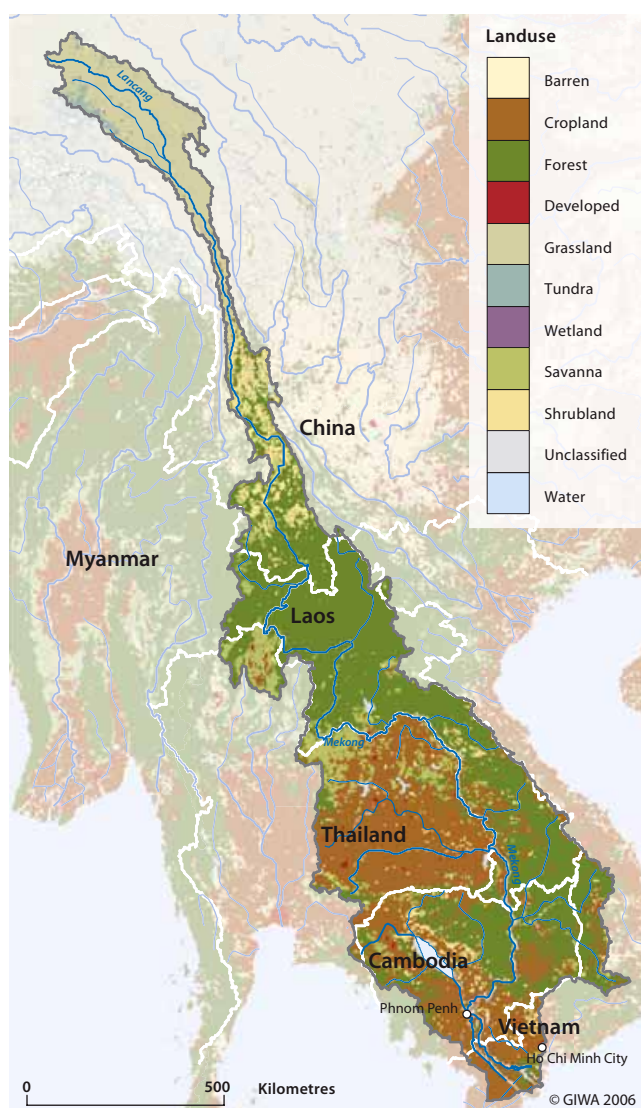


Figure 6 Land cover in the Mekong River region
(Source: IUCN 2004a)

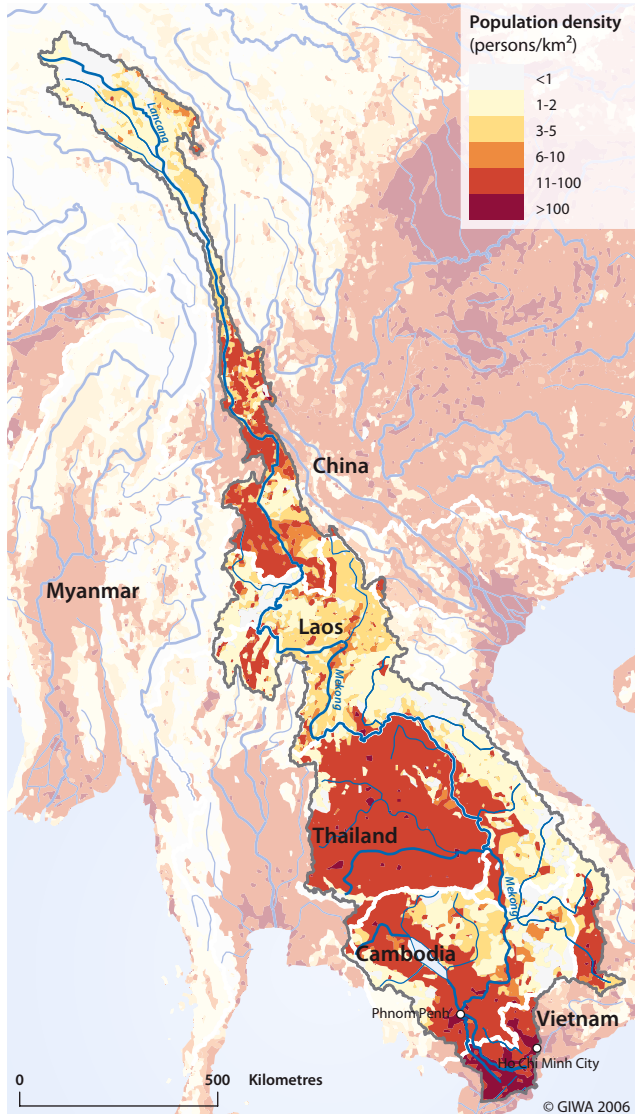


Figure 7 Population density in the Mekong River region.
(Source: data from ORNL 2003)

malaria and HIV/AIDS are the two leading public health problems. Cambodia has the highest and fastest growing rates of HIV/AIDS, although recent data suggest that the situation is stabilising. HIV/AIDS rates in Thailand have fallen due to the implementation of effective prevention programmes. However, women in the general population and their unborn children are also at risk because so many men migrate to urban centres in search of work (MRC 2003).

Hydropower

The region has a large potential for hydropower development, with some dams already in commission (AMRC 2003). Over the past ten years, more than 100 large dams have been proposed by, for example, the Asian Development Bank (ADB) and the Mekong River Commission

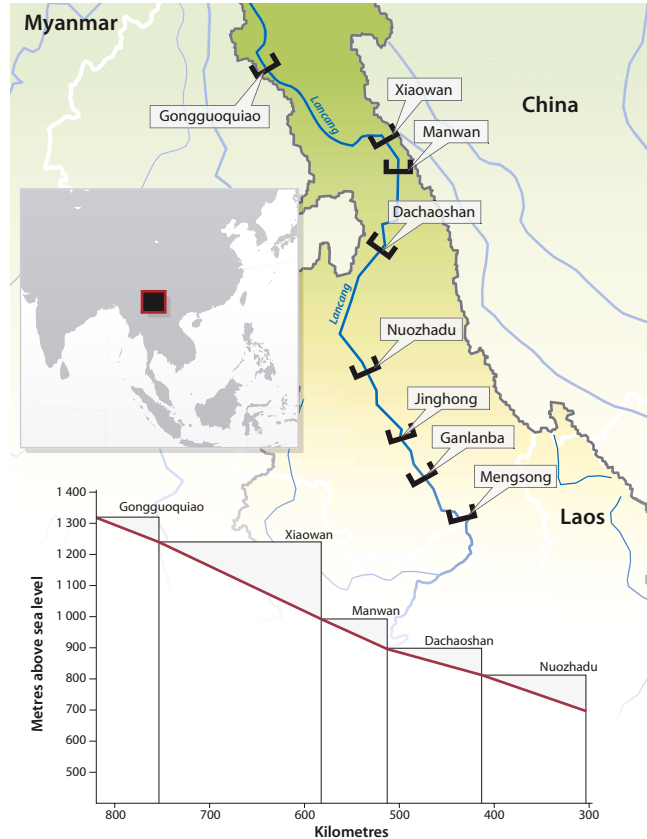


Figure 8 Location and elevation of the existing and proposed dams in Lancang River
(Source: McCormack 2000)

(MRC). In the Lancang River Basin (UMRB), development is typified by the Lancang Cascade project which aims to construct and operate dams for hydropower development. The project is creating a cascade of dams, taking advantage of a 700 m elevation drop occurring over 750 m-stretch of the middle and lower reaches of Lancang River (Figure 8). Construction of the dams began in 1986 with the Manwan Dam followed ten years later by the Dachaoshan Dam. In 2000, a total of eight dams were reported as constructed or planned (Figure 8), and, according to a recent report from the Hydropower Construction Management Professional Committee (HCMPC) of China Hydropower Engineering Association, the number of dams along the Lancang River is to be increased to 15, with a total installed capacity of 25 605 MW, construction is expected to be completed by the year 2020 (Xu & Moller 2004).

In the LMRB, most of the planned dam projects are located on tributaries in Lao PDR. A concession agreement for the development of 23 hydropower projects, having a combined installed capacity of around 6 800 MW and with an annual generation capacity of 38 000 GWh, has been signed (MRCS 1997). No new hydropower



Figure 9 Location of the completed hydro-dams along the Mekong River region

(Source: MRC 2003)

projects have been planned in the Thai part of the MRB since the most suitable sites have been developed. Although the tributaries in Cambodia have considerable potential for hydropower development, no new projects have commenced since 2000. Vietnam has plans for several hydropower projects along tributaries in the Central Highlands. Among them, the Yali dam with a capacity of 720 MW has been completed for operation (Chu et al. 2003). In addition, the MRC has plans to develop up to 13 run-of-the-river hydropower projects in the LMRB including nine sites with a total capacity of 14 000 MW, which are considered to be priority projects by the MRC (MRC 1994, MRC 1995). The existing hydropower dams in the MRB are shown in Figure 9.

Agriculture and irrigation

Agriculture is a dominant economic sector in the Mekong River Basin. About 75% of the population in the MRB is dependent on agriculture and fisheries. In 1996, agriculture contributed 11% of Thailand's national income and 52% of Lao PDR's national income. During 1987 to 1997, growth in the agricultural GDP was largest in Vietnam at 5.4% per year and slowest in Cambodia at 3.6% per year. In 1996, at least one-third of the economically active population in the MRB was reported to be employed in agriculture. Cambodia has the largest share of labour employed in agriculture at 41% of basin's total labour force (Chu et

al. 2003). For generations farmers in the MRB have used waters from the Mekong River and its tributaries to irrigate their crops. In 1999 in Cambodia, Vietnam and Lao PDR respectively about 7%, 30% and 40% of their total agricultural areas were irrigated by farmers using waters from the Mekong River and its tributaries (FAOSTAT 2004).

About 10% of the Korat-Sakon Plateau in northeast Thailand has been reported as irrigated, mainly supplementary wet season irrigation, with a total irrigated area estimated at 450 000 to 900 000 ha. In the dry season, less than 100 000 ha are irrigated by means of a series of reservoirs deriving water from the tributaries of the Mekong River (MRC 1997b). In Cambodia in 1993, the total irrigated agricultural area was estimated to be 390 500 ha, of which 70% were provided with fully or partially controlled irrigation, the remainder being used largely for floating rice production (FAO 1999). In the Mekong Delta of Vietnam, irrigation has been of particular importance in view of the rapid agricultural development in this area. The total cultivated area in 1990 was estimated to be around 2.4 million ha, of which about 1.0 million ha were irrigated. The introduction of fully or partially controlled irrigation has tripled food production, mainly of rice, from 4.5 million tonnes to 13 million tonnes between 1975 and 1995 (Phan 1996). In the Lowlands of the MRB, irrigation is increasingly used to enable a second, and even a third, rice crop as well as dry season or perennial cash-crops to expand rainy season production. The total irrigated area in the Chinese part of the UMRB in 1990 was estimated to be 291 000 ha, 90% of which were located in Yunnan province (Ringler 2001). Although large irrigation schemes have been constructed on the Chi and Mun watersheds of the MRB, local opposition to construction has slowed additional irrigation schemes. In the Central Highland areas of the MRB, irrigation is limited and used primarily for rice and coffee production (Ringler 2001).

Fisheries

Fish is the major source of low-cost and high quality protein for the people in the Mekong River Basin. Fisheries also provide income-earning opportunities for the unemployed and under-employed local communities. The Mekong River and its associated tributaries and wetland habitats provide 70-80% of fish and other aquatic animals consumed by the LMRB's inhabitants (Hortle & Bush In prep.). The MRB, mostly the LMRB, supports one of the richest river fisheries in the world. Catches from the capture fisheries constitute around 90% of the total fish production in LMRB. In 1998, total production of the capture fisheries from the MRB as a whole was around 1.16 million tonnes. Aquaculture production comes mainly from the LMRB (Coates et al. 2003),

where there are at least 2 million rural households involved in culturing fish. Total freshwater aquaculture production in the LMRB rose from 60 000 tonnes in 1990 to 255 000 tonnes, valued at 244.6 million USD per year in 2001 (MRC 2003).

Navigation

Inland water transport by boats and vessels navigating the Mekong River and its tributaries is an important mode of transport particularly for bulk cargo. The Mekong River is navigable in various sections from Nandeba, in Yunnan province, to the Mekong Delta and into the South China Sea. Almost all sections of the Mekong River and its associated tributaries are navigable during the rainy season when the river water level is high, with the exception of a 14 km-long section which contains the impassable barrier of the Khone Falls, just north of the border between Cambodia and Lao PDR (MRC 2003). Water transport in the MRB, particularly the LMRB, has traditionally been the principal means of travel for much of the population, especially for those in remote areas (Chu et al. 2003). It has been estimated that some 1.4 million Cambodians depend totally on inland waterways for transport, while in Lao PDR around 320 000 people depend on water transportation for most of the year. In Vietnam about 73% of the country's cargo tonnage and 27% of its passengers travel by water, while Thailand makes the least use of water transport because the country has the benefit of extensive all-season roads (MRC 2003).

Urbanisation and industrial development

Urban centres and industries in the Mekong River Basin depend very much on the Mekong River and its tributaries for their water supply. For example, around 60% and 30% of the population respectively of Phnom Penh in Cambodia and Vientiane in Lao PDR are connected to public water supply systems which draw waters from the Mekong River and its tributaries. The total water demand per capita and domestic-industrial water demands in 1990 and 2020 are presented in Table 7.

Table 7 Total water demand per capita and domestic-industrial demand in the Mekong River region

| Riparian country or province | Total demand per capita (m ³) | Domestic-industrial demand (million m ³) | |
|------------------------------|---|--|-------|
| | 1990 | 1990 | 2020 |
| Yunnan province, China | 250 | 121 | 328 |
| Thailand | 350 | 725 | 1 467 |
| Lao PDR | 280 | 70 | 168 |
| Cambodia | 150 | 78 | 187 |
| Vietnam | 550 | 899 | 1 994 |
| Total | | 1 893 | 4 144 |

(Source: Ringler 2001)

Minerals and energy

There are high geological and economic potentials for the development of mineral commodities in the region (ADB/UNEP 2004). Mineral resources include gemstones, alluvial gold, alluvial cassiterite, silica, bauxite, calcite and construction materials. In addition to hydropower, energy resources include fuelwood, oil, natural gas, coal and lignite. Oil, natural gas and coal occur in Myanmar, Cambodia and Yunnan province. The reserves are probably sufficient to meet future domestic needs (MRC 1997a, ADB/UNEP 2004). Fuelwood is a vital resource in most areas of the MRB and is used in 80-90% of the households in Cambodia (Sokhem pers. comm.).

Legal and institutional frameworks

Various institutions and government agencies in the region are involved in addressing and managing water-related environmental issues and problems. The functions and activities of these institutions/agencies are illustrated in Annex III. Over recent decades, all the riparian countries of the MRB have developed strategies, policies, laws, legislation and action plans (Table 8), while numerous national and international donors, funding agencies and NGOs have initiated study programmes and assessments to facilitate and support the management of the region. The programmes and initiatives as well as specific laws and legislation related to the environmental management of the region are provided in Annex IV. These initiatives form a strong legal and institutional framework playing vital roles in ensuring the environmental well-being of the region.

Table 8 National initiatives for managing the environment of the Mekong River region

| Riparian country/province | State of environment report | UNCED national report | National conservation strategy | National environmental action plan | Sector action plans for | | | |
|---------------------------|-----------------------------|-----------------------|--------------------------------|------------------------------------|-------------------------|---------------|-------------------|----------|
| | | | | | Protected areas | Bio-diversity | Tropical forestry | Wetlands |
| Cambodia | 1995 | | | 1995 | | | | 1995 |
| Lao PDR | 1995 | 1992 | | 1993 | 1993 | 1995 | 1995 | |
| Myanmar | 1995 | 1992 | | Under Prep. | | | | |
| Yunnan | 1995 | 1991 | 1990 | 1995 | | | | |
| Thailand | 1995 | 1992 | Under prep. | | | | | |
| Vietnam | 1995 | 1991 | 1985 | 1995 | | 1993 | 1991 | |

(Source: MRC 1997a)

Regional cooperation and external support agencies

External support agencies (ESAs) have contributed significantly to environmental management in the MRB, through supporting bilateral and multilateral assistance in environmental management

or assessment programmes (MRC 1997a). These programmes provide very significant inflows of foreign capital for capacity building, human resource development and technical studies related to environmental management, totalling more than 800 million USD in 1995. They provide not only funding but also technical expertise. Multilateral programmes are delivered by UN agencies, the World Bank, ADB, international NGOs and others. Bilateral programs are often facilitated through government international assistance agencies such as CIDA, DANIDA, JICA, Sida and USAID. ESAs have funded environmental activities for almost 40 years. Recently, ADB has funded projects for strengthening environmental institutions in the areas of training, NGO support, establishing legislation and regional standards and EIA. Some ESAs promote interest in technologies and services while others promote development initiatives such as infrastructure and energy development (MRC 1997a, Chu et al. 2003).

The MRC is a regional agency responsible for the overall management of the MRB with the participation of four LMRB riparian countries – Thailand, Cambodia, Lao PDR and Vietnam. The MRC has the vision of promoting “an economically prosperous, socially just and environmentally sound Mekong River Basin” with a mission to “promote

and coordinate sustainable management and development of water and related resources for the countries’ mutual benefit and the people’s well being by implementing strategic programs and activities and providing scientific information and policy advice” (MRC 2003).

Transboundary issues and implications in managing the Mekong River Basin

The Mekong River is a transboundary international waterway that traverses six countries. The land, water, forest and fish resources are shared in a number of senses and at a number of scales among the riparian countries in the region (Hirsch 2004). Thus, water used by an upstream country may become unavailable to a downstream country on a temporary, seasonal or even permanent basis. Many transboundary environmental issues, such as the upstream-downstream watershed dynamics of water quantity, quality and timing, the trade in timber and non-timber forest products, and air pollution, have begun to receive attention as regional issues. Similarly, some actors and decision-makers in the region have begun to consider issues such as livestock movements, labour migration and public health as being of importance to the regional environment.