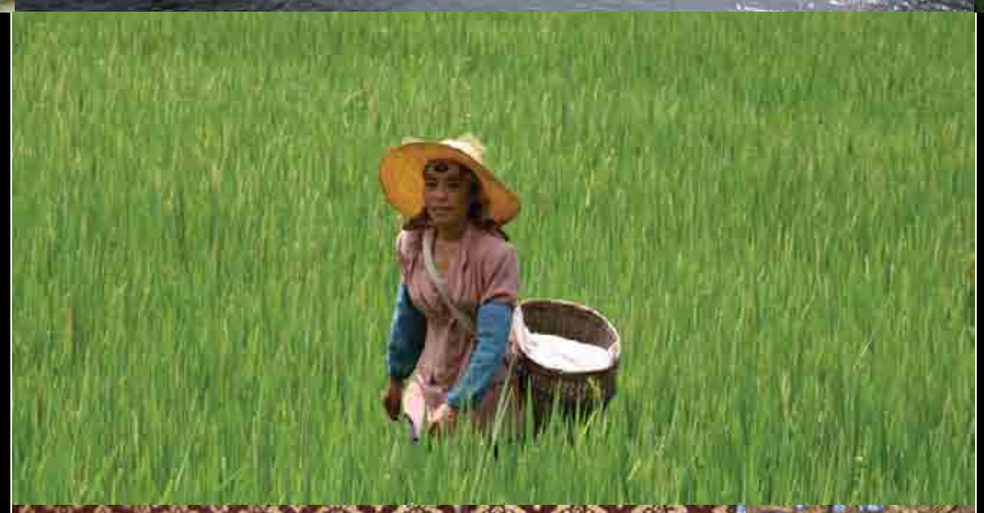
GREATER MEKONG SUBREGION

ATLAS OF THE ENVIRONMENT

2nd Edition



The Atlas has six parts:

Part I provides brief geographical, economic, and social profiles of the countries that make up the subregion.

Part II presents the diversity of peoples of the subregion and their cultures, highlights the extent of their dependence on natural resources, and shows why sustaining the environment is important for poverty reduction.

Part III discusses the state of the environment and natural resources—geology, river basins and wetlands, seas and coasts, forests, fauna and flora, and the conservation of biodiversity in protected areas.

ADB

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OF THE ENVIRONMENT

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Asian Development Bank
Manila, Philippines
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Contents

Foreword

Greater Mekong Subregional Profile
- The Greater Mekong Subregion **1**
- Cambodia **13**
- Guangxi Zhuang Autonomous Region, People's Republic of China **19**
- Yunnan Province, People's Republic of China **25**
- Lao People's Democratic Republic **31**
- Myanmar **37**
- Thailand **43**
- Viet Nam **49**

Peoples of the Greater Mekong Subregion
- Peoples and Cultures **55**
- Poverty and Environment **65**

Environment and Natural Resources
- Geology **77**
- River Basins and Wetlands **85**
- Seas and Coasts **113**
- Biodiversity **121**

Development in the Greater Mekong Subregion
- Agriculture, Fisheries, and Food Security **153**
- Water Availability, Demand, and Use **179**
- Energy **185**
- Urbanization **199**
- Transport **209**
- Tourism **227**

Challenges and Responses
- Human Resource Development **237**
- Climate Change and Natural Disasters **243**
- Regional Cooperation: Challenges and Opportunities **251**

Information Resources **261**
- List of Tables **262**
- References **289**

Abbreviations and Acronyms **295**
Photo Credits **296**
Acknowledgments **297**
Indexes **298**

This page: Evening sky, central Annamite Mountains, Viet Nam.

Front cover: *upper left:* Indochinese tiger; *lower left:* Floating Market, Mekong Delta, Viet Nam; *right top to bottom:* Li River, Guilin, Guangxi, PRC; Woman tending rice field, Yunnan, PRC; Temple detail, Luangprabang, Lao PDR; Temples of Bagan, Myanmar; Flower of red torch ginger.

Inside flap: *upper:* Nanning, capital city of Guangxi, PRC; *lower:* Women vegetable traders in Bagan, Myanmar

Back cover: Kaeng Krachan National Park,Thailand.

Inside flap: *upper:* School children, Lao PDR; *lower:* Red Lacewing butterfly.

List of Maps and Satellite Images

PAGE	FEATURE
4	Topography of the Greater Mekong Subregion
6	Population Distribution in the Greater Mekong Subregion, 2010
14	Cambodia
20	Guangxi Zhuang Autonomous Region, PRC
26	Yunnan Province, PRC
32	The Lao People's Democratic Republic
38	Myanmar
44	Thailand
50	Viet Nam
56	Ethnic Groups of the Greater Mekong Subregion
82	Soil Types of the Greater Mekong Subregion
83	Satellite Image showing the South China Karst Complex, Guangxi, PRC
83	Satellite Image showing Bolaven Plateau in the Lao PDR
86	Major River Basins of the Greater Mekong Subregion
88	Ayeyarwady River Basin
90	Thanlwin River Basin
92	Chao Phraya River Basin
96	Mekong River Basin
100	Red River Basin
102	Pearl River Basin
104	Satellite Image showing the Ayeyarwady River Delta, Myanmar
105	Satellite Image showing Tonle Sap, Cambodia
119	Satellite Image showing Mangrove Forests in Koh Kong Province, Cambodia
130	Forest Cover in the Greater Mekong Subregion, 2010
132-133	Satellite Images showing Rubber Plantations in Xishuangbanna Prefecture, Yunnan, PRC, 1998 and 2011
134	Terrestrial Ecoregions of the Greater Mekong Subregion
150	Protected Areas in the Greater Mekong Subregion
154	Land Use in the Greater Mekong Subregion
158	Rice Production in the Greater Mekong Subregion
160	Satellite Image showing Small-scale Agriculture in Isaan, Thailand
161	Satellite Image showing Rice Fields in the Mekong Delta, Viet Nam
166-167	Satellite Images showing Shifting Cultivation in Northern Lao PDR, 1993 and 2011
176	Satellite Image showing Establishment of a Commercial Plantation in Northern Myanmar, 2010 and 2011
186	Dams, Present and Projected, in the Greater Mekong Subregion
195	Proposed GMS Cross-Border Electricity Transmission Network by 2025
196	Satellite Image showing Srinakarin Hydropower Dam, Thailand
197	Satellite Image showing Nam Ngum Hydropower Dam, Lao PDR
202-203	Satellite Images showing Development of Nay Pyi Taw, Myanmar, 1990 and 2011
206-207	Satellite Images showing Kunming, Yunnan, PRC, 1992 and 2011
210	Transport Corridors of the Greater Mekong Subregion
219	Railway Network, Present and Projected, of the Greater Mekong Subregion
223	Satellite Image showing the Mekong River Rapids at Si Phan Don, Lao PDR
224	Major Airports and Routes in the Greater Mekong Subregion
228	Major Tourism Sites of the Greater Mekong Subregion
234-235	Satellite Images showing Siem Reap and Angkor Wat, Cambodia, 1990 and 2010
245	Climate Change and Rice Production in the Greater Mekong Subregion
246	Cambodia - Areas Affected by the 2011 Flood
247	Peam Krasaob, Koh Kong, Cambodia, Potentially Affected by Sea Level Rise
258	Transport Corridors, Biodiversity Landscapes, and Biodiversity Corridor Pilot Sites in the Greater Mekong Subregion

Foreword

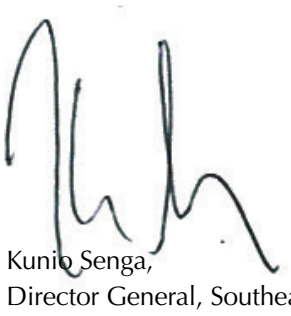
In 1992, Cambodia, the People's Republic of China, the Lao People's Democratic Republic, Myanmar, Thailand, and Viet Nam established the Greater Mekong Subregion (GMS) Economic Cooperation Program with the aim of strengthening economic linkages between them and to foster the achievement of common policy goals. When the program began, protecting the environment was a high priority.

Twenty years later, celebrating the unique culture, biodiversity, and rich environmental heritage of one of the fastest developing areas of the world, the subject of the second edition of this Atlas has become more important than ever: how to improve the livelihood of the subregion's people while maintaining its ecosystems and the services they provide for a sustainable future.

Progress in the Greater Mekong Subregion over the last two decades is reflected in improvements in infrastructure connectivity, promotion of trade and investment, stimulation of economic growth, and reduction of poverty. However, this progress has not been without adverse impacts on the environment. The GMS is poised to grow at 7.5% annually, doubling its economic output by 2020. However, increasing resource constraints, in particular finite land and water resources, suggest that innovative ways of achieving higher resource efficiency will be needed to support future development. In particular, integrating the management of energy, water, and agriculture systems will be essential in the GMS to move to more sustainable, greener paths of development.

In the 20th anniversary year of the GMS, this second edition of the atlas illustrates the exquisite beauty, bounty, and diversity of the subregion's natural environment, the tremendous progress made by the GMS countries over the past decades, and the need to address the increasing risks that they face. We hope that the atlas will be useful in providing an introduction and sound overview to those who are new to the subregion, and a benchmark of the progress made so far and the challenges that lie ahead for those who live and work there, and shape the destiny of the subregion in their daily lives.

ADB acknowledges the generous financial support provided by the governments of Finland and Sweden, and the People's Republic of China's Poverty Reduction Fund to the GMS Core Environment Program and Biodiversity Conservation Corridors Initiative, enabling publication of this atlas.



Kunio Senga,
Director General, Southeast Asia Department (SERD)
Asian Development Bank

Sunrise in Bagan, Myanmar.

The Greater Mekong Subregion

The Greater Mekong Subregion (GMS) comprises six countries Cambodia, the People's Republic of China (PRC, specifically Yunnan Province), the Lao People's Democratic Republic (Lao PDR), Myanmar, Thailand, and Viet Nam that share the longest river in Southeast Asia, the Mekong. In 1992, with assistance from the Asian Development Bank, the six countries entered into a program of economic cooperation, designed to enhance economic relations among them. Guangxi Zhuang Autonomous Region, the only other entity in the PRC sharing a border with the GMS countries, joined the GMS in 2004. Guangxi has strong linkages with the GMS especially in resources, culture, trade, transport, and tourism.

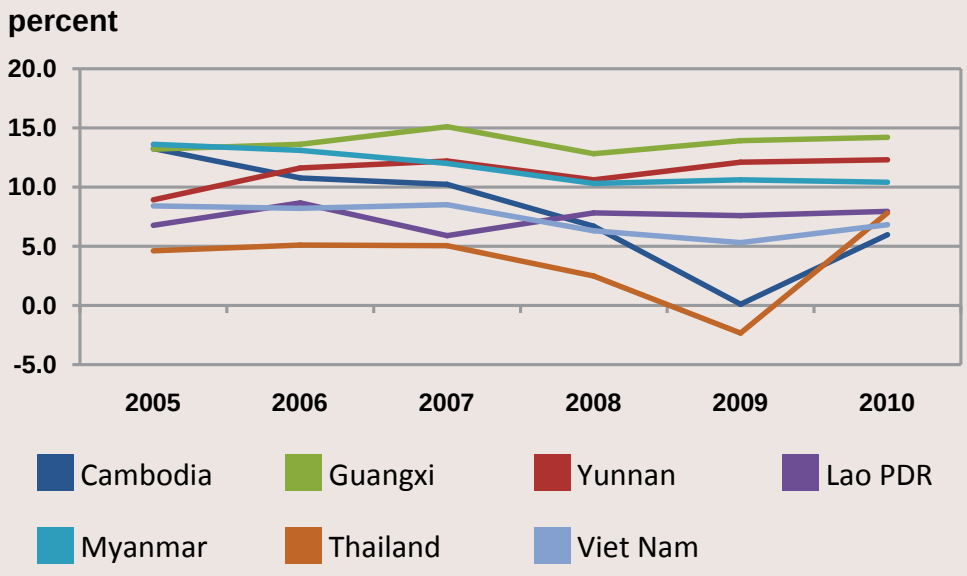
The seven culturally, ethnically, and linguistically diverse GMS entities have a total population of about 332 million (2010) spread over 2.6 million square kilometers, comparable to the population of the United States but with only one quarter of the area, and with only a small fraction of the wealth.

The subregion embraces flora and fauna that have expanded northward along the Malay Peninsula into Thailand, encroached on the high mountains from the Himalayas, or advanced along the broad river valleys as dry deciduous forests similar to those of India. Ten million years of changing sea levels have left a rich legacy of unique life forms that have evolved in isolation on the Cardamom and Annamite mountains of Cambodia, the Lao PDR, Thailand, and Viet Nam.

These resources provide both income and sustenance to the great majority of people in the subregion, who are leading subsistence or near subsistence agricultural lifestyles. The land yields timber, minerals, coal, and petroleum, while water from the many rivers supports agriculture and fisheries and provides energy in the form of hydropower. The coal reserves of the subregion are abundant and there are considerable oil and gas reserves. Most of them are in Myanmar, Thailand, and Viet Nam. These abundant energy resources are still relatively underused.

■ **Upper:** Green and modern Nanning, capital of the Guangxi Zhuang Autonomous Region, PRC. **Lower:** Golden Buddhas line a wall at Wat Po, Bangkok, Thailand.

GDP Growth in GMS Countries, 2005–2010



GDP = gross domestic product, GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Source: ADB. 2011. *Key Indicators for Asia and the Pacific 2011*. Manila; Guangxi Bureau of Statistics. *Guangxi Statistical Yearbook 2011*. Beijing; World Data Bank. *World Development Indicators and Global Development Finance*. http://databank.worldbank.org/ddp/home.do?Step=1&id=4; World Economic Outlook Database 2011; Yunnan Bureau of Statistics. Yunnan Statistical Yearbooks 2001–2011. Beijing.

Economic development in the GMS has outpaced many other parts of the world over the past two decades with national average annual gross domestic product (GDP) rates of 5%–10% in most GMS countries. Between 2000 and 2009, GDP of the subregion as a whole grew at an average rate of over 9.5%. Much of the growth was fueled by demand within the subregion for food, energy, and commodities. Between 1992 and 2004, exports grew by 300% while intraregional trade expanded even more dramatically, eleven-fold. Foreign direct investment has contributed significantly to development, with increasing amounts originating within the subregion. For instance, between 1988 and 2007, Viet Nam recorded $96.6 billion in foreign direct investment inflows; a four-fold increase being recorded between 2002 and 2006.

GMS economies have shown increasing resilience to global economic shocks; only Cambodia and Thailand dipped into negative growth during the global recession in 2008 and these as well as the

other countries showed strong positive growth in 2010. Aside from growing interregional economic links, stronger resilience can also be attributed to increasing diversification of GMS economies from primarily agricultural economies to a mix of agriculture, manufacturing, and service-oriented economies. The contribution of the agriculture sector to the overall net output of the GMS economy has declined steadily since 1995, and the contribution of the service and industry sectors has showed a corresponding increase. However agricultural practices in the GMS are also shifting from traditional subsistence approaches to more modern and commercial approaches. Although at different paces, all the GMS countries are showing trends toward increased intensification and specialization of agriculture.

The subregion's development has had a significant positive impact on human well-being. Per capita incomes have increased, with gross national income (GNI) per capita doubling in most countries between 1997 and 2007, notwithstanding inflation. GMS countries have shown steady progress toward achieving the Millennium Development Goal targets, with a number of national goals having "on track" or "early achiever" status. This is echoed by trends in the Human Development Index, which shows consistent improvement across the GMS between 2000 and 2010, and most GMS countries (with the exception of Myanmar) were classified as achieving "medium human development" in 2010.

In spite of impressive economic growth over the past two decades, the subregion still remains relatively poor, with the percentage of the population living in poverty ranging from 7.8 in Thailand to 27.6 in the Lao PDR. There are also significant differences in per capita income between GMS countries; gross national income per capita in 2011 ranged from $830 to $1,260 in the Lao PDR, Cambodia, and Viet Nam compared with over $4,420 in Thailand. Within countries, the gap between rich and poor has generally widened—the GINI coefficient, a measure of income distribution, increased for most GMS countries between 1990 and 2009, meaning increasing disparity of wealth among populations.

Economic disparities within the subregion are partially attributable to the concentration of infrastructure along the coastal areas and inaccessibility of the hinterlands, particularly upland areas, which support about a quarter of the GMS population. The subregion's population remains largely rural, ranging from 80% in Cambodia and 65% in Yunnan, to 58% in Guangxi. As elsewhere in the world, poverty is concentrated in rural areas where most households depend on agriculture and to a lesser extent on a diversified basket of farm and other wages and income from overseas relatives. Defining features of the subregion's poor are that they own very few productive assets and that self-employment, or unskilled agriculture labor, is the major source of income. Amongst the poor, women and marginalized groups, such as ethnic minorities, are affected most.

Life expectancy in the subregion, except in Myanmar, Cambodia, Yunnan, and the Lao PDR, is more than 70 years. Cambodia, the Lao PDR, and Myanmar still suffer high infant mortality rates (43, 42, and 50, respectively, per 1,000 live births, compared with Singapore's 2), while the maternal mortality ratio per 100,000 live births is high in the Lao PDR (470), Cambodia (250), and Myanmar (200) compared with Singapore's 3 (in 2010).

Cambodia, the Lao PDR, and Myanmar are particularly dependent on their large expanses of forest for the export of timber, wildlife, and other nontimber forest products. In all countries, water use for hydropower is important, and growing. All the countries in the subregion are enjoying revenues from tourism, with ecotourism—tourism based on features of the natural environment—increasing in importance.

The subregion is rich in inland riverine areas that contain a variety of wetlands and there are numerous smaller coastal rivers and drainage basins. Thus, it is not surprising that fisheries are important in several economies of the subregion as a source of protein and foreign exchange; Thailand ranks among the 10 largest fish producing nations in the world. Frozen shrimp and canned tuna are the major exports. Coastal marine fisheries are heavily exploited. If they are to remain sustainable, effective management will be needed. For all the economies (except perhaps Myanmar and Yunnan), the Mekong represents a major source

Upper: A vendor in the Bagan fruit and vegetable market, Myanmar. **Lower:** Father and son, Bagan, Myanmar.

KUNMING

NANNING

HA NOI

NAY PYI TAW

VIENTIANE

BANGKOK

PHNOM PENH

Topography of the Greater Mekong Subregion

Elevation
(meters above sea level)

- >3,000
- 1,501 - 3,000
- 751 - 1,500
- 251 - 750
- 101 - 250
- 26 - 100
- 1 - 25

- National capital
- Administrative center
- Main river
- Major lake

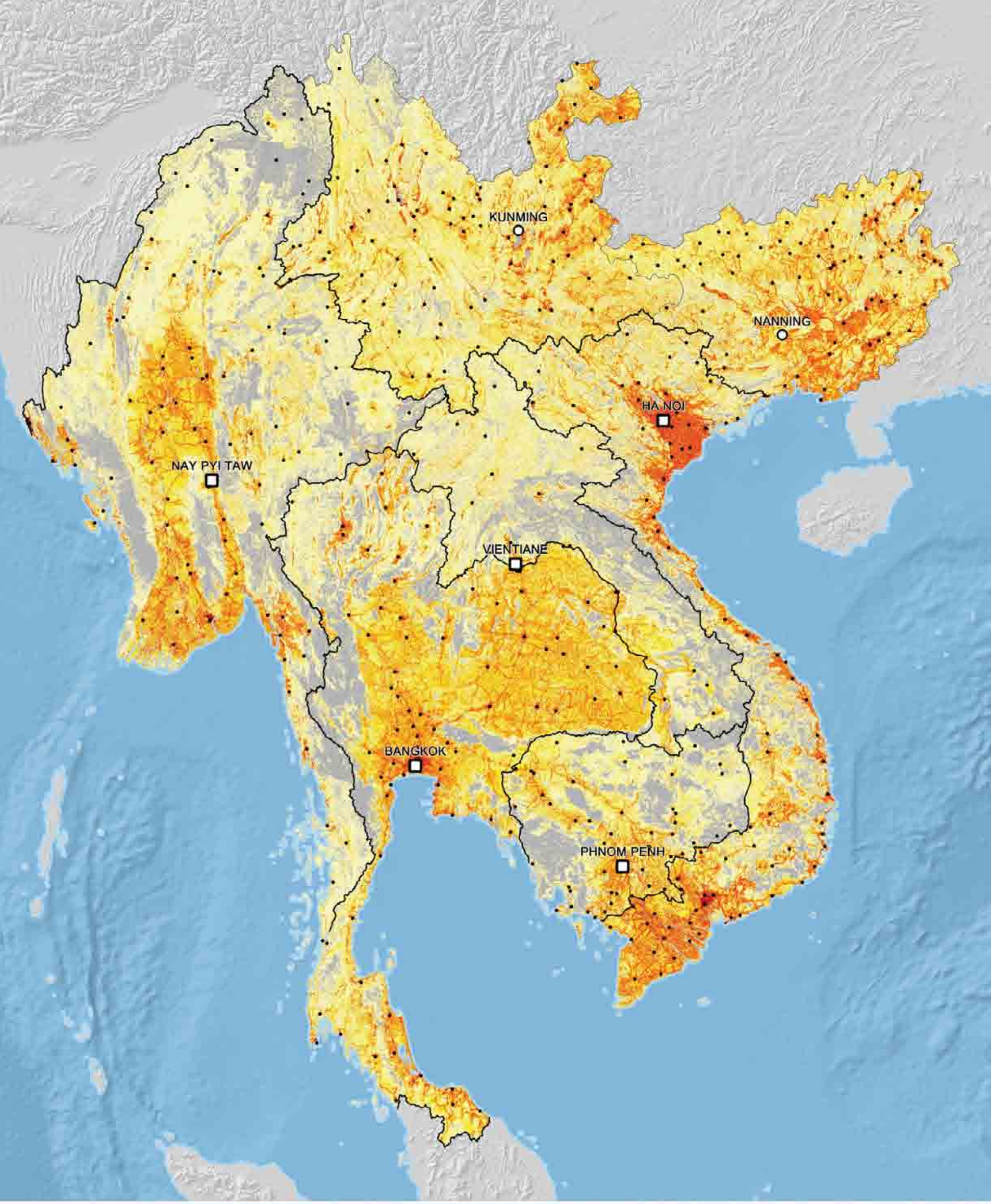
0 100 200 400 Kilometers

Boundaries are not necessarily authoritative
Data source: GMS EOC, UN FAO GAUL, NASA SRTM

Facts and Figures about the Greater Mekong Subregion

Indicator	Cambodia	Guangxi, PRC	Yunnan Province, PRC	Lao PDR	Myanmar	Thailand	Viet Nam
Official name	Kingdom of Cambodia	Guangxi Zhuang Autonomous Region	Yunnan Province	Lao People's Democratic Republic	Republic of the Union of Myanmar	Kingdom of Thailand	Socialist Republic of Viet Nam
Capital	Phnom Penh	Nanning	Kunming	Vientiane Capital	Nay Pyi Taw	Bangkok	Ha Noi
Major ethnic groups	Khmer 95.64%, Khmer Islam: 2.09%, Vietnamese 0.61%, Lao 0.11%, Phnong 0.37%, Kouy 0.33%, Stieng 0.06%, Tompuonn 0.24, Charay 0.18%, Kroeung 0.16%, Prov 0.07% and other ethnic groups.	Han 62% Zhuang 32%, Yao 3%, Miao 1%, Dong 0.7%, Gelao 0.4%, others 0.9%	Han 66.6%, Yi 10.9%, Hani 3.5%, Pai 3.4%, Dai 2.7%,Zhuang 2.6%, Hmong 2.6%, others 4%	Lao Tai 66%, Mon-Khmer 21.5%, Chinese-Tibetan 3.1%, Hmong-Lu Mien 8.8%, and others 0.6% (2008)	Bamar 68%, Tibeto-Burman 18%, Sino- Thai 8%, Mon-Khmer 5%, and others 2%	Thai 85%, Chinese 10-12%, Malay 5% and Mon, Khmer and highland ethnic groups 1-2% (2000)	54 ethnic groups: Kinh people (86%); Tay, Thai, Muong, Hoa, Khmer, and Nung (around 1 million each); Brau and Odu (several hundred people each)
Languages	Khmer (official) 96%, Vietnamese, Chinese, Lao, Thai, English and etc. France is still spokenin by some elder Cambodians (2008)	Southwest Mandarin Chinese, and Chuang patois, Cantonese	Mandarin Chinese and ethnic dialects	Lao (official), French, English, and ethnic dialects	Burmese and ethnic dialects	Thai, English (secondary language of the elite), ethnic and regional dialects	Vietnamese (official) and ethnic languages
Religions	Theravada Buddhism 96.93%, Islam 1.92%, Christianity 0.37%, others 0.78% (2008)	Taoism, Buddhism, Catholicism, other Christian denominations, Islam	Buddhism and others	Buddhism	Buddhism 89.4%, Animism 1.2%, Hinduism 0.5%, Islam 3.9%, Christianity 4.9%, and others 0.1%	Buddhism 98%, Islam 0.46%, Christianity 0.01%, others 1.53% (2005)	Buddhism, Hoa Hao, Cao Dai, Christian (predominantly Roman Catholic, some Protestant), indigenous beliefs, Islam
Climate	"Annual monsoon cycle of rainy and dry seasons. The rainy season lasts from May to October, and the dry season from November to April. December to January are the coolest months, while the hottest period is in April. The average temperature is around 27-28ºC	Subtropical, humid, monsoon climate; long, hot summers; warm, short winters; conspicuous dry and rainy seasons;	Subtropical monsoon in the southeast (East Asia monsoon) and southwest (South Asia monsoon); temperate between 2,000 and 3,000m, and frigid in the high alpine in the northwest	Tropical monsoon; rainy season (May to October); dry season (November to April)	Tropical monsoon; cloudy, rainy, hot, humid summers (southwest monsoon, June to September); less cloudy, scant rainfall, mild termperatures, lower humidity during winter (northeast monsoon, December to April)	Tropical; rainy, warm, cloudy southwest monsoon (mid-May to September); dry, cool northeast monsoon (November to mid-March); southern isthmus always hot and humid	(1) Northern Viet Nam (from Hai Van Pass northwards): highly humid tropical monsoon climate with 4 seasons (spring, summer, autumn and winter); influenced by the Northeast and Southeast monsoon. (2) Southern Viet Nam (from Hai Van Pass southwards): weak influence of monsoon; characterized by dry and rainy seasons and warm weather all year round
Total area, km^2	181,035	236,700	394,139	236,800	676,578	513,116 (2009)	331,051
Population, million	14.3	51.6	46.0	6.3	60.4 (2011)	67.3	86.9
Rural population, % of total	80.5	59.9	65.2	67	69.2 (2011)	66.0	69.8
Average annual population growth rate, %	1.5	1.3	0.7	2.2	1.0 (2011)	0.6 (2008-2010)	1.1
Population density, persons per km^2	80	195	117	26	89 (2011)	131	263
Rural population density, persons per km^2 of arable land	278 (2008)	624	493.57	366 (2009)	315 (2009)	295 (2008)	987 (2008)
Urban population with access to improved sanitation, %	82 (2008)	80	—	89	84	95	94
Total gross national income, $ million	12,296 (2011)	—	—	7,669 (2011)	42,026	333,232 (2011)	117,762 (2011)
Gross national income per capita, $	830 (2011)	—	—	1,130 (2011)	876	4,420 (2011)	1,260 (2011)
Proportion of population below poverty line, %	25.8	7.5	14.1	27.6 (2009)	25.6	7.8	14.2
Life expectancy at birth, years	63 (2011)	76	68	65	65	74	75 (2011)
Infant mortality rate per 1,000 live births	43	8	12	42	50	11	16
Net primary school enrollment ratio, %	96	99.4	99.7	96.8	87.7	90.0 (2009)	95.5 (2009)
Adult literacy rate, %	87.1 (2009)	94.4	94.0	72.7 (2005)	90.6	94.0 (2005)	93.5 (2009)
Ratio of girls to boys in primary and secondary education, %	94	100 (2009)	90.3	90	94	103 (2009)	94
Forest area, % of total land area	57	58	48	44	47	33 (2008)	40
Average annual deforestation, %	(-)1.2 (2005-2010)	(+) 5.8 (2005)	(+)1.3	(-)0.5 (2005-2010)	(-)0.9 (2000-2010)	0 (2000-2010)	(+)1.6 (2000-2010)
Protected area, % of total land area	24 (2009)	6	8	16 (2009)	6 (2012)	19 (2008)	6
Freshwater resources per capita, m^3	33,675	3,771	4,224	53,782	30,838	6,345	10,064
Freshwater withdrawal for agriculture, %	94 (2006)	67	64.6	90 (2009)	91	90 (2007)	95 (2009)

PRC = People's Republic of China.
All values are for 2010 unless otherwise indicated.



Population Distribution in the Greater Mekong Subregion, 2010

National capital
Administrative center
City/Town
National boundary
Provincial boundary

Population density 2010
(Persons per square kilometer)

0 | 1 - 5 | 6 - 25 | 26 - 50 | 51 - 100 | 101 - 500 | 501 - 2,500 | 2,501 - 5,000 | >5,000

0 125 250 500 Kilometers

Boundaries are not necessarily authoritative
Data source: ORNL 2010 through East View Cartographic Inc., UN FAO GAUL, NASA SRTM

Populations: Diverging Growth Rates

The divergent cultural, social, and historical factors that have shaped the countries in the Greater Mekong Subregion are reflected in varied and sometimes startling population demographics. Population growth rates in the Lao PDR (2.2%) and Cambodia (1.5%) have fallen over the past decade but are nevertheless high in the light of continuing high fertility rates and steep declines in infant mortality. Myanmar and Viet Nam have a population growth rate of 1.1%; Thailand (0.6%) and Yunnan Province of the PRC (0.69%) have far lower growth rates; however, in Guangxi Zhuang Autonomous Region of the PRC, the population growth rate was higher in 2010 (1.3%), than in 2009 (0.9%), perhaps reflecting fluctuations in the floating, migrant labor population of that region.

These trends have implications for the future. Cambodia, the Lao PDR, and Viet Nam have relatively young populations, while in Thailand and Yunnan Province, because of low birth rates and longer life expectancies, there will be a fairly steep rise in old-age dependency in the next few decades.

of freshwater fish, while in Thailand and Viet Nam about half of freshwater fish production comes from aquaculture. Both the inland and coastal fisheries in Cambodia are important, with catches making a significant contribution to Cambodia's gross domestic product.

For centuries, the subregion's wetlands have served as an important resource for the people who live alongside them, providing fish, waterfowl and other products, livelihood, and water for irrigation and consumption. The wetlands are mostly along the lowlands of the Mekong River Basin, the deltas of the major rivers, and the coastal plain of Thailand.

One of the most important wetlands in the subregion is Cambodia's Tonle Sap, or Great Lake. Connected to the Mekong River system, it plays a crucial economic and environmental role in Cambodia and downstream; about 1 million people are said to depend on the lake's fisheries. However, the lake provides much more than fish; it is a reservoir of biological diversity that includes— besides fish species—an array of birds and other animals.

Wetlands are being converted to agricultural land, including conversion to ponds for fish and shrimp farming, and are affected by the altered flood patterns. Such changes are drastically reshaping large areas of natural wetlands, resulting in the disappearance of indigenous species. Some of the

Upper: Sunday strollers in Yangshuo, Guangxi, PRC. **Lower:** Tending rice fields in the Mekong Delta, Viet Nam.

■ Fisher with his elaborate lift net on Tonle Sap, Cambodia.

subregion's most endangered species are closely associated with wetlands. They include the Siamese crocodile, freshwater turtles, and large migratory water birds.

Good arable land is scarce and at a premium throughout the subregion because of high population densities and the dominant hilly and mountainous terrain, which is unsuitable for agriculture. Large areas of land are being converted into cash crop farming, and the clearing of secondary forest is pushing some local people into primary forest. Viet Nam has cleared large areas of forest in the past 10–15 years for farming coffee, rubber, cashews, and sugar. The same process is beginning in Cambodia and the Lao PDR. Shifting cultivation for subsistence agriculture has been practiced by a large portion of the population—mostly hill tribe people—for hundreds of years. However, population pressure in recent years has meant less land available for rotation, leading to shorter fallow periods, less fertile land, and further forest encroachment.

Unsustainable harvesting practices and the export of a number of natural resources have had a significant impact on the subregion's biodiversity. For instance, forests provide vital protection from siltation and soil erosion, generate tourism, and provide subsistence to rural communities in the form of fuelwood, food, medicine, and other nontimber forest products. The poorer countries in the subregion have the larger remaining natural forest cover, equivalent to more than half the land area in Cambodia, the Lao PDR, and Myanmar.

Economic expansion in the subregion since 1990 has been fueled largely by exports, driven in turn by the extraction of natural resources—water resources to support expansion of hydropower generation; land resources for increased agricultural production, mining, and mineral-based industries; and forest resources for timber and other products. In some cases, the result has been severe pressure on the resource base, causing resource depletion, environmental degradation, and ecosystem fragmentation. Between 10% and 40% of arable land in the GMS countries is already degraded. National environmental performance assessments show

Where the Fish Swim

The main river systems traversing the subregion are—from west to east—the Ayeyarwady or Irrawaddy, Thanlwin (or Salween), Chao Phraya, Mekong (or Lancang), and Red (or Hong). There are numerous smaller coastal rivers and drainage basins, and many small lakes and wetlands. Major deltaic formations exist in estuaries of the Ayeyarwady, Chao Phraya, Mekong, and Red rivers. There are large dams on the rivers and tributaries and these have created artificial environments for fish production. Freshwater ponds are also widespread.

Not surprisingly, given this varied and extensive aquatic environment, the subregion harbors substantial fish biodiversity, which includes Southeast Asian fish fauna (comprising those from the Mekong River Basin and Chao Phraya), Indian fish fauna (from the Ayeyarwady and Thanlwin, as well as the Ganges and Brahmaputra basins), and Chinese fish fauna (from the Red and Yangtze rivers). The total number of freshwater fish species in the subregion is 1,600–1,800. Yunnan Province of the People's Republic of China has the highest diversity because all three main faunal groupings occur within its boundaries.

Fisheries in the Mekong River Basin are among the most productive freshwater fisheries in the world, second only to the Amazon. The Mekong River Commission estimates that for the entire Mekong River Basin and other large and smaller river basins, the total annual freshwater catch, including fish farming, or aquaculture, approaches 3.1 million tons. Total fish production in the subregion based on recent statistics from the Food and Agriculture Organization of the United Nations (FAO) is 6.8 million tons per year.

In the long term, opportunities for increasing catches are limited. Coastal marine fisheries are generally already heavily exploited and in need of effective management. Meanwhile, aquaculture production is expanding rapidly, in inland ponds and cages and coastal shrimp ponds.

■ Mustard growing in Guangxi, PRC.

that GMS-wide environmental indicators are on downward trends, notwithstanding moderately improving government responses. Continued unsustainable resource extraction practices could seriously undermine future economic development of the subregion.

Threatening the existence and viability of natural forests are logging operations, which can vary in size from individuals with handsaws to extraction on an industrial scale. Commercial logging and log exports are regulated by government in all the countries. However, strong demand and weak enforcement of regulations have hampered efforts to control logging and the international log trade. Meanwhile, the closure of production forests in Yunnan, Thailand, and Viet Nam has put greater pressure on the remaining forests in Cambodia, the Lao PDR, and Myanmar.

Despite considerable effort by GMS governments to manage forest resources sustainably, the magnitude of pressures still outpaces responses. Recent statistics indicate a slowing of overall forest loss in the GMS over the last decade; however, the effective rate of forest loss is on the rise if forest degradation is taken into account. This is reflected in the decline in growing stock per unit of forest area, which accelerated between 2005 and 2010 compared with the previous five years.

The decline in forest cover and density poses threats to the subregion's biodiversity. Sixteen of the 200 World Wildlife Fund classified ecoregions that represent critical landscapes of international biological importance are found in the GMS. Between 1997 and 2008, 1,231 new species were discovered across the GMS, with an impressive 308 new species identified in 2008 and 2009 alone. Fragmentation of these landscapes due to development pressures, combined with uncontrolled exploitation of wild plants and animals to meet growing consumer demands, threatens the GMS with the "empty forest syndrome."

Infrastructure development could also adversely affect biodiversity in the subregion as land is cleared to make way for roads, transmission lines, and the expansion of urban areas. Past practices have not always provided adequate protection for the environment and the people directly affected by such development.

Socioeconomic developments, including infrastructure projects (mainly for irrigation and hydropower); increased demand for domestic, industrial and agricultural use; and increased pollution have had profound effects on the quantity and quality of water in the GMS. Future development will increase the pressure on water resources and the extensive animal and plant resources they contain that support the livelihood

■ **Upper left:** One of the few remaining Indochinese tigers in the Greater Mekong Subregion. **Lower left:** *Troides helena*, the common birdwing, one of Asia's largest butterflies, in the Tenasserim Range, Thailand. **Right:** Waterfalls straddling the border between the PRC, where they are called Detian, and Viet Nam, where they are called Ban Gioc.

and economic activities of about 66 million people living along river banks and in the Mekong Delta.

Increased water withdrawals and dry-season water shortages create competition for water, particularly in intensively irrigated areas, such as the Red and Chao Phraya river deltas. In addition, pesticide and heavy metal contamination in these rivers has implications for food safety and human health. In densely populated areas and industrial zones around the Mekong River, for example, the ecological health of the river is a key concern due to limited treatment of industrial wastewater and improper disposal of hazardous wastes.

Growing populations in GMS countries, combined with changing dietary patterns (preferences shifting from cereals to animal products, fish, and vegetables) will significantly increase the demand for food in the subregion by a projected 25% by 2050. Meanwhile undernourishment continues to be a problem in all countries—"moderate" in Thailand, "serious" in Viet Nam and Myanmar, and "alarming" in the Lao PDR and Cambodia according to the 2008 Global Hunger Index. Food security concerns in the subregion are aggravated by deteriorating sanitary conditions, which affect food quality and safety.

Rapid economic development has resulted in energy demand growing in excess of supply options. Coupled with volatile global fuel prices, this has caused growing concerns over energy security in the GMS. Energy demand is expected to grow as a consequence of continued economic development and improvements in grid connectivity; the annual peak demand for power in GMS countries is forecast to increase by 175% between 2010 and 2025.

Meeting the subregion's energy demand will have a number of social and environmental impacts. Hydropower in excess of 900 megawatts is

Upper: Water lilies in a pond, Yunnan, PRC. **Lower:** The wealth of timber in production forests of Champasak Province, Lao PDR.

envisaged in the Lower Mekong Basin, which will inundate almost 2 million hectares of land, threatening conservation target landscapes in the Lao PDR. Similarly, in the Cardamom Mountains in Cambodia proposed hydropower stations will inundate large forest areas. Biofuel production to supplement energy supplies is on the rise in the GMS. While biofuels present a low-carbon fuel option, thereby helping to reduce the subregion's greenhouse gas emissions, the uncontrolled expansion of biofuel plantations would impinge on productive agricultural lands and forest areas and have knock-on effects for food security and loss of ecosystem services. Additionally, planned expansion of coal-powered thermal plants will result in increased emissions of carbon dioxide and particulates. A ten-fold increase in coal power generation is expected in Viet Nam by 2030, for example, which could cost the country close to $9 billion per year unless actions are taken to mitigate these impacts.

Climate change is expected to exacerbate the impact of development pressures on the subregion's economic activities, natural resources, and livelihoods with profound effects on the population. The geographic and socioeconomic features of the GMS make it particularly vulnerable to climate change. Large expanses of low-lying coastal areas with high concentrations of infrastructure and populations are exceedingly vulnerable to sea level rise. Key economic sectors of the GMS, such as agriculture with its high dependence on rain-fed farming in the highlands and on aquaculture and irrigated agriculture in the lowlands and deltas; energy, particularly hydropower; and tourism are all highly dependent on climatic conditions.

Climate change is likely to affect rural poor populations disproportionately due to the lack of adequate social safety nets. Climate-related impacts can have cascading effects that compound

■ **Upper:** Monks and devotees in the Wat Po temple complex, Bangkok, Thailand. **Lower:** Pa-O woman at a village market, Inle Lake, Myanmar.

the above threats. Prolonged extreme weather events that affect food and energy production, and in turn affect livelihoods and employment, force increasing numbers to live in poverty. Recent studies have suggested that the cost of climate change could be as high as 6.7% of gross domestic product per year by 2100 in Thailand and Viet Nam, through impacts on infrastructure and natural resources, significantly higher than the global average due to the largely rural and agrarian nature of the GMS.

There are also cross-border environmental issues, including hydropower development along the Mekong River and its tributaries; canalization and other navigation improvements in the Upper Mekong River Basin; conflicting maritime claims to offshore fishery resources; illegal cross-border trade in timber, wildlife, and rare and endangered species; expansion of protected areas, parks, and nature reserves across borders; and conservation of rare wildlife whose habitats straddle national borders.

Initiatives taken by one country usually affect neighboring countries. Subregional cooperation is critical in ensuring that the use of the subregion's resources, especially hydropower, is well planned and sustainable so that the intended benefits can be shared by all. Forest conservation and biodiversity protection can be fostered through common efforts to stem illegal cross-border trade, and joint agreements for the creation and management of protected areas that straddle international borders.

In response, the subregional countries have put environmental laws and regulations in place. However, the degree of success of these laws and regulations differs among countries. Environmental standards have been set, but not in all countries. Environmental impact assessment procedures, and often the legal and institutional framework for minimizing the adverse environmental impact of projects, vary widely, as do the capacities of institutions with an environmental mandate.

There is a need for better economic and development planning, particularly for infrastructure projects—especially for roads and hydropower—if the subregion is to become a sustainable growth center.

Who is in the Minority?

Ethnic minorities comprise nearly one fourth of the combined population of the subregion—more than 80 million people. The subregion boasts several major ethnic groups, namely the Cham and Vietnamese in Cambodia; Zhuang, Yao, and Dong in Guangxi Zhuang Autonomous Region of the People's Republic of China (PRC); Yi, Bai, Hani, Dai, and Miao in Yunnan Province, PRC; Phutai, Kamu, Hmong, and Lue in the Lao People's Democratic Republic; Kachin, Kayah, Kayin, Chin, Mon, Rakhine, and Shan in Myanmar; Karen, Hmong, and Lahu in Thailand; and Tay, Thai, Muong, and Khmer in Viet Nam. Increasing tourism to the subregion, particularly to Thailand, Viet Nam, and Yunnan has focused interest in those groups that live in the uplands and rely mostly on natural resources for their livelihood. Their intimate knowledge of traditional systems related to the sustainable use and management of resources, handed down to them by their ancestors, makes these ethnic groups guardians of their natural heritage.

Cambodia

Cambodia is the subregion's smallest country, situated between Thailand to the west, the Lao People's Democratic Republic to the north, and Viet Nam to the east. Much of its land area of 181,035 square kilometers is taken up by a shallow basin, centered on a huge lake, Tonle Sap, and surrounded by the Cardamom and other mountains in the southwest.

About 96% of the population of 14.3 million are Khmer, with the rest composed of ethnic groups (Cham 2.1%, Lao 0.1%, and hill tribes 1.5%) as well as some Chinese and Vietnamese. More than 80% of the people live in the countryside. The gross national income (GNI) per capita was $760 in 2010. In 2000, life expectancy at birth was a low 56 years but by 2010 it had improved to 63.1; infant mortality has declined, from 95 per 1,000 live births in 2000 to 43 in 2010; maternal mortality is also declining, from more than 400 per 100,000 live births in 2000 to 206 by 2010. Poverty reduction resulting from development should lead to better health and education; the current low levels of health and education (especially basic education and youth literacy) constrain the pace of development.

Many people feel they fare better in urban than in rural areas, which has resulted in some rural-urban migration, a trend that may increase in the future and heighten the stress on urban infrastructure and the urban environment.

In 2009, agriculture employed 57.6% of the total workforce of 7,480,000. The agriculture sector's share of gross domestic product (GDP) decreased from 55% in 1990 to less than 40% in 2001, and to 36% in 2010. While the low level of irrigation is a major constraint to agricultural productivity, a significant hazard is posed by land mines strewn over about 300,000 hectares of countryside, including 55,000 hectares of prime rice-growing land in Siem Reap, Banteay Meanchey, and Battambang provinces, the country's traditional grain basket. The Government is systematically clearing areas of land mines and unexploded ordinance but it will take many years of patient effort to complete the task.

Upper: The Bayon Temple, Siem Reap. **Lower left:** Mother and child in rural Cambodia. Both infant and maternal mortality rates have improved greatly in the past decade. **Lower right:** Independence Monument in Phnom Penh (Vimean Ekareach), built to celebrate independence from France in 1953.

Khmer boy looking after his younger sibling.

Cambodia is very vulnerable to natural disasters, especially flooding, given the dominance of agriculture and the vast Tonle Sap and Mekong River system in the country. In September 2011, these water bodies reached their highest levels on record—at the same time as Thailand's disastrous floods—displacing some 1.2 million people, or more than 8% of the population, and ruining much of the country's crops. Another recent major disaster was typhoon Ketsana, which hit Cambodia in 2009. Fourteen out of 24 provinces were affected by the storm and subsequent flash floods, and the homes and livelihoods of some 49,000 families, about 180,000 people were destroyed.

Cambodia is a biodiversity hotspot, rich in species and in genetic and ecosystem diversity. It has the world's highest proportion of undeveloped land (forest and wetlands) and one of the least disturbed coastlines. The recorded species found so far in Cambodia—2,308 plants, 123 terrestrial mammals, 545 birds, 490 freshwater fish, and 410 marine fish—are likely to be underestimates, given the limited and often unverified information available. Many people rely directly on biological resources for their livelihood. Cambodia's ecosystems—forests, wetlands, freshwaters, and marine waters—house the rural Cambodian's main source of income. The southwestern coastal ranges and marine waters, northeastern forests, and Tonle Sap floodplains deserve priority action to conserve their biodiversity.

But wetland and forest ecosystems have been degraded and species are threatened because of their conversion for agricultural use, poor planning, weak regulatory enforcement, uncertainties in land tenure, hunting, and wildlife trading, among other problems.

The Mekong River, the Tonle Sap River, and Tonle Sap itself define Cambodia's water and fisheries resources. The Tonle Sap system supports fisheries, agriculture, and transportation. The lake—Southeast Asia's largest and one of its most important biodiversity areas—is crucial to the economy and environment of Cambodia and beyond. The 120-kilometer Tonle Sap River connects it to the Mekong River. It was estimated in 2011 that the fishery sector employed around 420,000 people directly and more than 2 million

Facts and Figures about Cambodia

GEOGRAPHY	
Location	Southeast Asia, bordering the Gulf of Thailand, between Thailand, Viet Nam, and Lao PDR
Total area, km^2	181,035
Climate	Dominated by the annual monsoon cycle of rainy and dry seasons. The rainy season lasts from May to October, and the dry season from November to April. December to January are the coolest months, while the hottest period is in April. The average temperature is around 27-28ºC.
Terrain	Mostly low, flat plains; mountains in southwest and north
Lowest point	Gulf of Thailand 0 m
Highest point	Phnom Aural 1,810 m
Natural resources	Oil and gas, timber, gemstones, metal ores, phosphates, hydropower potential
Natural hazards	Mekong River flood, flash flood, drought, topical storms, and typhoons
PEOPLE	
Total population, million	14.3 (2010)
Average annual population growth rate, %	1.5 (2010)
Population density, persons/km^2	80 (2010)
Major ethnic groups	Khmer 95.64%; Cham: 2.09%; Vietnamese 0.61%; Lao 0.11%; Phnong 0.37%; Kouy 0.33%; Stieng 0.06%; Tompuonn 0.24; Charay 0.18%; Kroeung 0.16%; Prov 0.07% (2010)
Religions	Theravada Buddhist 96.93%, Muslim 1.92%, Christian 0.37%, others 0.78% (2008)
Language	Khmer (official) 96%, Vietnamese, Chinese, Lao, Thai, English, and others. France is still spoken by some elder Cambodians (2008)
Poverty	
Human Poverty Index/Rank	27.7; 87th out of 182 (2009)
Human Development Index/Rank	0.523; 139th out of 187 countries (2011)
Proportion of population below poverty line, %	25.8 (2010)
Proportion of population below $1.25 (PPP) per day, %	28.3 (2007)
Education	
Net enrollment ratio in primary education, %	96 (2010)
Adult literacy rate, %	87.1 (2009)
Government expenditure for education, % of GDP	1.8 (2010)
Gender Equality and Women Empowerment	
Ratio of girls to boys in primary and secondary education, %	94 (2010)
Ratio of literate females to males among 15-24-year olds, %	95.7 (2008)
Proportion of seats held by women in national parliament, %	21 (2011)
Health	
Under-5 mortality rate, per 1,000 live births	51 (2010)
Infant mortality rate, per 1,000 live births	43 (2010)
Life expectancy at birth, years	63.1 (2011)
Maternal mortality ratio, per 100,000 live births	206 (2010)
Undernourished children, weight for age, %	28 (2010)
Proportion of population with access to an improved water source, %	64 (2010)
Proportion of population with access to improved sanitation, %	35.4 (2010)
HIV prevalence among 15-24-year-old women, %	0.1 (2009)
Contraceptive prevalence rate, %	51 (2010)
Government expenditure for health, % of GDP	1.3 (2010)

ECONOMY	
Total gross national income (GNI), $ million	10,686 (2010)
Per capita GNP, $	760 (2010)
GDP Composition by sector	
Agriculture, %	36 (2010)
Industry, %	23 (2010)
Services, %	41 (2010)
Major economic activity	Services
Unemployment rate, %	0.1 (2009)
Value of exports, f.o.b., $ billion	5.0 (2010)
Value of imports, c.i.f., $ billion	6.7 (2010)
Total external debt, $ billion	3.5 (2010)
Debt service as percentage of exports of goods and services	1.3 (2010)
ENVIRONMENT	
Total forest area, % of land area	57 (2010)
Average annual deforestration, %	(-)1.2 (2005–2010)
Protected area, % of total land area	24 (2009)
Freshwater resources per capita, m^3	33,675 (2010)
Freshwater withdrawal for agriculture, %	94 (2006)
Rural Environment	
Rural population, % of total	80.5 (2010)
Rural population density, persons/km^2 of arable land	278 (2008)
Arable land, % of land area	22.1 (2009)
Permanent cropland, % of land area	0.9 (2009)
Urban Environment	
Urban population, % of total	19.5 (2010)
Population in largest city, % of urban population	48 (2010)
Population with access to improved sanitation, % of urban population	81.5 (2008)
Solid waste generation in Phnom Penh area, kg/capita/day	0.74 (2008)
Energy Efficiency of Emissions	
CO_2 emissions, total million tons	4.613 (2009)
CO_2 emissions per capita, total tons	0.3 (2009)
Energy use per capita, kg of oil equivalent	370.75 (2009)

Top: Cambodian village girl. **Middle:** Royal Palace, Phnom Penh. **Bottom:** Motorcycles are the vehicles of choice for almost every purpose in Cambodia.

■ **Upper left:** Apsara dancers performing for tourists, Siem Reap. **Lower left:** Angkor temple relief, Siem Reap. **Right:** Cambodian rice famer.

people are thought to derive some type of livelihood benefit from involvement in the sector. Tonle Sap also provides irrigation to rice fields in the area and harbors an abundance of bird and other animal species. However, the lake's inundated forests have recently come under increasing seasonal pressure largely because of the demand by households for wood for fuel and handicraft production; expanding fishing-lot operations; and conversion of inundated forest to farming, caused by increasing seasonal migration toward the lake of people looking for income-earning opportunities. Apart from forest cover loss, the spread of farming in the inundated forest zone has brought with it the prospect of fertilizer and pesticide runoff that could devastate the lake's fisheries.

The management of water resources is a key environmental issue with direct implications for the poor. In 2010, only about 35.4% of the country's population had access to improved sanitation and only a little over half the rural population had access to safe drinking water. The livelihood of most of the rural poor is dependent on water, particularly for agriculture and fisheries. Only a small portion of cropland is supported by irrigation systems (7%); the rest is mainly rainfed. Farmers face the risk of crop failure or reduced yields in the event of drought. Weak legislation, policies, and institutional capacity; poor management of irrigation and drainage systems; and competing water uses remain outstanding issues in the water sector.

Cambodia is the only place in the subregion where tropical forest still reaches all the way to the seashore (as it does near Koh Kong). However, forest cover is dwindling at the rate of 1.3%, (or 145,000 hectares) a year to satisfy the domestic demand of rural people for wood. Around 98% of rural households used firewood and charcoal. In 2010, Cambodia consumed about 8.7 million cubic meters of fuelwood. Other factors causing forest depletion are illegal logging, widespread shifting cultivation by upland dwellers, forest clearing for agriculture, and lack of sound forest management.

Cambodia's 443 kilometer shoreline is dotted with 64 islands of various sizes, mostly uninhabited. Some are fringed by coral reefs, making them likely tourist or ecotourism destinations. Elsewhere, tourism—focused on the Angkor temples, the beaches of Sihanoukville, and ecotourism in the Koh Kong mangrove area and Ratanakiri—has grown due to the present stable political climate, following a decline in the late 1990s. Between 2000 and 2009, the cumulative annual growth rate of tourist arrivals was about 18%, jumping from 786,524 in 2002 to over 2.5 million in 2010, earning the country $1.56 billion in receipts from tourism, its fastest-growing industry.

Upper: Flower market Phnom Penh.
Lower: Sunrise at Angkor Wat.

Although Cambodia's coastal resources are less degraded than those of neighboring countries, activities that result in sedimentation, such as charcoal extraction, shrimp farming, salt farming, and logging, have degraded the marine environment, particularly the mangrove forests. In recent years, the marine fishery has seen a significant increase in the number of fishing boats (both national and foreign), resulting in an increase in pressure on coastal resources. Annual catches by licensed Thai vessels in Cambodian waters are thought to range from 26,500 to 37,500 tons per annum but there is probably also a substantial amount of illegal fishing by unlicensed foreign vessels. The growing fishing effort in coastal areas is placing the natural resources under increasing pressure. There is substantial habitat degradation from destructive fishing practices (dynamiting, cyanide fishing, and illegal trawling in shallow nursery areas), destruction of mangrove forest for firewood and conversion to shrimp farms, sand mining from rivers and the sea bed, siltation, and pollution from urbanization/industrialization and increasing tourism.

Industrial growth has contributed a significant share of Cambodia's recent economic growth, particularly through a rapid expansion in garment exports. However, the industrial sector's contribution to GDP in 2010 was only about 23%, still outweighed by services at 41% of GDP and agriculture at 36%. A ban on illegal logging, while necessary to conserve forest ecosystems, has reduced the supply of timber, causing a sharp drop in value-added income for manufactured wood and related products. Municipal discharges continue to dwarf the volume of industrial effluent in terms of total pollution load; however, very little, if any, industrial pollution abatement has taken place in Cambodia save for a subdecree on water pollution control issued in 1999.

Nevertheless, the economy since 1993 has been relatively strong and a dynamic export industry has developed, resulting in a dizzying economic growth rate of 10.2% in 2007 before the global financial crisis of 2008, a rate that the country expects to achieve again within a few years. This will require sound policies, supported by an appropriate legal system and effective governance. Social development has been slower than economic development; the United Nations Development Programme's Human Development Index showed an improvement from 0.407 in 1995 to 0.523 in 2011, though Cambodia ranked 139 out of 187 countries in 2011.

■ **Upper:** Young monks in Phnom Penh. **Lower:** Phnom Penh street scene, viewed from a Tuk Tuk, a popular motorbike-powered passenger vehicle.

Phnom Penh

Once considered the loveliest of the French-built cities in Indochina, Phnom Penh, the capital of Cambodia, is still a place of great historical beauty. Established in 1434, the city is noted for its cultural and historical attractions, such as the Royal Palace, the Silver Pagoda, the National Museum, Wat Phnom (a small hill crowned by an active pagoda marking the legendary founding place of Phnom Penh), and the Central market (completed in 1937, designed by a French architect), as well as the relaxing ambience of its wide boulevards and picturesque riverside.

Situated at the confluence of the Tonle Sap, Mekong, and Bassac rivers, Phnom Penh is now home to about 1.5 million people (with a population density 2,213 people per square kilometer). More than 95% of the city's population are Khmer; Cham make up 2.3%, 1.7% are Vietnamese, and other ethnic groups make up the rest.

Because of its economic opportunities, many rural residents have flocked to Phnom Penh. With population growth have come greater pressures on municipal services and infrastructure, and, inevitably, increasing environmental deterioration. Waste generation and other problems have increased. In 2001, Phnom Penh produced 0.46 kilograms of waste per person per day; this increased gradually to 0.74 kilograms by 2008. Although much of the waste generated is biodegradable, the lack of disposal sites is a major environmental problem. The disposal of wastewater also constitutes a problem. Water used by households and industries is drained through stormwater pipes and discharged untreated into rivers and other water bodies. The rapidly growing number of vehicles means that new and better roads are needed, along with vehicle emission regulations to control a slow but steady rise in air pollution.

To keep pace with the growing urban population, the local government has been trying to improve the power supply, water supply, drainage systems, telephone connections, and solid waste collection. The national Government, for its part, is promoting tourism and has adopted an open investment policy to boost the economy of Phnom Penh and the country as a whole.

Guangxi Zhuang Autonomous Region, PRC

Guangxi Zhuang Autonomous Region is situated in the southwestern People's Republic of China (PRC), bordered by Yunnan Province on the west, Guizhou on the northwest, Hunan on the northeast, Guangdong on the east, and Viet Nam on the southwest, facing Beibu Gulf in the south. The total length of land border with Viet Nam is 637 kilometers. Guangxi has an area of 236,700 square kilometers or 2.5% of the area of the PRC. The region has a terraced topography, sloping from the northwest to the southeast; hilly land makes up 85% of its total area.

A large number of multi-ethnic groups live in Guangxi, the largest of which is the Zhuang, with 16.71 million; the others include Han, Yao, Miao, Dong, Mulam, Maonan, Hui, Jing, Yi, Shui, and Gelao, as well as about 25 smaller ones. By 2011, the population of ethnic minorities was 19.73 million accounting for nearly 38% of the total population.

Apart from the festivals shared with the Han family, such as the Spring Festival, Lantern Festival, Qingming Festival, Duanwu (Dragon Boat Race), Zhongyuan Festival, Mid-Autumn Festival, and Double Ninth Festival, the ethnic minorities in Guangxi have several unique, local festivals. The third day of the third month in the lunar calendar is the annual folk-song singing festival of the Zhuang ethnic group. On that day, young men and women, wearing beautiful costumes and carrying a variety

Top: Spectacular karst backdrop on the Li River, Guilin. **Middle:** Zhuang traditional dance. **Bottom:** Grandparents usually look after grandchildren while the parents work.

of foods, and young girls carrying carefully-made colored silk balls, crowd from all directions onto the stages to perform songs. The Panwang Festival is a grand traditional festival of the Yao ethnic group to pay tribute to their ancestors. The festival is held on the 16th of the tenth lunar month and usually lasts for three days and nights, although sometimes it can last as long as seven days and nights. The Changha Festival is the grandest traditional festival for the Jing ethnic group to show their tribute to the god of the sea. During the festival they gather at ceremonial sites to sing to the gods and their ancestors. Timing of the festival varies from village to village on the three islands inhabited by the Jing people.

Guangxi has very close cultural and social links with Southeast Asian countries. Some ethnic groups in Guangxi, such as Zhuang, Dong, Shui, Mulao, and Maonan, have traditional relations with many ethnic groups in the Lao People's Democratic Republic, Myanmar, Thailand, and Viet Nam. They share similarities in language and folk customs. These relationships provide a favorable foundation for economic and cultural exchanges between the PRC and Southeast Asian countries.

Guangxi is the only coastal economy in the western PRC well positioned to develop as a hub of the China-Association of Southeast Asian Nations (ASEAN) Free Trade Zone. The economic opportunities offered by this trade zone and by the Pan-Pearl River Delta economic zone make Guangxi a spectacular "new star" in the western PRC. Since 2004, the PRC and 10 ASEAN countries as well as the ASEAN Secretariat have co-hosted the China-ASEAN Expo, which is held annually in Nanning, Guangxi's capital.

Thanks to its geographical advantages and the PRC reform and opening up policy, Guangxi's economy grew faster than the PRC as a whole during 2001–2010. In 2010, the gross domestic product (GDP) of Guangxi reached $141.35 billion, with a per capita GDP of $2,987. The region's total industrial output is valued at $57.02 billion, of which farming, forestry, animal husbandry, and fisheries totaled $36.12 billion.

In recent years, Guangxi's economy has fallen behind that of its wealthy neighbor, the province of Guangdong. However, with the construction of the Beibu Gulf Economic Zone and speeding up of key projects in transportation, marine industry, agriculture, forestry, fisheries, energy, cross-border tourism, and environmental protection, the region expects an acceleration of investment. The focus of spending in the next

Facts and Figures about Guangxi Zhuang Autonomous Region, PRC

GEOGRAPHY

Location	Southwestern People's Republic of China, bordered by Yunnan to the west, Guizhou to the north, Hunan to the northeast, and Guangdong to the east and southeast. Also bounded by Viet Nam in the southwest and the Beibu Gulf in the south
Total area, km^2	236,700
Climate	Subtropical, humid, monsoon climate; long, hot summers; warm, short winters; conspicuous dry and rainy seasons
Terrain	Surrounded by mountains, hills, and plains in the middle, with hilly land constituting 85% of its total area, and plains 15%
Lowest point	0 m.
Highest point	2,141 m above sea level.
Natural resources	Vanadium, tungsten, antimony, silver, aluminum, talcum, marine resources, subtropical vegetation, and animals
Natural hazards	Drought, flooding, frost, tropical cyclone

PEOPLE

Total population, million	51.59 (2010)
Average annual population growth rate, %	1.32 (2010)
Population density, persons/km^2	195 (2010)
Major ethnic groups	Han 62%, Zhuang 32%, Yao 3%, Miao 1%, Dong 0.7%, Gelao 0.4%, others 0.9%
Religion	Taoism, Buddhism, Catholicism, other Christian denominations, Islam
Language	Southwestern Mandarin Chinese, Chuang patois, and Cantonese

Poverty

Human Poverty Index/ Rank (refers to the entire PRC)	14.1 (2010)
Human Development Index/ Rank	
Proportion of population below poverty line, %	7.5 (2010)

Education

Net enrollment ratio in primary education, %	99.4 (2010)
Adult literacy rate, %	94.39 (2010)
Government expenditure for education, % of GDP	3.8 (2010)

Gender Equality and Women Empowerment

Ratio of girls to boys in primary and secondary education, %	99.9 (2009)
Ratio of literate females to males among 15-24-year olds, %	93.2 (2010)
Proportion of seats held by women in national parliament, %	27.9 (2009)

Health

Under-5 mortality rate, per 1,000 live births	10.88 (2010)
Infant mortality rate, per 1,000 live births	7.65 (2010)
Life expectancy at birth, years	76.3 (2010)
Maternal mortality ratio, per 100,000 live births	18.88 (2010)
Undernourished children, weight for age, %	4.64 (2010)
Proportion of population with access to improved water source, %	87.93 (2009)
Proportion of population with access to improved sanitation, %	60.01 (2010)
HIV prevalence among 15-24-year-old women, %	
Contraceptive prevalence rate, %	86.71 (2009)
Government expenditure for health, % of GDP	1.7 (2010)

ECONOMY

Total GDP, $ million	141,350 (2010)
Per capita GDP, $	2,987 (2010)
GDP, $ million, PPP	
GDP per capita, $ PPP	
GDP per capita growth	14.2 (2010)
GNI per capita $ PPP	

GDP Composition by sector

Agriculture, %	17.5 (2010)
Industry, %	40.3 (2010)
Services, %	35.4 (2010)
Major economic activity	Industry
Labor force, million	27.69 (2009)
Unemployment rate, %	3.66 (2010)
Value of exports, f.o.b., $ million	8,096 (2010)
Value of imports, c.i.f., $ million	9,610 (2010)

ENVIRONMENT

Total forest area, % of land area	58 (2010)
Average annual deforestration, %	5.75 (2005)
Protected area, % of total land area	6.1 (2010)
Freshwater resources per capita (annual), m^3	3,770.7 (2010)
Freshwater withdrawal for agriculture, %	67.3 (2010)

Rural Environment

Rural population, % of total	59.89 (2010)
Rural population density, persons/km^2 of arable land	624.01 (2010)
Arable land, % of land area	18.62 (2010)
Permanent cropland, % of land area	15.4 (2009)

Urban Environment

Urban population, % of total	40.11 (2010)
Population in largest city, % of urban population	37.2 (2010)
Population with access to improved sanitation, % of urban population	80 (2010)
Solid waste generation in urban areas, kg/capita/day	0.78 (2010)

Energy Efficiency of Emissions

GDP per unit of energy use	4 (2008)
CO_2 emissions, total million tons	
CO_2 emissions per capita, total tons	
Energy use per capita, kg of oil equivalent	1,171 (2010)

Upper: River cruise on the Li River, Guilin.
Lower: Food vendor in a Yangshuo park.

■ **Upper left:** Woman tending vegetable garden. **Lower left:** Francois' Langur. **Right:** Karst landscape with old pagoda.

5–10 years will include infrastructure projects, industrial parks, major industrial projects, and development of shipping lines.

Guangxi is one of the PRC's most important bases for growing sugarcane, vegetables, and fruit. In 2010, it produced 71.2 million tons of sugarcane, 21.3 million tons of vegetables, and 8.4 million tons of fruit. Forestry also plays an important role in the agricultural sector. In 2010, timber production reached 17.4 million cubic meters, 56% higher than in 2005. Pine resin is an important forestry product, with a harvest in 2010 of 495,800 tons.

Criss-crossed by rivers, Guangxi is rich in water resources. Surface water flowing in the region amounts to 188.2 billion cubic meters, or 6.3% of the nation's total. The per capita water resources in Guangxi are estimated at 3,770.7 cubic meters, even higher than that of Yunnan. The three largest water systems running through the region are the Zhujiang (Pearl), Yangtze, and Duliu rivers. The energy potential of the region's water resources has an estimated annual power generating capacity of 78.8 billion kilowatt hours. In 2010, Guangxi had a total installed capacity of 25.1 million kilowatts from existing hydropower stations, with an annually generated electricity of 47 billion kilowatt hours, leaving immense room for further development.

The southern section of Guangxi embraces the Beibu Gulf, a natural semi-enclosed bay in the northwestern South China Sea, covering an area of 129,300 square kilometers. The Beibu Gulf provides a favorable environment for many marine species. It is home to over 500 types of fish and shellfish. Among them over 50 are of commercial value, including red snapper, grouper, Spanish mackerel, butterfish, and red coat. In 2010, the marine fisheries output was 750,000 tons.

Upper: Lady carrying sugarcane leaves in a village in Jingxi County, near the border with Viet Nam. **Lower:** Farmer bringing in sugarcane harvest using a manual tractor.

Guangxi is also known for its mineral deposits and serves as one of the 10 important production bases of nonferrous metals in the PRC. The region has especially abundant reserves of manganese and tin, which account for one third of the national total deposit. In addition, Guangxi leads in having reserves of vanadium, tungsten, antimony, silver, aluminum, talcum, and others. Bauxite proven reserves amount to 650 million tons and prospective reserves are estimated at 1 billion tons. Guangxi's Pingguo Aluminum is the largest aluminum production company in the PRC and plans are afoot to make it the biggest aluminum industrial base in Asia.

The region has established several tourist attractions, including natural scenic spots, natural reserves, sites with cultural and historical relics, forest parks, and summer and winter resorts. In 2010, the number of domestic tourists reached 140.73 million and international tourist arrivals reached 2.5 million. The city of Guilin—a former capital—and nearby waterways are well known worldwide for their magnificent steep karst hill and mountain landscapes. But care will be needed to maintain the region's biodiversity, which is threatened by economic development activities, including agricultural practices and over-extraction of natural resources.

■ **Top left:** A Guangxi craftsman. **Top right:** Waterfalls along the Li River. **Middle:** Nanning International Convention and Exhibition Center. **Bottom:** The Nanning Bridge.

Nanning

Nanning, sometimes called Yong, has a history of more than 1,680 years and is the capital of Guangxi Zhuang Autonomous Region. It is located in the southeast of the region in the Nanning basin, surrounded by mountains. Nanning is an important hub linking the southeastern coast with the southwestern inland, as well as the only coastline capital in the southwestern PRC. It has an area of 22,112 square kilometers and a population of 6.87 million.

Nanning enjoys a subtropical monsoon climate with relatively high temperatures and plenty of rainfall. The winters are short and summers are long. Its average annual temperature is 22.4 degrees Celsius. The Yong River flows through picturesque scenery and Nanning is rich in plant and water resources. There are more than 2,000 kinds of medicinal plants in the capital. The Yiling Caves and the Damingshan scenic areas are the region's premier tourist attractions. Nanning is being promoted as "The Green City of [the People's Republic of] China," where social, ecological, and economic systems are said to coexist harmoniously.

Nanning is the political, economic, cultural, educational, financial, and informational center of Guangxi. In 2010, Nanning's GDP was over $26.6 billion with a per capita GDP of $3,929.

Being a core city for the Beibu Gulf Economic Zone, Nanning provides the benefits of a coastal city, tax holidays, and other preferential treatment. Tertiary industries are flourishing and economic growth points have been linked mainly to tourism, real estate, conferences, exhibitions, and catering.

Yunnan Province, PRC

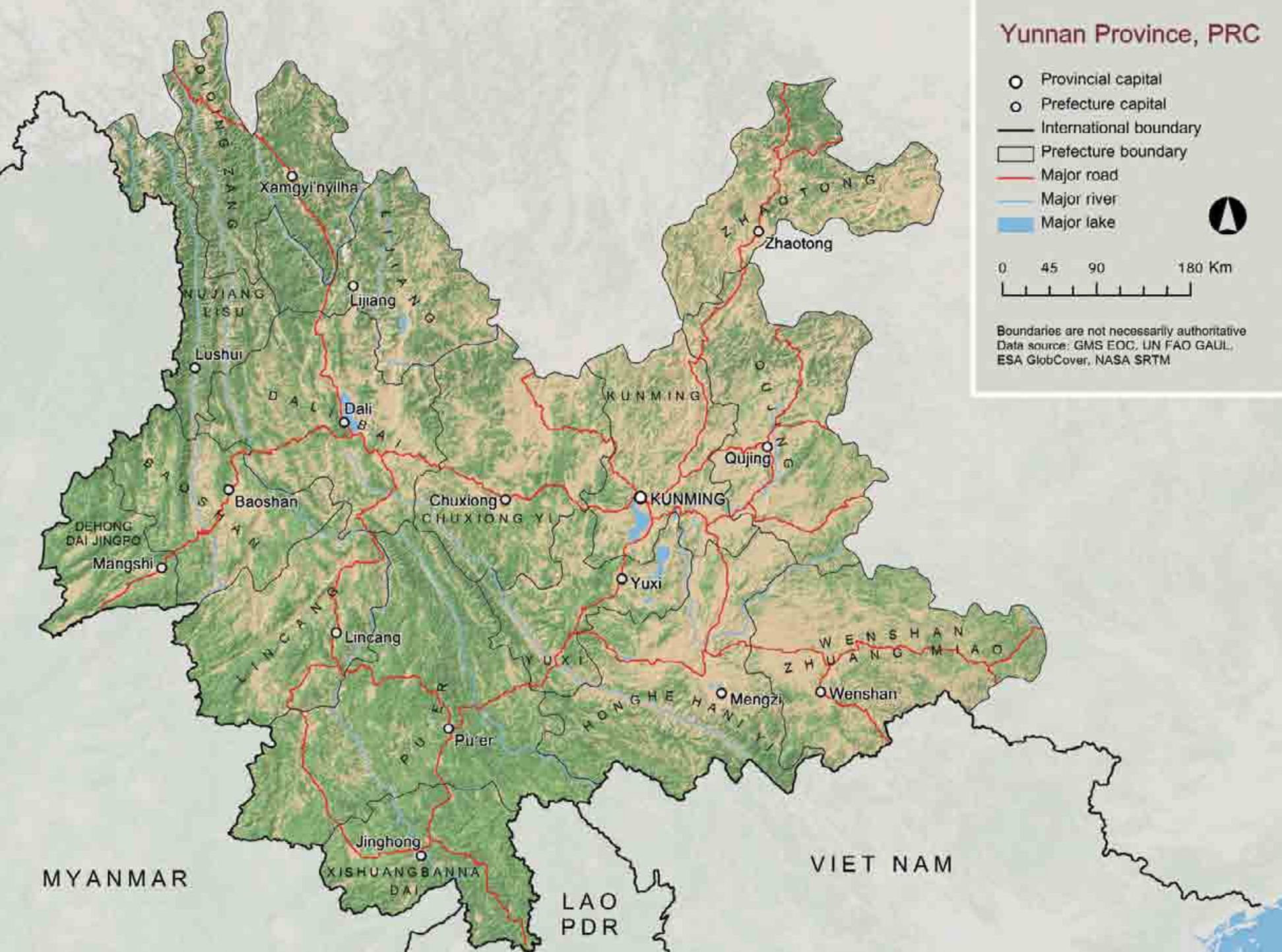
Yunnan Province, south of the Yun Mountains (hence the name) in the extreme southwest of the People's Republic of China (PRC), houses an exceptionally rich biological diversity within its land area of 394,139 square kilometers.

Yunnan is the eighth-largest province of the PRC, bordered to the south and west by the Lao PDR, Myanmar, and Viet Nam. Located on the lush Yunnan-Guizhou Plateau, a continuation of the Tibetan Plateau to the northwest, the province is mountainous over 94% of its land area. The valleys between these mountain ranges contain the headwaters of major rivers like the Jinsha Jiang or Chang Jiang (Yangtze), Nu Jiang (Salween), Dulong Jiang (Ayeyarwady), and, of course, Lancang Jiang (Mekong River).

About 14% of the population, or 6.44 million (2010), lives in the provincial capital, Kunming. The rest live mainly in eastern river basins and in the center, while populations are sparse in the mountainous and semi-mountainous areas of the west and the northern and southern areas. Twenty-five ethnic groups make up almost a third of the population. Prominent among these are the Yi (the most populous), Bai, Hani, Zhuang, Yao, Dai, and Miao. The major religions in Yunnan are Buddhism, Islam, Christianity and Taoism.

Yunnan Province is also among the PRC's least developed, with more poverty-stricken counties than any other province. Gross domestic product

■ **Top:** Black Dragon Pool in the Jade Spring Park, Lijiang. **Middle:** Jing Po women picking tea leaves in Xishuangbanna. **Bottom:** Dai grandmother with grandchild.



■ **Upper:** Yangtze River bend. **Lower:** *Strelitzia reginae*, one of the most popular horticultural perennial flowers grown in Yunnan.

Yunnan's Declining Biodiversity

Habitat loss from logging, land clearing for cultivation, fuelwood collection, and hunting are threatening the diversity of flora and fauna in Yunnan Province. In the Ai Lao Shan Nature Reserve alone, 12 plant species are endangered. More than 14 species of economic or agricultural value are now protected by the provincial government. One of these is *Ginkgo biloba*, a plant widely used for various types of medicinal applications. The Government protects 13 kinds of mammals, including the black gibbon, which is on the verge of extinction. The habitat of the black gibbon used to be spread over 10 provinces in central and southern PRC; now it is found only in Yunnan Province and northern Viet Nam. The Government has established 29,600 square kilometers of protected areas in an effort to protect the endangered species. Recently, the Three Parallel Rivers of Yunnan Protected Areas were placed on the United Nations Educational, Scientific and Cultural Organization's World Heritage List.

Facts and Figures about Yunnan Province, PRC

GEOGRAPHY	
Location	Southwestern area of People's Republic of China; surrounded by Guizhou, Guangxi, Sichuan, and the autonomous region of Tibet; bordering Myanmar, Lao PDR, and Viet Nam
Total area, km^2	394,139
Climate	Subtropical monsoon in the southeast (East Asia monsoon) and southwest (South Asia monsoon); temperate between 2,000 and 3,000 m, and frigid in the high alpine in the northwest
Terrain	Largely mountainous especially in the north and west. A series of high mountain chains spreads across the province. A distinct canyon region to the west and a plateau region to the east.
Lowest point	Honghe River Valley in Hekou County, 76.4 m
Highest point	Kagebo Peak in Deqin County on the Deqin Plateau, 6,740 m
Natural resources	Plants, animals, nonferrous metals, and medicinal herbs
Natural hazards	Forest fires, landslides, and flashfloods
PEOPLE	
Total population, million	46.02 (2010)
Average annual population growth rate, %	0.69 (2010)
Population density, persons/km^2	116.6 (2010)
Major ethnic groups	Han 66.6%, Yi 10.9%, Hani 3.5%, Pai 3.4%, Dai 2.7%, Zhuang 2.6%, Hmong 2.6%, others 4%
Religion	Buddhism and others
Language	Mandarin Chinese and ethnic dialects
Poverty	
Human Poverty Index/Rank	
Human Development Index/ Rank	
Proportion of population below poverty line, %	14.1 (2010)
Proportion of population below $1.25 a day, %	
Education	
Net enrollment ratio in primary education, %	99.71 (2010)
Adult literacy rate, %	93.97 (2010)
Government expenditure for education, % of GDP	5.19 (2010)
Gender Equality and Women Empowerment	
Ratio of girls to boys in primary and secondary education, %	90.3 (2010)
Ratio of literate females to males among 15-24-year-olds, %	
Proportion of seats held by women in national parliament, %	26.8 (2008)
Health	
Under-5 mortality rate per 1,000 live births	15.31 (2010)
Infant mortality rate, per 1,000 live births	12.24 (2010)
Life expectancy at birth, years	68 (2010)
Maternal mortality ratio per 100,000 live births	35.91 (2010)
Undernourished children, weight for age under 5, %	3.6 (2010)
Proportion of population with access to an improved water source (rural area), %	85.1 (2010)
Proportion of population with access to an improved sanitation (rural area), %	56.4 (2010)

Health (cont.)	
HIV prevalence among 15-24-year-old women, %	
Contraceptive prevalence rate, %	86.2 (2010)
Government expenditure for health, % of GDP	2.54 (2010)
ECONOMY	
Total GDP, $ million	106,717 (2010)
Per capita GDP, $	2,327 (2010)
GDP, $ million, PPP	183,076 (2010)
GDP per capita, $ PPP	3,994 (2010)
GDP growth (annual %)	12.3 (2010)
GNI per capita, $ PPP (Data refer to the entire PRC)	4,260 (2010)
GDP Composition by sector	
Agriculture, % at current market	15.3 (2010)
Industry, % at current market	44.7 (2010)
Services, % at current market	40.0 (2010)
Major economic activity	Industry and services
Labor force, million	35.73 (2010)
Unemployment rate, %	4.2 (2010)
Value of exports, $ million	7,606 (2010)
Value of imports, $ million	5,762 (2010)
Total external debt, $ billion	
Debt service as percentage of exports of goods and services	
ENVIRONMENT	
Total forest area, % of land area	47.5 (2010)
Annual change rate of forest area, %	1.34 (2010)
Protected area, % of total land area	7.5 (2010)
Freshwater resources per capita, m^3	4,224 (2010)
Freshwater withdrawal for agriculture, %	64.6 (2010)
Rural Environment	
Rural population, % of total	65.19 (2010)
Rural population density, persons/ km^2 of arable land	493.57 (2010)
Arable land, % of land area	15.4 (2009)
Permanent cropland, % of land area	10.7 (2010)
Urban Environment	
Urban population, % of total	34.8 (2010)
Population in largest city, % of urban population	40.2 (2010)
Population with access, to improve sanitation, % of urban population	
Solid waste generation in urban areas, kg/capita/day	0.25 (2010)
Energy Efficiency of Emissions	
GDP per unit of energy use	3.9 (2009)
CO_2 emissions, million metric tons	
CO_2 emissions (kg per PPP $ of GDP)	
Energy use per capita, kg of oil equivalent	

Upper: Woman tending rice field.
Lower: Weaving basket in a Dai village, Xishuangbanna.

■ **Top:** Rubber tapping. **Middle:** Tea plantation. **Bottom:** Female tea picker.

(GDP) per capita in 2010 was $2,373 . But comparing urban and rural dwellers highlights the rich-poor divide. Urban dwellers each earned on average about $2,373 in 2010, versus only $584 for rural dwellers.

Apart from subsistence crops, Yunnan grows rice, wheat, and other grains as major cash crops. Other important revenue earners are fruits (bananas, pineapples, and oranges), walnut and other nut-bearing trees, tea, coffee, sugarcane, soybeans, peas, rapeseed, and tobacco. There are more than 40 freshwater lakes, including Dian Chi, Er Hai, and Fuxian; these are important for aquaculture, which is strictly regulated and limited in the lakes.

The mountainous nature of the province limits cultivable land to 10.7% of the total, yet farmers comprise 80%–95% of the labor force. Cultivation is intensive. Terraced farmlands gird the hills and mountains and traverse the smaller areas of river basins and floodplains.

Yunnan is one of PRC's, and Asia's, largest flower producers and exporters, turning out 3 billion stems annually. It has three big flower producing areas—one each for tropical, temperate, and cold-climate bulb flowers.

The industries in the province, located mostly in Kunming, Yuxi, Qujing, and the Red River, produced $116.4 billion worth of goods in 2010. The major exports are sugar, tobacco, kidney

Upper left: The famous Yuanyang rice terraces. **Upper right:** Dai girls welcoming tourists during water festival, Xishuangbanna. **Lower:** Fruit of Jungle Night, *Amorphophallus paeoniifolius*.

beans, tea, beer, cement, cigarettes, phosphates, jade ornaments, garments, tin, and machine tools.

More than 50 scenic spots of exceptional beauty make Yunnan a major tourist center as well. Within its borders are the primeval forests and magnificent animals of Xishuangbanna; the Stone Forest of Lunan; Kunming, the capital city, also once the secondary capital of a kingdom in the area; the lakes and mountains around Dali; and Lijiang under the snow-capped Jade Dragon Mountain. In 2010, more than 3 million international tourists visited these and other sites, generating about $1.5 billion in revenue.

The province also abounds in natural resources. Over one third of the land is forested, twice the average elsewhere in the PRC. Pine forests predominate throughout much of the province; the Yunnan pine and Simao pine, in particular, are prized for their high commercial value. Yunnan not only has more species of tropical, subtropical, temperate, and frigid-zone plants than anywhere else, but also has many ancient derivative plants, as well as species introduced from abroad. Among the 30,000 species of plants in the PRC, 18,000 are found in Yunnan. There are also about 300 species of mammals, 780 species of birds, and numerous species of fish, reptiles, and amphibians.

Blessed with enough rainfall and many rivers and lakes, the province produces an annual water flow of 194.1 billion cubic meters, three times that of the Yellow River. Rivers flowing into the province from outside add 153 billion cubic meters. This means that for each person in the province there are more than 4,224 cubic meters of water, compared to the national average of 2,500.

Hydropower resources are abundant and are relatively concentrated in the water systems of the Jinsha, Lancang (Mekong), and Nu rivers. Planned projects on the Lancang River (main stem) total 25,605 megawatts.

The province is also rich in mineral resources and is a major producer of copper, lead, zinc, tin, and aluminum. Gejiu City, whose tin reserves are the PRC's most plentiful, is well known as "the Kingdom of Tin." At present, Yunnan still has at least 382 million tons of iron ore reserves, 6.25 billion tons of coal, and about 660 million tons of phosphorus.

Recognizing the harmful effect on the environment of past exploitation of natural resources, the Government is pursuing economic growth based on environmental sustainability.

Agricultural and rural productivity must increase to raise incomes in the rural areas, where many of Yunnan's poor live. Governance, economic, and environmental reforms, and more investments in social infrastructure for human development, will allow people to develop their full potential and lead productive lives. Yunnan could well become a major growth hub in southwestern PRC.

■ **Upper:** Kunming City, also known as the Spring City because of its mostly mild climate and flowers, here the *Viola tricolor*. **Lower:** Buddhist Golden Temple, Kunming.

Kunming

Girded by mountains and bordered by Dian Chi Lake to the south, Kunming, the capital of Yunnan Province, is a city of picturesque landscapes and a pleasant temperate climate often described as "eternal spring." Kunming's fascinating arboretum and botanical garden show off many of Yunnan's rare and endangered plant species.

Kunming has a total population of about 6.44 million. The city dates back to the Han Dynasty (206 BC–220 AD), but did not become part of what is now the People's Republic of China until the 13th century. Known at the time as Yünnan or Yünnanfu, it was renamed Kunming in 1913. Modern industrialization began around the time of World War II and accelerated after 1949 with the construction of large industrial complexes to produce iron, steel, and chemicals. The city is now a hub of commerce, industry, and transport, which generated 30% of gross provincial output in 2010. It is also a major tourist destination for both domestic and international visitors. Based on Kunming's location as a "border" city, its existing and planned infrastructure, and its specific (natural and human) resources, Kunming intends to become a transportation hub of national importance, bridging the gap to Southeast Asia.

Recent foreign investment has given rise to more than 1,100 enterprises, mostly in the flower, food, timber processing, real estate, tourism, electrical and mechanical, and high-tech industries. The Kunming Economic and Technological Development Zone was set up for commerce, trade, and real estate activities. The High-Tech Industrial Development Zone hosts companies in biology and biomedical engineering, mechanical and electrical engineering, new building materials, and information technology.

Given such rapid urbanization and industrial growth, however, environmental problems have been inevitable. Inadequate wastewater treatment facilities, a faulty sewerage system, and uneven enforcement of environmental regulations have led to widespread pollution, especially of lakes and water systems. The Government, with external assistance, is addressing these problems as a matter of priority.

Lao People's Democratic Republic

The Lao People's Democratic Republic (Lao PDR) is the only landlocked country in Southeast Asia. It shares borders with the People's Republic of China (PRC) to the north, Viet Nam to the east, Cambodia to the south, Thailand to the west, and Myanmar to the northwest. The Lao PDR serves as a "land bridge" for the subregion. Most of the country's land, totaling 236,800 square kilometers, is rugged calciferous mountains bisected by narrow river valleys. There are some 4,600 kilometers of navigable waterways, of which the Mekong River is the most important; more than a third of the Mekong's volume originates in the Lao PDR's vast watersheds. The Mekong enters the country from the PRC's Yunnan Province in the north, forms the border with Thailand for 1,100 kilometers and exits the Lao PDR into Cambodia after flowing over Khone Phapheng Waterfall in the southernmost part of the country.

More than half the country is too steep for agriculture. In addition, a little more than half of the land and a quarter of the country's villages are affected by unexploded ordnance. Steady progress is being made to clear this deadly legacy of years of conflict; however, large areas in the eastern part of the country and the Xieng Khouang Plateau are still seriously affected.

The land holds a population of about 6.26 million, two thirds of which are rural. Population density is by far the lowest in the region, at about

Top: The Mekong River at Luangprabang. **Middle:** Manual rice harvesting. **Bottom:** Happy Laotian village child.

■ **Buddhist ceremonial offerings, Champasak.**

26 persons per square kilometer. The population growth rate has slowed from 2.5% in 2001 when it was the highest in the subregion, but remains high at 2.2% in 2010. The Lao Front for National Construction has identified 49 ethnic groups under four main ethnolinguistic classes: Lao-Tai or Tai Kadai, Mon-Khmer, Hmong lu-Mien, and Chinese-Tibetan. There is a diversity of religions, but most of the people are Buddhist.

Although more than one quarter of the population is classified as poor, economic and social indicators confirm that living standards are steadily improving. Average life expectancy has increased in the last decade by more than 10 years to 64.7 years and the country's Human Development Index rating, 0.524, has improved its ranking from 143 to 138 out of 187 countries over the same period. The

Facts and Figures about the Lao People's Democratic Republic

GEOGRAPHY	
Location	Southeast Asia, northeast of Thailand, west of Viet Nam
Total area, km^2	236,800
Climate	Tropical monsoon; rainy season (May to October); dry season (November to April)
Terrain	Mostly rugged mountains; some plains and plateaus
Lowest point	Mekong River, 70 m
Highest point	Phu Bia in Xiengkouang, 2,820 m
Natural resources	Timber, hydropower, coal, gypsum, tin, gold, gemstones
Natural hazards	Floods, droughts, earthquakes, and blight
PEOPLE	
Total population, million	6.26 (2010)
Average annual population growth rate, %	2.2 (2010)
Population density, persons/km^2	26 (2010)
Major ethnic groups	Lao-Tai 66 %, Mon-Khmer 21.5 %, Chine-Tibet 3.1 %, Hmong-Iu Mien 8.8 %, Other 0.6 %
Religion	Buddhism
Language	Lao (official), ethnic dialects, French, and English
Poverty	
Human Poverty Index/Rank	30.7; 94th out of 135 countries (2009)
Human Development Index/ Rank	0.524; 138 out of 187 countries (2011)
Proportion of population below poverty line, %	27.6 (2009)
Proportion of population below $1.25 a day, %	33.9 (2008)
Education	
Net enrollment ratio in primary education, %	96.8 (2010)
Adult literacy rate, %	72.7 (2005)
Government expenditure for education, % of GDP	2.5 (2009)
Gender Equality and Women Empowerment	
Ratio of girls to boys in primary and secondary education, %	90 (2010)
Ratio of literate females to males among 15 years-old and above, %	77 (2008)
Proportion of seats held by women in national parliament, %	25.2 (2010)
Health	
Infant mortality rate, per 1,000 live births	42 (2010)
Life expectancy at birth, years	64.7 (2010)
Maternal mortality ratio per 100,000 live births	470 (2010)
Undernourished children, weight for age, %	37 (2009)
Proportion of population with access to an improved water source, %	67 (2010)
Health (cont.)	
Proportion of population with access to improved sanitation, %	63 (2010)
HIV prevalence among 15-24-year-old women, %	0.2 (2009)
Contraceptive prevalence rate, %	38 (2009)
Government expenditure for health, % of GDP	1.3 (2010)
ECONOMY	
Total GNI (GNP), $ million	6,500 (2010)
Per capita GNI (GNP), $	1,010 (2010)
GDP Composition by sector	
Agriculture, %	30.5 (2011)
Industry, %	24.5 (2011)
Services, %	38.7 (2011)
Value of exports, $ million	1,005 (2009)
Value of imports, $ million	1,414 (2009)
Total external debt, $ billion	3.9 (2010))
Debt service as percentage of exports of goods and services	16.2 (2010)
ENVIRONMENT	
Total forest area, % of land area	44 (2010)
Average annual deforestation, %	(-) 0.5 (2005-2010)
Protected area, % of total land area	16.3 (2009)
Freshwater resources per capita, m^3	53,782 (2010)
Freshwater withdrawal for agriculture, %	90 (2009)
Rural Environment	
Rural population, % of total	67 (2010)
Rural population density, persons/ km^2 of arable land	366 (2009)
Arable land, % of land area	5.9 (2009)
Permanent cropland, % of land area	0.5 (2009)
Urban Environment	
Urban population, % of total	33 (2010)
Population with access to improved sanitation, % of urban population	89 (2010)
Solid waste generation in urban areas, kg/capita/day	0.64 (2008)
Energy Efficiency of Emissions	
CO_2 emissions, million metric tons	1.811 (2009)
CO_2 emissions per capita, total metric tons	0.2963 (2009)

Top: Monk tending garden, Champasak Province. **Middle:** Luangprabang temple detail. **Bottom:** Hmong woman.

Upper left: Monks in Luangprabang. **Lower left:** Woman carrying rice, Champasak. **Right:** School children enjoying games.

infant mortality rate has fallen by almost 50% and the maternal mortality rate, while still high at 470 (2010) per 100,000 live births, is an improvement over the 1992 rate of 650. However, while nearly all children attend primary school, the adult literacy rate has increased only slightly in the past decade and remains the lowest in the subregion.

Growth in gross domestic product (GDP) was 8.1% in 2011, up from 7.5% in 2009 and comparing favorably with earlier GDP growth of 6.0%–6.3% from 1992 until 1997. Despite this growth, the gap between urban and rural consumption widened, which suggests greater inequality. The high rates of urban population growth, compared with the national average, give cause for concern because of increased risk of overburdening basic services and the absorptive capacity of the natural environment.

In general, the Lao PDR's environmental problems are relatively minor compared with those of the rest of Southeast Asia. The towns are mainly small, quiet, and residential, although motorized traffic is increasing and industrial activity is growing in a few of the largest towns. The economy is largely resource-based and its growth depends heavily on environmental sustainability.

Agriculture was formerly the largest sector, accounting for more than half the GDP and employing the great majority of the labor force. Rice, maize, sugarcane, tobacco, peanuts, and cotton were leading contributors to economic growth. However, by 2011, agriculture's share of the economy had fallen to 30.5%, and the service sector became the largest contributor (38.7%) to GDP. Tourism is growing rapidly, with international arrivals surpassing 2.5 million in 2010—more than double that in 2005. Lao PDR's tourism industry generated $381 million in receipts during 2010, making it the country's second largest source of foreign exchange that year after mineral exports. The majority of visitors come from neighboring Thailand and the PRC, with growing numbers coming from Europe and North America.

The manufacturing sector's share of the economy has been growing slowly over the past decade, reaching 24.5% in 2011. The country's major industries are textiles, garments, footwear, beer and soft drinks, wood and plastic products, and tobacco and cigarettes. Much of the sector is export oriented.

Hydropower, too, has been a major export in recent years, mostly to Thailand and Viet Nam. Technically exploitable hydropower potential is vast, about 26,000 megawatts, two thirds of this in the major Mekong sub-basins. In 2010, ten large and medium hydropower plants with an installed capacity of 1,976 megawatts were in operation while another 4 with a capacity of 1,265 megawatts were under construction. Various projects in planning and at the feasibility

stage are expected to add another 18,721 megawatts, bringing total output closer to the potential. However, large-scale hydropower and other projects affecting the Mekong River and its tributaries, if not appropriately planned, may impede the movements of fish—which are important in the Lao diet—or cause other significant changes in the river system.

The country's steady economic growth has created pressure on its biological resources. Forest cover in total has declined considerably over the past 50 years from 70% of the land area in 1940 to 44% in 2010. Both the quality and quantity of forest have declined markedly as a result of population growth, encroachment, slash-and-burn cultivation, illegal trade in wildlife and forest products for food and traditional medicines, excessive timber harvesting, forest fires, and the effects of wartime bombing and chemical defoliation.

Deforestation is estimated at 0.5% annually. It has caused erosion, silted reservoirs and navigation channels, and negatively affects the productivity of irrigation systems. Deforestation is also undermining the country's rich biological diversity, which is dependent on wide variations in climate, soils, and ecological niches created by the highly mountainous terrain.

In its 4th National Report to the Convention on Biodiversity, the Government reported that there are 1,140 animal species in the country, of which 319 are of national or global conservation significance. The Government has, therefore, stepped up reforestation to increase forest cover and has established 23 National Protected Areas and two corridors covering 16.3% of the land area. In the provinces of Champasak, Attapeu, and Xekong, the Government is carrying out the Biodiversity Conservation Corridors project, which applies a landscape approach to forest restoration in order to improve livelihoods and reverse the decline in biodiversity. Some provincial forest reserves are being upgraded to national protection forest status, taking into consideration trade-offs between the needs for development and conservation.

Fish and a wide range of other aquatic animals supply most protein consumed by the people. More than half are caught in the Mekong River and its tributaries, and the rest come from swamps, rainfed rice fields, floodplains, reservoirs (natural and human-made), and wetlands. There are about 500 indigenous fish species. The Government is promoting fisheries to help achieve food self-sufficiency and working to tackle such issues as the effects of hydropower dams, unsustainable fishing, introduction of exotic fish species, illegal trading in aquatic wildlife, pesticide use, industrial pollution, and sedimentation of rivers, streams, and reservoirs from forest clearance.

Upper: National Museum at Luangprabang. **Lower:** Kouang Xi waterfall.

A Challenging Land

The geography of the Lao PDR presents its people with many challenges. The northern topography is largely mountainous, with elevations above 500 meters typically characterized by steep terrain, narrow river valleys, and low agricultural potential. The soil is heavily leached and acidic. Many people still practice shifting cultivation to survive. In the central and southern plains, where the slopes are moderate and the soils fertile and less acidic, there are different problems. People converging in these areas are placing increasing pressure on the cultivated land. In a country that is the subregion's least densely populated, each hectare of cultivated land supports 5 people, compared with about 3 per hectare of cultivated land in Thailand and 10 in Viet Nam.

■ **Upper:** Nam Ngum 1 hydropower dam reservoir. **Lower:** Patuxai (Victory) Gate in Thannon Lanxing area of Vientiane.

Vientiane

Vientiane, capital city of the Lao PDR, is Asia's biggest village. The name means "city of sandalwood," a fragrant and valuable tree, but because "moon" is pronounced the same as sandalwood in the Lao language, "city of the moon" is a popular interpretation. A serene oasis among Southeast Asian capitals, Vientiane harks back to a quieter age before skyscrapers, extensive development, and industrialization. There are few tall buildings and traffic is light. The city has a rich cultural legacy as its historical monuments, temples, and other structures show. Today, the most famous landmark is That Luang or the Great Stupa, 3 km northeast of the center of Vientiane. That Luang was built in 1566 by King Setthatirat and has been restored many times since. Other notable sites are the Victory Monument (Patuxai), Buddha Park (Wat Xieng Khouane), Lao Revolutionary Museum, and Wat Ho Prakeo. Vientiane covers an area of 180 km^2 along the banks of the Mekong River and is home to about 10% of the Lao PDR's population.

Vientiane's population has been growing rapidly at nearly 5% per year—more than twice the national growth rate—mainly due to migration from rural areas. This is causing strains on the environment and the quality of urban services. Solid waste generation in Vientiane and other urban areas in Lao PDR is increasing with rising affluence and consumption. Most of the city's domestic waste is collected by the State or private companies and carted to a dumpsite on the outskirts of town. Facilities for sewage treatment in Vientiane and the major provincial towns are rudimentary but improving. Reliable piped water supply is however, widely available in Vientiane, provincial capitals, and some secondary towns.

Myanmar

By virtue of its strategic location, Myanmar forms a bridge between the peoples and cultures of South and Southeast Asia. The largest country in the subregion, it borders India and Bangladesh to the northwest, the People's Republic of China to the northeast, the Lao People's Democratic Republic to the east, and Thailand to the southeast.

Two thirds of the population of about 60 million live in rural areas. There are as many as 135 ethnic groups in the country, the largest of which are the Myanmars, who comprise 68% of the total. About 89% of the population are Buddhists, but, given the country's geographic location, it is also home to Christians, Muslims, and Hindus. In 2010, about 15.4 million people had no means to support their basic subsistence. Life expectancy at birth is low, 65 years. The infant mortality rate is 50 per 1,000 live births, the under-five mortality rate is 66 per 1,000 live births, and maternal mortality is 200 per 100,000 live births—all three indicators are the highest in the subregion.

Private enterprise in Myanmar is dominated by services, agriculture, light industry, and transport. The recovery in financial year 2009 was led by improved results from agriculture, mining, manufacturing, and the transport and communications subsectors. There is substantial state control in some areas, mainly energy, heavy industry, and the rice trade. Government policy in the 1990s aimed to revive the economy after 3 decades of tight central planning.

Growth recovered to an estimated 5.3% in the fiscal year 2010, after slowing in the previous year owing to the impact of cyclone Nargis and weakness in demand for imports from neighboring economies. Gross domestic product (GDP) grew by an average of 5.2% between 2005 and 2010. Agriculture, forestry, and fisheries account for about 36% of GDP and one fourth of total exports; the sector employs more than 50% of the total labor force.

Fertile cultivable land lies mainly in the valleys between the mountain ranges and in the 50,000 square kilometer Ayeyarwady Delta. Three parallel chains of forested mountain ranges running north to south—the Rakhine Yoma and Bago Yoma ranges and the Shan Plateau—separate the country's three river systems: the Ayeyarwady (2,170 kilometer long) and a tributary, the Chindwin (960 kilometers); the Sittaung (298 kilometers); and the Thanlwin (1,274 kilometers).

Besides substantial arable land, Myanmar is endowed with large freshwater and marine resources, and significant deposits of minerals, including oil and gas. The wide range of climatic conditions accommodates both tropical crops and those that thrive in moderate temperate climates. The main crops are cereals (such as wheat, maize, millet, and especially rice), oilseeds (including groundnut, sesame, and sunflower seeds), pulses, industrial crops (cotton, jute, rubber, coffee, mulberries, oil palm, and tobacco), and horticultural crops.

Upper: The majestic Shwedagon Pagoda in Yangon, also known as the Great Dagon Pagoda. It is said to be more than 2,600 years old. **Lower:** Mother and child at Inle Lake village market.

■ **Top:** Potter from the Shan ethnic minority. **Middle:** Yangon City from Bandoola Garden. **Bottom:** Mother and child at a village market, Inle Lake.

Facts and Figures about Myanmar

GEOGRAPHY	
Location	Southeast Asia, bordered on the north and northeast by the People's Republic of China, on the east and southeast by the Lao People's Democratic Republic and Thailand, on the south by the Andaman Sea and the Bay of Bengal and on the west by Bangladesh and India.
Total area, km^2	676,578
Climate	Tropical monsoon; cloudy, rainy, hot, humid summers (southwest monsoon, June to September); less cloudy, scant rainfall, mild temperatures, lower humidity during winter (northeast monsoon, December to April)
Terrain	Central lowlands ringed by steep, rugged highlands
Lowest point	Andaman Sea 0 m
Highest point	Hkakabo Razi, 5,881 m
Natural resources	Petroleum, timber, tin, antimony, zinc, copper, tungsten, lead, coal, some marble, limestone, precious stones, natural gas, hydropower
Natural hazards	Destructive earthquakes and cyclones; flooding and landslides common during rainy season (June–September); periodic droughts
PEOPLE	
Total population, million	60.38 (2011)
Average annual population growth rate, %	1.01 (2011)
Population density, persons/km^2	89 (2011)
Major ethnic groups	Bamar 68%, Tibeto-Burman 18%, Sino- Thai 8%, Mon-Khmer 5%, and others 2%
Religion	Buddhist 89.4%, Animist 1.2%, Hindu 0.5%, Muslim 3.9%, Christian 4.9%, and others 0.1%
Language	Burmese and ethnic dialects
Poverty	
Human Poverty Index/ Rank	20.4, 77th out of 135 countries (2009)
Human Development Index/ Rank	0.483, 149th out of 187 countries (2011)
Proportion of population below poverty line, %	25.6 (2010)
Education	
Net enrollment ratio in primary education, %	87.7 (2010)
Adult literacy rate, %	90.6 (2010)
Gender Equality and Women Empowerment	
Ratio of girls to boys in primary and secondary education, %	94.1 (2010)
Ratio of literate females to males among 15-24-year olds, %	99.38 (2010)
Health	
Under-5 mortality rate, per 1,000 live births	66 (2010)
Infant mortality rate, per 1,000 live births	50 (2010)
Life expectancy at birth, years	65 (2010)
Maternal mortality ratio, per 100,000 live births	200 (2010)
Undernourished children, weight for age, %	32 (2010)
Proportion of population with access to improved water source, %	69.4 (2010)
Proportion of population with access to improved sanitation, %	79 (2010)
Government expenditure for health, % of GDP	0.2 (2009)

ECONOMY	
Total gross national income (GNI), $ million	42,026 (2010)
Per capita GNI, $	876 (2010)
GDP Composition by sector	
Agriculture, %	36.4 (2010)
Industry, %	26.0 (2010)
Services, %	37.6 (2010)
Major economic activity	Services and agriculture
Labor force, million	29.54 (2009)
Unemployment rate, %	2.5 (2010)
Value of exports, $ million	6,413.0 (2010)
Value of imports, $ million	9,589.4 (2010)
Total external debt, $ billion	9.191 (2010)
Debt service as percentage of exports of goods and services	1.3 (2006)
ENVIRONMENT	
Total forest area, % of land area	46.96 (2010)
Average annual deforestration, %	(-)0.9 (2000–2010)
Protected area, % of total land area	5.60 (2012)
Freshwater resources per capita (annual), m^3	30,838
Freshwater withdrawal for agriculture, %	90.9
Rural Environment	
Rural population, % of total	69.24 (2011)
Rural population density, persons/ km^2 of arable land	315 (2009)
Arable land, % of land area	16.9 (2009)
Permanent cropland, % of land area	1.7 (2009)
Urban Environment	
Urban population, % of total	30.76 (2011)
Population in largest city, % of urban population	27 (2010)
Population with access to improved sanitation, % of urban population	84.1 (2010)
Solid waste generation in urban areas, kg/capita/day	0.267 (2010) Yangon; 0.53 (2010) Mandalay
Energy Efficiency of Emissions	
CO_2 emissions, total million tons	11.093 (2009)
CO_2 emissions per capita, total tons	0.233 (2009)
Energy use per capita, kg of oil equivalent	316 (2009)

Top: Vendor in a market in Bagan. **Middle:** Pagoda in Bagan. **Bottom:** Shan family in their home near Inle Lake.

■ **Upper left:** A monk carries donated food from Yangon market vendors. **Lower left:** Woman selling fresh vegetables in a Yangon street. **Right:** The Shwedagon Pagoda, Yangon, illuminated in the evening; a spectacular sight.

With a coastline of more than 2,800 kilometers, 8.2 million hectares of inland water bodies, and 0.5 million hectares of swamp areas along the coast, Myanmar is endowed with abundant fishery resources. Based on official estimates, the maximum sustainable yield of freshwater fisheries is 1.6 million tons and that of marine fisheries, 1.8 million tons. In addition to fishing, Myanmar's inland waters have massive hydropower potential, of which only about 1% is now exploited.

Forest resources cover about half of the land area and also play a dominant role in the country's development. As Thailand's supplies of top-quality teak have dwindled, Myanmar, whose forests hold about 80% of the teak remaining in the world, could eventually be the sole supplier. Shrinking world supply pushed up the price of top-quality teak in 2010 to nearly $2,820 per hoppus ton (or 1.8027 cubic meters) of teak logs. Besides teak and other hardwoods, Myanmar's forests also yield bamboo, rattan, and other products.

But the forests are under threat from logging, shifting cultivation, and fuelwood extraction. Shifting cultivation is practiced by up to 2 million people living mostly in the Kachin, Kayah, Kayin, Chin, and Shan states. Furthermore, few rural homes have gas or electricity. The people rely heavily on fuelwood, leading to depletion of forest cover in marginal forests outside the reserve forest areas. Obviously, as the population grows, the demand for fuelwood will grow.

Myanmar is one of the richest areas of natural resources in the world, and its ecosystems are home to numerous fauna and flora species, some of which have become endangered. The country, once called the "last frontier of biodiversity in Asia," has a high species tally: 11,800 plants, 251 mammals, 1,056 birds, 272 reptiles, 82 amphibians, 310 freshwater fish, and 465 marine fish. The count includes 841 medicinal plant species, 96 types of bamboo, and 37 rattan species

Myanmar also has a rich mineral resource base, which offers considerable potential for commercial development. The most important minerals are gemstones, tin, tungsten, zinc, lead, silver, copper, gold, coal, and industrial minerals. There were 522 metal mines and 26 nonmetal mines in 2008, including some private sector operated mines. In addition, Myanmar has major offshore oil and gas reserves, some of which are already being exploited in cooperation with foreign firms.

Upper: Commuting by boat along Inle Lake. **Lower:** Bringing cut flowers to sell in Bagan market.

Since its shift to market-oriented policies in 1988/1989, the Myanmar Government has encouraged private sector participation and foreign investment in industry. The pace of industrialization has been slow, partly because of the shortage of foreign exchange and disruptions caused by unrest in the production of energy. By 2010, a total of 25 enterprises invested nearly $20 billion in agriculture (0.7%), mining (7.0%), oil and gas (50.9%), manufacturing (0.3%), and the power generating sector (41.1%). Other industrial products are textiles, foodstuffs, pharmaceuticals, ceramics, paper, chemicals, automobiles, agricultural machinery, machine tools and electrical appliances, and tires and other rubber products. Top exports in 2010 were gas (28.4%), agricultural products (13.6%), wood products (7.0%), and garments (4.3%).

Myanmar, as a year round tourist destination, offers not only rich cultural attractions but also unique nature's endowment that make a great potential for tourism development of the country.

Myanmar has seen a steady growth in tourist arrivals as the result of joint efforts of the public and private sectors. There were more than 816,000 international tourists in 2011, generating revenue of $319 million. The major source markets were Asia, western Europe, and North America.

Entry procedures have been streamlined; a visa on arrival is granted for certain package tours and to package tour groups from countries without Myanmar representation. An E-visa system will soon be available.

Economic activities have created new pressures on the country's natural resource base and environment. The exploitation of natural gas and minerals and the development of large dam projects continue. There is little air and water pollution from industry or agriculture because of the low level of industrialization and the small amount of chemicals used in agriculture. This provides Myanmar with the opportunity to design effective policies and programs for pollution management and control in anticipation of future industrial development and agricultural expansion. Sustainable development will depend, in part, on new environmental policies and regulations, combined with financial support to improve institutions and environmental management skills.

■ **Upper Left:** Reclining Buddha, Yangon. **Upper right:** Seller at a market in Inle town. **Right:** A cyclist carries firewood along a broad boulevard with the new parliamentary buildings in the background, Nay Pyi Taw.

Nay Pyi Taw

Nay Pyi Taw, translated as "royal capital," "seat of the king," or "abode of kings," is the new capital city of Myanmar, located 320 kilometers north of Yangon (Rangoon), the former capital. The name literally means "royal city of the sun" in Burmese. Nay Pyi Taw is located between the Bago Yoma and Shan Yoma mountain ranges.

The embryonic city covers an area of 7,054 square kilometers. Construction began in 2006 and the population is already nearly 1 million, making it the country's third largest city after Yangon and Mandalay, although many people presently commute between Yangon and Nay Pyi Taw, a 4-hour drive.

Nay Pyi Taw is also a transportation hub adjacent to the Shan, Kayah, and Karen states. A new 8-lane highway linking Yangon with Nay Pyi Taw directly was opened in March 2011. This highway has become part of the 563 kilometer Yangon-Nay Pyi Taw-Mandalay highway, while 4-, 6- and 8-lane roads and even a 20-lane boulevard have been built across the city. An international airport is also under construction.

The sprawling city with its two new "Hluttaws," or legislative chambers, is a maze of 53 ministry buildings, as well as government mansions, civil servants' quarters, and presidential palaces, complete with grand Roman-style pillars—all rising from dusty, arid scrubland. At its heart is the parliamentary complex's 31 buildings, with pagoda-style roofs. It has football grounds; basketball, volleyball, and tennis courts; billiards rooms and bowling alleys; and a 30,000 capacity stadium under construction. On completion of the stadium, Myanmar looks forward to hosting international sports events, including the Southeast Asian Games.

The Uppatasanti Pagoda in Myanmar's new capital is a replica of the magnificent Shwedagon Pagoda in Yangon. The shimmering golden pagoda, 99 meters high, is visible from all major roads leading into the capital. Other attractions include a planetarium, zoological garden, and Myanmar's biggest gem museum containing unique pearls, jade, and rubies. The National Landmark Garden is a model in miniature of the states and divisions of Myanmar on a 160 hectare plot that also includes displays of traditional houses of national ethnic groups and their traditional food stalls, as well as golf courses, resort hotels, and a shopping mall.

A large reservoir, the Chaungmagyi Dam, was constructed between nearby mountain ranges for greening the city and to provide adequate water supply.

Thailand

With its warm hospitality, flavorful cuisine, ancient traditions, vibrant culture, beaches, and hill resorts, plus the shops, entertainment, and historic buildings of Bangkok, the capital city, Thailand is a well known tourist destination in the subregion. It should, therefore, come as no surprise that the country was at the center of the Asian economic miracle in the 1990s, just as geographically it lies at the heart of the Southeast Asian mainland.

It is bordered by Myanmar to the west, the Lao People's Democratic Republic and Cambodia to the east, and peninsular Malaysia to the south. Within a land area of 513,116 square kilometers, the country consists, of four main upland tracts—in the west, north, northeast, and southeast, respectively surrounding a large central plain drained by the principal river, the Chao Phraya; and a long isthmus in the southwest where it meets Malaysia.

Upper: Royal Guards march at the Grand Palace, Bangkok. **Lower:** Ko Phi Phi island.

More than half of the population of about 67 million (in 2010) is rural. Thailand's main natural resources are agricultural, particularly in the bountiful central plain (and to a lesser extent the Khorat Plateau), which produces a substantial surplus of rice. In the late 1950s, large areas were opened up for the cultivation of cassava (tapioca), kenaf (upland jute), corn, cotton, pineapple, soybeans, sugarcane, coconut, and rubber. Rice and other processed agricultural products, textiles and garments, furniture, beverages, and tobacco are major exports. Thailand today, like Viet Nam, is a net food exporter.

Thailand's abundant arable land, water, forest, fish, and wildlife resources have provided the raw materials for the impressive economic growth achieved over the last 50 years. However, as the manufacturing and service sectors expand, the relative role of primary production is declining.

■ **Upper:** Exhibit of Thai orchids at the Siam Paragon, a large shopping mall in Bangkok. **Lower:** Heavy traffic, Bangkok.

Facts and Figures about Thailand

GEOGRAPHY	
Location	Southeast Asia, bordering the Andaman Sea and the Gulf of Thailand, southeast of Myanmar
Total area, km^2	513,116 (2009)
Climate	Tropical; rainy, warm, cloudy southwest monsoon (mid-May to September); dry, cool northeast monsoon (November to mid-March); southern isthmus always hot and humid
Terrain	Central plain; Khorat Plateau in the east; mountains elsewhere
Lowest point	Gulf of Thailand, 0 m
Highest point	Doi Inthanon, 2,576 m
Natural resources	Limestone, tin, rubber, natural gas, tungsten, tantalum, timber, lead, fish, gypsum, lignite, fluorite
Natural hazards	Drought; flooding
PEOPLE	
Total population, million	67.31 (2010)
Average annual population growth rate, %	0.6 (2008-2010)
Population density, persons/km^2	131 (2010)
Major ethnic groups	Thai 85%, Chinese 10%–12%, Malay 5% and Mon, Khmer and highland ethnic groups 1%–2% (2000)
Religion	Buddhist 98%, Muslim 0.46%, Christian 0.01%, Others 1.53% (2005)
Language	Thai, English (secondary business language), ethnic and regional dialects
Poverty	
Human Poverty Index/Rank	8.5; 41st out of 135 countries (2009)
Human Development Index/ Rank	0.654; 92nd out of 169 countries (2010)
Proportion of population below poverty line, %	7.8 (2010)
Proportion of population below $1.25 a day, %	10.8 (2009)
Education	
Net enrollment ratio in primary education, %	90 (2009)
Adult literacy rate, %	94 (2005)
Government expenditure for education, % of GDP	4.2 (2010)
Gender Equality and Women Empowerment	
Ratio of girls to boys in primary and secondary education, %	103 (2009)
Ratio of literate females to males among 15 years-old and above, %	100 (2004–2008)
Proportion of seats held by women in national parliament, %	13.3 (2010)
Health	
Under-5 mortality rate, per 1,000 live births	13 (2010)
Infant mortality rate, per 1,000 live births, years	11 (2010)
Life expectancy at birth, years	73.93 (2010)
Maternal mortality ratio, per 100,000 live births	48 (2010)
Undernourished children, weight for age under 5, %	21 (2009)
Proportion of population with access to an improved water source, %	96 (2010)
Proportion of population with access to improved sanitation, %	96 (2010)
HIV prevalence among 15-24-year-old women, %	0.8 (2009)
Contraceptive prevalence rate, %	61 (2009)
Government expenditure for health, % of GDP	2 (2010)
ECONOMY	
Total GNI, $ million	305,087 (2010)
per capita GNI, $	4,526 (2010)
GDP, $ million, PPP	586,823 (2010)
GDP per capita, $ PPP	8,490 (2010)
GDP growth (annual %)	7.8 (2010)
GNI per capita, PPP (current international $)	8,120 (2010)
GDP Composition by sector	
Agriculture, %	11.6 (2010)
Industry, %	43.3 (2010)
Services, %	45.1 (2010)
Major economic activity	Industry and services (2011)
Labor force, million	38.64 (2010)
Unemployment rate, %	1 (2010)
Value of exports, $ million	193,600 (2010)
Value of imports, $ million	179,600 (2010)
Total external debt, $ billion	64.8 (2008)
Debt service as percentage of exports of goods and services	7.7 (2008)
ENVIRONMENT	
Total forest area, % of land area	33.4 (2008)
Annual change rate of forest area, %	0 (2000-2010)
Protected area, % of total land area	19 (2008)
Freshwater resources per capita, m^3	6,345 (2010)
Freshwater withdrawal for agriculture, %	90 (2007)
Rural Environment	
Rural population, % of total	66 (2010)
Rural population density, persons/km^2 of arable land	295 (2008)
Arable land, % of land area	29.9 (2009)
Permanent cropland, % of land area	7.2 (2009)
Urban Environment	
Urban population, % of total	34 (2010)
Population in largest city, % of urban population	29.69 (2010)
Population with access to improved sanitation, % of urban population	95 (2010)
Solid waste generation in Bangkok, kg/capita/day	1.54 (2009)
Energy Efficiency of Emissions	
GDP per unit of energy use	5.2 (2009)
CO_2 emissions, million tons	220 (2010)
CO_2 emissions (tons per capita)	3.31 (2010)
Energy use per capita, kg of oil equivalent	1,503.74 (2009)

Upper: Monks praying at Wat Po, Bangkok. **Lower:** Women drying chillies in Tenasserim.

■ **Upper left:** A stone guard with Chinese features in the Grand Palace, Bangkok. **Lower left:** Forest nursery, Department of National Parks, Tenasserim. **Right:** Commercial pineapple plantation in Tenasserim.

Economic Success, Social Progress

Thailand enjoyed unprecedented economic success for several decades before the regional financial crisis in 1997, when growth became negative. Since then, economic growth has see-sawed, with GDP growth rising from 2.2% in 2001 to 7.3% in 2003 and falling to -2.3% in 2009, following the global financial crisis, but rebounding remarkably to 7.8% in 2010 despite political tensions. In less than 4 decades from 1960 to 1995, before the regional financial crisis, per capita income grew nearly fourfold. The number of people living below the national poverty line fell from 30% to 10% of the population from 1988 to 1996; despite setbacks during the crisis, the poverty rate had been reduced to 7.8 % by 2010. Most of the poverty is concentrated in rural areas in the north and northeast. In 2010, some 10.4% of people in rural areas were below the poverty line, while only 2.6% were poor in urban areas. Decentralization of political power and investments in transport infrastructure at local levels have spurred economic growth through the local administrations called Tambons.

Social progress has been on the whole positive over the past decade, although Thailand's rating in the global Human Development Index fell significantly from 70th in 2000 to 92nd in 2010. Yet, primary school enrollment has continued to increase, infant and under-five mortality rates have both been halved during the decade, and nearly all the population now have access to improved sanitation and water sources.

Although the agricultural sector employed approximately 40% of total labor force in 2010, primary production and processing of agricultural and natural resources accounted for just a little more than one tenth of gross domestic product (GDP) and one fifth of exports. By comparison, the industrial sector contributed 43.3% to GDP in 2010.

Thailand is not especially well endowed with minerals. Limestone for cement manufacture has overtaken lignite coal as its most important mineral production. The country is still one of the world's top ten producers of tungsten and tin, but it now also exports computers and computer components, integrated circuits, and cement.

Thailand's rapid economic development over the past 5 decades has strained environmental and natural resources. In fact, the damage to the environment will need to be repaired and improvements made to ensure that further economic development is not constrained.

The substantial opening of uplands in the late 1950s shrank the forest cover from about half of the land area in 1961 to about one third in 2010. The resulting changes in the use of land, including the loss of forest cover, inevitably reduced species diversity and abundance. In some areas soil erosion has approached 30 tons per hectare per year and has affected a third of the land, damaging the watersheds and, consequently, the supply of freshwater. More than half of the country's villages are reportedly short of water and the cities, particularly Bangkok, face the continuing threat of land subsidence as more groundwater is extracted to meet their increasing demand for water.

Meanwhile, intensive fishing, an activity in which Thailand ranks third amongst the world's fish exporters (in 2008), has severely reduced the country's highly diverse and naturally productive coastal resources, driving its fishing fleet deeper into international fishing areas.

Tourism is an important sector in the Thai economy. In the past decade, it has been affected by the severe acute respiratory syndrome (SARS) epidemic in 2003, the Asian tsunami in December 2004, the global financial crisis in 2008, and political disturbances in 2009 and 2010. Yet, overall, the number of visitors has continued to grow, from 9.5 million arrivals in 2000 to 16 million in 2010. However, while bringing many economic benefits, tourism has increased the stress on coastal ecosystems, threatening or degrading the islands, estuaries, coral reefs, seagrass beds, and sandy beaches.

Rapid growth of industrial and agroindustrial production has caused serious air, surface, and groundwater pollution in the urban areas. For example, solid waste disposal problems are increasing as cities and consumerism continue to grow. For decades, industries have discharged partially treated or untreated wastewater into the Chao Phraya River as it runs through Bangkok, and industrial water pollution is expected to worsen in the medium term as industrial production expands upcountry. In response, the Ministry of Natural Resources and Environment has, in collaboration with communities and the agricultural and industrial sectors, launched a project on environmental prevention and eradication of water quality problems in critical river basins in order to maintain good water quality from the essential water sources. As a result, municipal sewage management systems were established in 7,575 locations throughout Bangkok and local administrations. Water quality from at least 19 water sources was found to have improved between 2008-2009 according to monitoring data.

The good news is that Thailand has reached or is nearing the income level at which, as the experience of more advanced countries suggests, a strong national consensus favoring environmental protection emerges. It is hoped that this will increasingly influence the environmental debate.

Natural resources will likely remain the primary source of livelihood for a significant proportion of the Thai people, who will continue to live in rural communities well into the 21st century. Population growth, coupled with ambitious export-led growth targets, industrialization, and rising per capita consumption, may almost double the demand on natural resources in the next quarter-century. To meet this demand—to double the current stock and flows of infrastructure, food and commodities, manufacturing, and services—the management of natural resources and environmental systems must become much more efficient, equitable, and sustainable.

One of the biggest flooding disasters in five decades hit Thailand in the latter half of 2011 affecting 3 million people in 64 out of 77 provinces. The death toll reached over 600. Major economic zones with some 848 factories in many provinces in the central region were submerged; the floods affected 7 critically important industrial estates located in Ayutthaya, Pathum Thani, and Nonthaburi that contribute more than 22% of the country's manufacturing output. Apart from the industrial sector, others affected were the agriculture, tourism, and financial sectors. Damage ranged from inundation of 1.8 million hectares of crop land, decline in number of tourist arrivals by a million, and closing of 452 bank branches. Initially, economic loss was estimated at $7 billion–$10 billion, which is around 2% of GDP. However, this might reach a staggering $33 billion depending on the recovery process. These devastating floods were a great setback for the Thai economy but the country has gradually recovered, showing the same resilience it displayed following previous natural disasters.

Upper: Bangkok suburb flooded in 2011. **Lower:** Pedestrians in the Bangkok flood.

Bangkok

Bangkok, the capital of Thailand, is situated on the low flat plain of the Chao Phraya River that extends to the Gulf of Thailand. Bangkok, locally called "Krung Thep," which means the City of Angels, was established in 1782 by King Rama I as the capital of Siam. Since then, Bangkok has grown from a small village, little more than 4 square kilometers in area, to today's megacity of more than 1,560 square kilometers. Much of this growth has occurred since 1960. Bangkok had 5.7 million residents in 2010, although sometimes with the hustle and bustle and traffic, it seems to have many more. Shopping, world famous cuisine, nightlife, and cultural sights have made Bangkok one of the tourist havens of Southeast Asia. Today, Bangkok is a mixture of its old cultural heritage, new modern skyscrapers, luxurious hotels, shopping centers, street shopping, famous Thai food, restaurants, sports, and entertainment.

Bangkok's well-developed infrastructure has established it as the political, economic, tourism, and cultural center of Thailand, and the growth gateway of the whole region as well. From the late 1980s to the mid-1990s, industry mushroomed. With urbanization and the influx of people came environmental problems of air and water pollution and solid waste generation. Bangkok's numerous "khlongs" or canals, estimated at 1,357 in 2000, have become polluted due to direct discharges of wastewater. Still, wastewater treatment projects and canal water improvements have resulted in better water quality.

As the number of vehicles more than doubled in the 1990s, traffic became increasingly congested and air quality declined. However, since the implementation of new air and water pollution policies and stricter environmental standards in the late 1990s, air quality in Bangkok has started to improve.

Moreover, the subway and the skytrain are efficient and environmentally friendly alternative transportation modes that can help reduce traffic congestion to some extent. Bangkok has established rapid and direct connection from Suvarnabhumi international airport and suburbs into the heart of the city.

Bangkok is now facing problems of land subsidence due to excessive groundwater extraction. Subsidence has occurred at rates up to 10 centimeters per year in some areas, worsening flood conditions and causing damage to buildings and other infrastructure. Several royal projects initiated by His Majesty the King, such as the construction of Pasak Jolasit Dam and the Monkey Cheeks (Kaem Ling) Project to construct water retention facilities throughout the country have helped prevent and minimize flooding in Bangkok and its surrounding area. Even so, the disastrous floods of 2011 hit Bangkok particularly hard and further steps will be needed to improve flood control and flood defenses for the city.

■ Modern city buildings along the Chao Phraya River.

Viet Nam

Viet Nam, with an area of 331,211.59 square kilometers (Decision number 272/QĐ-TTg), lies along the western shore of the South China Sea , known as the East Sea (Biển Đông) in Viet Nam, and is bordered by the People's Republic of China to the north, the Lao People's Democratic Republic to the west, and Cambodia to the southwest. Ranging in width from 50 to 600 kilometers, it is a narrow country, except in the north, and is 1,662 kilometers long. Viet Nam has more than 3,000 islands along its coastline. There is a dense network of rivers and waterways in the Red River in the north and the Mekong River in the south.

Of all the countries in the subregion, Viet Nam has shown perhaps the most remarkable social progress in recent decades. Poverty decreased by a factor of five, from 70% in 1990 to 14.2% in 2010; gross national income (GNI) per capita more than doubled in the past decade alone, from $390 in 2000 to $1,110 in 2010; and there have been advances in many indicators of human development, including life expectancy (from 68 years in 2000 to 75.2 in 2011), infant mortality (from 30 per 1,000 live births in 2000 to 15.8 in 2010), and under-five mortality rate (from 34 per 1,000 live births in 2000 to 23.8 in 2010). However, the population tripled over the last half-century to about 87 million in 2010; population density, about 263 persons per km^2, is one of the highest in Asia.

Viet Nam's advances in human development are closely linked with its tradition of social protection and the notable economic growth since 1986, when economic reforms changed the structure of the economy to one that is more open to the market and the international community, and transition began from a solely agrarian to an industrial focus. From the early 1990s, gross domestic product (GDP) increased rapidly, reaching a peak growth rate of 9.5% in the mid-1990s. In the following years, many events, such as joining the World Trade Organization in 2007, the increased influx of foreign exchange in 2007–2008, the problems in the foreign exchange markets in 2009 and 2010, and the global economic crisis with the threat of returning inflation, have posed many new challenges for macroeconomic management. Nevertheless, during 2000–2010, GDP grew at an average rate of 7.4%. Viet Nam recently became a middle-income country.

Agriculture is the cornerstone of Viet Nam's economic productivity, engaging 48.7% of the employed labor force in 2010. It accounted for almost one fifth of GDP in 2010. The land law passed in 1993, which granted farmers 20-year renewable tenure rights to their land, helped increase the rice output by 50% during 1988–1997. During 2000–2010, rice output further increased by 18.7% even though total planted area decreased by 2%. This made the country a major rice exporter and led to a steady decline in poverty. Also contributing to economic performance is the expanded production of cash crops, such as groundnuts, cashew nuts, rubber, coffee, and tea.

Upper: Hạ Long Bay, a UNESCO World Heritage Site and a major tourist attraction of Viet Nam. **Lower:** Rice planting in the Mekong Delta.

■ **Upper:** Notre Dame Cathedral, Ho Chi Minh City. **Lower:** Traditional and modern dress in Ha Noi.

PEOPLE'S REPUBLIC OF CHINA

LAO PDR

THAILAND

CAMBODIA

Viet Nam

- National capital
- Provincial capital
- International boundary
- Provincial boundary
- Major road
- Major river or lake

0 40 80 160 Kilometers

Boundaries are not necessarily authoritative
Data source: GMS EOC, UN FAO GAUL, ESA GlobCover, NASA SRTM

Ha Giang
Cao Bang
Lao Cai
Bac Kan
Lai Chau
Tuyen Quang
Yen Bai
Lang Son
Thai Nguyen
Dien Bien Phu
Son La
Vinh Yen
Viet Tri
Bac Ninh
Bac Giang
HA NOI
Hai Duong
Hai Phong
Ha Long
Hoa Binh
Hung Yen
Phu Ly
Thai Binh
Ninh Binh
Nam Dinh
Thanh Hoa
Vinh
Ha Tinh
Dong Hoi
Dong Ha
Hue
Da Nang
Tam Ky
Quang Ngai
Kon Tum
Pleiku
Quy Nhon
Tuy Hoa
Buon Ma Thuot
Nha Trang
Gia Nghia
Da Lat
Dong Xoai
Phan Rang-Thap Cham
Tay Ninh
Thu Dau Mot
Bien Hoa
Phan Thiet
Ho Chi Minh City
Cao Lanh
Tan An
Vung Tau
Long Xuyen
Vinh Long
My Tho
Ben Tre
Rach Gia
Can Tho
Tra Vinh
Vi Thanh
Soc Trang
Bac Lieu
Ca Mau

Facts and Figures about Viet Nam

GEOGRAPHY	
Location	Southeast Asia, bordering the Gulf of Thailand, Gulf of Tonkin, and South China Sea; and land borders with the People's Republic of China, the Lao People's Democratic Republic, and Cambodia
Total area, km^2	331,211.59
Climate	(1) Northern Viet Nam (from Hai Van Pass northward): highly humid tropical monsoon climate with 4 seasons (spring, summer, autumn and winter); influenced by the northeast and southeast monsoon. (2) Southern Viet Nam (from Hai Van Pass southward): weak influence of monsoon; characterized by dry and rainy seasons and warm weather all year round.
Terrain	3/4 of terrain made up of low mountains and hilly regions; low, flat delta in south and north; central highlands; hilly, mountainous in far north and northwest
Lowest point	South China Sea (Vietnamese name East Sea, Bi n Đông), 0 m
Highest point	Fansipan, 3,143 m
Natural resources	Almost 60 mineral commodities, such as coal, bauxite, gold, copper, zinc, tin, copper, chromite, manganese, titanium, barite, ilmenite, limestone, and phosphate. Offshore oil and gas deposits, forests, hydropower, thermopower
Natural hazards	Floods, storms, landslides.
PEOPLE	
Total population, million	86.927 (2010)
Average annual population growth rate, %	1.05 (2010)
Population density, persons/km^2	263 (2010)
Major ethnic groups	54 ethnic groups: Kinh people (86%); Tay, Thai, Muong, Hoa, Khmer, and Nung (around 1 million each); Brau and Odu (several hundred people each)
Religion	Buddhist, Hoa Hao, Cao Dai, Christian (predominantly Roman Catholic, some Protestant), indigenous beliefs, Muslim
Languages	Vietnamese (official) and ethnic languages
Poverty	
Human Poverty Index/Rank	12.4; 55th out of 135 countries and areas (2009)
Human Development Index/ Rank	0.593; 128th out of 187 countries (2011)
Proportion of population below poverty line, %	14.2 (2010)
Education	
Net enrollment ratio in primary education, %	95.5 (2009)
Adult literacy rate, %	93.5 (2009)
Government expenditure for education, % of GNI	13.36 (2009)
Gender Equality and Women Empowerment	
Ratio of girls to boys in primary and secondary education, %	94.0 (2010)
Ratio of literate females to males among 15-24-year olds, %	100 (2009)
Proportion of seats held by women in national parliament, %	24.4 (2011)
Health	
Under-5 mortality rate, per 1,000 live births	23.8 (2010)
Infant mortality rate, per 1,000 live births	15.8 (2010)
Life expectancy at birth, years	75.2 (2011)
Maternal mortality ratio, per 100,000 live births	69 (2009)
Undernourished children, weight for age, %	18.9 (2009)
Proportion of population with access to an improved water source, %	95 (2010)
Health (cont.)	
Proportion of population with access to improved sanitation, %	76 (2010)
HIV prevalence among 15-24-year-old women, %	0.1 (2009)
Contraceptive prevalence rate, %	79.5 (2008)
Government expenditure for health, % of GDP	4.7 (2009)
ECONOMY	
Total GNI, $ million	96,321 (2010)
Per capita GNI, $	1,110 (2010)
GDP Composition by sector	
Agriculture, %	20.58 (2010)
Industry, %	41.10 (2010)
Services, %	38.32 (2010)
Labor force, million	50.392 (2010)
Value of exports, f.o.b., $ million	72.191 (2010)
Value of imports, c.i.f., $ million	84.801 (2010)
Total external debt, $ billion	27.929 (2009)
Debt service as percentage of exports of goods and services	1.8 (2009)
ENVIRONMENT	
Total forest area, % of land area	39.5 (2010)
Average annual deforestation, %	(+) 1.6 (2000-2010)
Protected area, % of total land area	6.2 (2010)
Freshwater resources per capita, m^3	10,064 (2010)
Freshwater withdrawal for agriculture, %	94.78 (2009)
Rural Environment	
Rural population, % of total	69.83 (2010)
Rural population density, persons/km^2 of arable land	987 (2008)
Arable land, % of land area	20.3 (2009)
Permanent cropland, % of land area	10.8 (2009)
Urban Environment	
Urban population, % of total	30.17 (2010)
Population in largest city, % of urban population	Ho Chi Minh City: 28.2 (2010)
Population with access to improved sanitation, % of urban population	94 (2010)
Solid waste generation in urban areas kg/capita/day	1.45 (2008)
Energy Efficiency of Emissions	
GDP per unit of energy use	4.0 (2009)
CO_2 emissions, million tons	142.258 (2009)
CO_2 emissions per capita, total tons	1.637 (2009)
Energy use per capita, kg of oil equivalent	744.53 (2009)

Upper: Ho Chi Minh City and Saigon River. **Lower:** Fisher in a coracle near Nha Trang.

■ **Upper left:** Family from the Katu ethnic minority preparing vegetables, central Annamites. **Lower left:** Katu lady weaving. **Right:** Fishing boats at dawn near Nha Trang.

The large and fertile deltas of the Red and Mekong rivers, which cover half of the country's territory, have been important in agricultural production.

In terms of mineral wealth, the uplands, particularly in the north, contain a wide variety of lesser metallic ores and also some useful apatite, but the anthracite coal field in Quang Ninh, immediately to the northeast of the Red River Delta, contains the most important energy reserves. The country has commercially viable reserves of petroleum, natural gas, iron ore, bauxite, chromite, copper, tin, titanium, and even gold.

Destroyed mostly by war during 1955 to 1975, heavy industries began to decline and were replaced by light and consumer goods industries, which expanded to relieve the shortages in basic commodities. Four manufacturing areas showed particular promise in the 1990s as significant sources of export earnings: textiles, footwear, and garments; processing agricultural products; electrical industries; and automobile and motorcycle assembly. In spite of achieving impressive annual growth, Vietnamese industry is still considered underdeveloped due to obsolete equipment and machinery with high energy intensity. Viet Nam has designed policies with strong incentives to create a favorable environment for investors.

Rapid industrialization and urbanization, which go hand in hand with economic growth, have taken their toll on the environment. In 2010, about 30% of the population lived in urban areas, the most prominent of which are Ha Noi, Ho Chi Minh City, Thanh Hoa, and Nghe An. The increasing flow of migrants from the rural areas has stretched the already burdened urban infrastructure, including housing, water supply and drainage systems, and roads.

By 2008, virtually all the urban population nationwide had access to an improved water source and three quarters had access to improved sanitation facilities. Domestic and usually untreated industrial wastewater is discharged directly into open canals, polluting lakes and rivers at concentration levels higher than government standards. Cars and motorcycles, the numbers of which have been increasing by about 14% per year, have become major sources of air and noise pollution. Seventy percent of air pollution in urban areas is caused by transportation. Dust concentration is up to three times the acceptable limit. In general, however, air pollutants—carbon monoxide, nitrogen dioxide, and sulfur dioxide—have not exceeded acceptable limits except in some industrial zones in cities. The complete phase out of lead in gasoline in July 2001 effectively reduced the level of curbside lead concentration in urban centers.

Economic reforms in recent years were crucial in spurring industrial growth, which averaged a substantial 3.5% over the last decade despite slowdowns in 2005 and 2008. The contribution of industry to GDP rose to more than a third by 2000, reflecting the strong effects of the Government's development program and increased consumer confidence.

Upper: Youth in a Cham village at Chau Doc. **Lower:** Selling flowers at Hoi An market, central Viet Nam.

However, amid such high growth, the limits of natural systems are becoming evident. Intensive farming, the main source of rural livelihood, has pushed the country to the limits of its arable land. The amount of cropland per capita, 0.07 hectares (2009), is one of the lowest in the world.

Half of the original forest cover was lost over the 4 decades to 2000, when only about 98,190 square kilometers, or 30% of the country's land area, remained. Reasons for this are migration to forested areas (from the Red River Delta to the Central Highlands, which harbor the country's richest remaining biodiversity), fuelwood collection, logging, forest fires, and war damage. However, while cutting of natural forest continues, reforestation and re-greening programs during the last two decades have increased forest cover. About 20% of Viet Nam's forests have been recently planted.

The country's exceptional biodiversity has been declining at a rate considered the highest in the subregion. There are more than 23,200 terrestrial and aquatic species in all. Of the endemic species, 28% of the mammals, 10% of birds, and 21% of reptile and amphibian species are endangered—a sign of ecosystem degradation and diminishing genetic diversity. National protected areas accounted for only 6.2% of the land area in 2010.

The accessibility and quality of water have diminished because of the loss of surface water from upstream countries, disruption in natural water regulation caused by forest loss, and degradation of watersheds and wetlands as a result of soil erosion. The country receives about 2,000 millimeters of rain each year but rainfall is highly variable, causing floods, then drought of increasing severity. Each year, on average, the country is affected by 6–8 typhoons. Urbanization and industrialization, coupled with the use of agrochemicals, are degrading the quality of surface water bodies and groundwater sources. Erosion rates are very high in the northern mountains and central highlands. Some of the wells in and around Ha Noi have tested positive for arsenic at levels exceeding the World Health Organization international standards.

There is significant economic activity in coastal and marine areas. More than 50% of the protein intake of the Vietnamese comes from a national fish harvest of more than 4 million tons each year, 50% of which comes from the sea. However, the productivity of coastal and marine areas has been decreasing throughout the 29 coastal provinces as a result of the rapidly increasing urban population along the coast, where many industrial zones are located. Coal mining is also a major cause, while the growing numbers of foreign and domestic tourists—expected to reach 25 million each year by 2010—could further strain coastal and marine resources.

Viet Nam has been successfully making an economic transition, with incomes rising and poverty on the retreat. The challenges are to ensure that growth is environmentally sustainable and that its benefits are shared throughout the country and among all population groups—including the rural population, ethnic minorities, and the poor.

Upper: Ha Noi, decked out with floral displays for May Day celebrations.
Lower: A traditional basket trader plying his wares on a bicycle, Ha Noi.

Ha Noi

Emperor Ly Thai To founded modern-day Ha Noi as Thang Long ("Ascending Dragon") in 1010. Despite its present population density of 1,962 persons per square kilometer, Ha Noi prides itself as a green city. With more than 1,100 hectares of lakes and streams and streets lined with 180,000 trees, there are many pleasant areas for walking and recreation. Van Mieu - Quoc Tu Giam is a famous historical and cultural relic of Ha Noi. Van Mieu ("Temple of Literature") was built in 1070 in honor of Confucius, his followers and Chu Van An, a moral figure in Vietnamese education. Quoc Tu Giam, which is the first university of Viet Nam, was built in 1076.

The 1,000th anniversary of Thang Long-Ha Noi, at which the fine traditional values of the capital's heroism, peace, and friendship were honored, was celebrated on 10 October 2010. Eighty-two doctoral laureate steles (stone commemorative tablets), bestowed under the Le-Mac dynasties and displayed at Van Mieu - Quoc Tu Giam were recognized by UNESCO as world heritage documents. UNESCO also recognized the Thang Long-Ha Noi Royal Citadel vestige complex as a world cultural heritage site.

Lying on the western bank of the Red River in northern Viet Nam, the city has an area of 3,344.6 square kilometers. Ha Noi's 6.56 million inhabitants make up 7.5% of Viet Nam's population. Although second to Ho Chi Minh city in population size, Ha Noi is the political, economic, and cultural hub of Viet Nam. Because of reforms encouraging private ownership, foreign investments, and exports, Ha Noi's economy is becoming more diversified. As the country moves from a centrally planned to a market-oriented economy, Ha Noi also faces increasing demand for better public services and infrastructure. The drainage and sewerage system, for instance, needs major improvement. Increasing amounts of solid waste are being generated while air and noise pollution are rising in commercial and residential areas.

To deal with these problems, the local government plans to move old and polluting factories to the suburbs. New landfills have been developed and the drainage system, including canals and natural lakes, has been upgraded. Ha Noi's residents rely on motorcycles and bicycles as their main mode of transportation, while increasing numbers of cars and buses clog the narrow streets. Air quality is still good in most areas but there is growing concern about increasing traffic congestion and associated emissions.

Ha Noi grew at 2% per year in the decade to 2008, adding about 200,000 people annually to its population. In 2008, Ha Noi absorbed several neighboring communes and an adjacent province, which more than tripled the city's area and increased its population substantially. There are also informal settlers who occupy land without legal ownership. They are mostly street vendors, street children, and those involved in small businesses. Several government and social institutions have undertaken poverty reduction work, such as providing education and health care services, to reduce the number of households living below the poverty line.

Peoples and Cultures

The majority of people inhabiting the valleys and lowlands of the subregion are lowland ethnic groups—Khmer of Cambodia, Han of the People's Republic of China (PRC), Lao of the Lao People's Democratic Republic (Lao PDR), Bamar of Myanmar, Thai of Thailand, and Kinh of Viet Nam. The highland ethnic minorities are found in the mountainous areas that define the borders between the countries. Both the majority ethnic populations and the highland ethnic minorities can be classified as belonging to the three major families of languages used by the populations of mainland Southeast Asia—Sino-Tibetan, Austro-Thai, and Mon-Khmer. These major families of languages are further differentiated into subfamilies, such as the Tibeto-Burman branch of the Sino-Tibetan, the Austronesian and Kadai branches of the Austro-Thai, and the Hmong groups of the Mon-Khmer family.

Both majority and minority ethnic groups can be identified on the basis of their linguistic differences. Sometimes, mainstream society lumps them together and treats them as undifferentiated groups. An example is the Karen of Myanmar and Thailand, who are generally treated as one group without regard for the subgroups. Ethnic subgroups in Viet Nam, such as Muong, Nguon, Tay Pong, Hung, Tum, Sach, May, Ruc, Arem, Thavung, Phon Sung, Pakatang, Kha Tong Luang, Pong, and Bo are clustered with the majority group of the Vietnamese. In the same manner, the majority ethnic groups

Top: Katu dance ceremony in the central Annamites, Viet Nam. **Middle:** Monks at an Angkor temple, Cambodia. **Bottom:** A Dai mother with her child, Yunnan, PRC.

Ethnic Groups of the Greater Mekong Subregion

- Achang
- Assamese
- Banar
- Bengalis
- Bo and So
- Boloven
- Burmese
- Caolan
- Cham
- Cham Re
- Chaonam
- Chinese (Han)
- Chini
- Chuang
- Ede
- Hani
- Hui
- Jarai
- Kachins
- Karen
- Kayah
- Kehlao
- Khamtis
- Khatu
- Khmers
- Khmu
- Khun
- Kui
- Lahu
- Lamet
- Lao
- Lati, Lakwa
- Lisu
- Loba
- Lu
- Lushei
- Ma
- Malays
- Manipuris
- Maonan
- Miao
- Mnong, Brao
- Mon (Talaing)
- Mongols
- Mulao
- Muong
- Nagas
- Nahsi
- Nua
- Nung, Gial
- Pai
- Palaung
- Phuteng
- Pulang
- Puok, Ksakau
- Puyi
- Raglai
- Sedang
- Selung
- Semangs
- Shan
- Shuichia
- Siamese
- Sre
- Stieng
- Sui
- Tay
- Thado etal
- Thai
- Tibetans
- Tulung
- Tung
- Vankieu
- Ve
- Vietnamese
- Wa
- Yao
- Yi
- Yuang

Boundaries are not necessarily authoritative. Map displays a generalized overview of ethnic groups and follows the spelling of the data source.
Data source: Geo-referencing of Ethnic Groups (GREG; Weidmann, Rod & Cederman 2010), UN FAO GAUL, NASA SRTM

0 125 250 500 Kilometers

in Thailand include subgroups, such as Yay, Saek, Zhuang Nong, Tay (Cho), Caolan, Tai Nuela, Shan, Khyn, Yuan, Lue, Tai Dam, Tai Kaw, Tai Deng, Phutaij, Yo, Lao, and Phuan, which are grouped together with the mainstream Thai as part of the Tai subgroup of Tai-Kadai. Tai-Kadai is part of the Austro-Thai family of languages.

Ethnicity is a fluid concept. Attempts at defining it from linguistics, cultural, social, political, economic, or religious perspectives have limitations. Ethnic groups tend to change their identities in response to threat, or to take advantage of opportunities that would enhance their survival.

One example is the minority nationalities of Yunnan, which, as a result of affirmative action of the Government, have gained stronger ethnic identities. With exemption from the "one-child policy" and preferential state support, they have grown into a larger minority constituting about 33% of the total population. However, without state support and with a policy of assimilation, ethnic minorities can soon become integrated into the mainstream society.

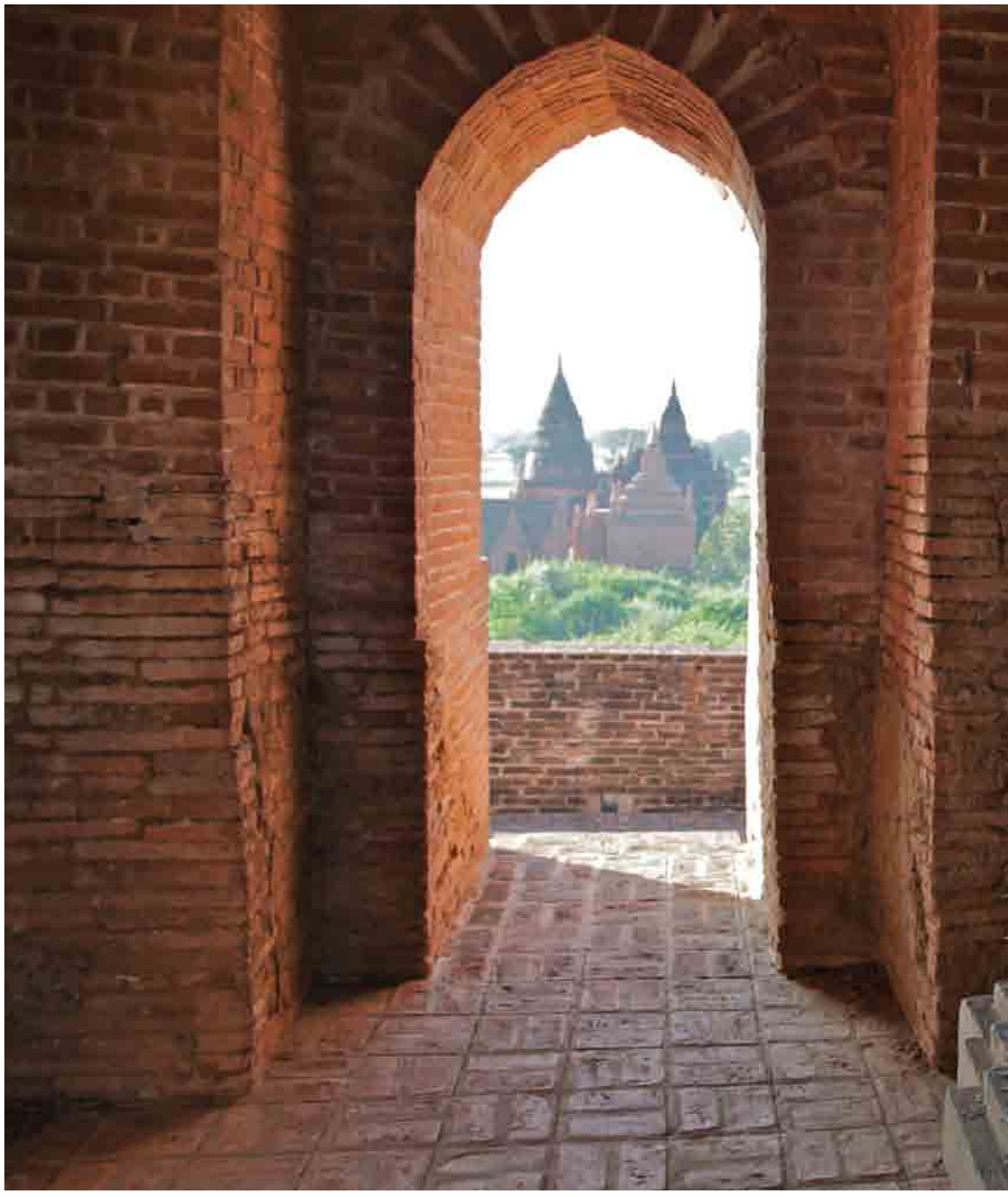
The ethnic minorities in the subregion generally live in remote areas and face problems of marginality, poverty, and lack of basic

Upper: Zhuang ethnic festival in Guangxi, PRC. **Lower:** Vegetable seller at Hoi An market in Viet Nam.

Major Ethnic Groupings

Major Groups	Cambodia	Guangxi, PRC	Yunnan, PRC	Lao PDR	Myanmar	Thailand	Viet Nam
National Majority Peoples							
Khmer	13,627,262						
Han		32,019,000	30,662,000				
Lao				4,129,090			
Bamar					40,650,400		
Thai						57,213,500	
Kinh							65,800,000
Highland Peoples							
Tibeto-Burman			9,774,000	122,640	8,423,914	464,640	45,794
Sino-Thai		16,587,200	2,440,000	799,280	3,591,640	966,280	4,125,479
Hmong-Mien	8,008		1,424,000	294,800	10,000	132,400	1,313,664
Mon-Khmer	274,249		518,000	1,045,984	2,268,610	2,123,137	3,320,450
Austronesian	320,114				7,000	1,008,500	833,050
Others	19,179					1,174,080	1,010,200

Source: Cambodia-Commune Database 2010; Communique on Sixth Population Census of Guangxi; Guangxi Bureau of Statistics. 2011; Lewis, M.P., ed. 2009. *Ethnologue: Languages of the World. Sixteenth edition*. Dallas: SIL International. http://www.ethnologue.com/; Yunnan Statistical Yearbook 2011.



Upper left: Dai traditional weaving in Yunnan, PRC. **Lower left:** Ethnic minority ladies in traditional costume, Lao PDR. **Right:** Pagodas of Bagan, Myanmar.

infrastructure. Increasingly over time, many have been assimilated into mainstream national cultures, often moving to lower valleys or plains and adopting the mainstream language and culture to such an extent that to outsiders they become virtually indistinguishable.

At present, many ethnic minorities of the subregion's highlands still inhabit the critical watersheds of the Mekong River and its tributaries, where some have been rice farming for generations. However, there are still ethnic minorities inhabiting remote and mountainous areas and their subsistence is based on limited hunting and gathering combined with swidden agriculture. Their subsistence is supplemented with income derived from trade of forest products with lowlanders along the Mekong River and its tributaries. Small game animals and fish are caught in the upstream parts of tributaries. Some of the Mon-Khmer bands in remote areas of the subregion may still be hunters and gatherers, and may be the descendants of some of the earliest human societies in Southeast Asia. Some have traditionally cultivated, for medicinal purposes, poppy plants from which opium and other drugs are extracted.

Swidden or shifting cultivation has been blamed for deforestation and degradation. However, the established swidden agriculture of groups with a horticultural tradition, such as the Mon-Khmer, Austronesian, and highland Sino-Thai, is sustainable as long as it is focused on subsistence rather than market production.

Ethnic minorities living in forested areas or important watersheds have faced eviction in the name of conservation. Their population growth has increased pressure on available land resources and, as a result, traditional fallow periods are no longer observed, resulting in unsustainable swidden practices. This issue is often overshadowed by deforestation attributed to illegal commercial

Upper: Pa-O ethnic couple in Myanmar.
Lower: Han men at a park in Yangshuo,Guangxi, PRC.

logging or the conversion of so-called "fallow" lands to plantations. Relocation programs have been drawn up for particularly vulnerable areas, such as the Xishuangbanna National Nature Reserve in Yunnan or as part of a much broader program of officially sponsored assimilation and relocation to lowlands.

Since the 1980s, there has been growing awareness throughout the subregion of the negative effects of deforestation and watershed degradation and the need to preserve or restore forests and watersheds. Some areas like the Thung Yai Naresuan Wildlife Sanctuary in Thailand have been added to the World Heritage Site list of the United Nations Educational, Scientific and Cultural Organization (UNESCO).

Nongovernment organizations, funding agencies, and governments are gaining greater awareness of the need to involve the highland ethnic minorities in conservation efforts. The Thung Yai Naresuan Wildlife Sanctuary has been cited as an example of how Karen communities protect forest resources and generally live in harmony with nature.

To protect its natural forest, the National Nature Reserve Bureau of Xishuangbanna Dai National Autonomous Prefecture in Yunnan has sought to build on the long harmonious coexistence of its 10 national minorities with the forest and their rich lore of biodiversity use.

Some ethnic groups in Guangxi, such as Zhuang, Dong, Shui, Mulao and Maonan, have traditional relations with many ethnic groups in the Lao PDR, Myanmar, Thailand, and Viet Nam. They share similarities in language and folk customs. All this constitutes a favorable foundation for economic and cultural exchanges between the PRC and Southeast Asian countries.

■ **Upper left:** Apsara dancers in Siem Reap, Cambodia. **Lower left:** Katu woman smoking traditional pipe, Viet Nam. **Right:** Chengyang Wind and Rain Shelter bridge, Guangxi, PRC.

National minorities are also becoming more and more involved in the highly successful handicrafts and ecotourism industries, which have sparked both a cultural renaissance and the fusion of tradition and modernity in a reinvented ethnic identity. The Lijiang World Heritage Site in Yunnan for example, features the culture and handicrafts of the Tibeto-Burman Naxi national minority group.

A Rich Diversity of Cultures

Cambodian culture and tradition date back many centuries. There are many classical dance forms in Cambodia, of which a highly stylized art form was once confined mainly to the courts of the royal palace and performed mainly by females. Known formally in Khmer as Robam Apsara, the dancers of this classical form are often referred to as Apsara dancers. The Apsara dance is particularly inspired by the style of the more than a thousand Apsara carvings in the Angkor temple complex. Silk weaving in Cambodia also has a long history. The practice dates to the first century when textiles were used in trade. It is common to see men and women using a krama (Khmer Scarf), a long, narrow checked cotton cloth round the neck. Cambodia's three important silk textiles are ikat silks (chong kiet in Khmer), or hol, the twill-patterned silks, and the weft ikat textiles.

Though now associated with the Zhuang ethnic minority, **Guangxi's** culture traditionally has had a close connection with the Cantonese. Cantonese culture and language moved up the Xi River valley from Guangdong Province and is still predominant in the eastern half of Guangxi today. Most Zhuang follow a traditional animist/ancestor-oriented religion; however, Buddhism is the major religion and there are a number of Christians and Muslims as well. The world-famous Huashan Cliff Paintings were created by the ancestors of Zhuang

■ **Upper:** Young novice monk, Myanmar. **Lower:** Jing Po ethnic minority women, Yunnan, PRC.

people. The Zhenwu Pavilion of Rongxian County, the Chengyang Wind and Rain Shelter bridge and Mapang Drum Tower from Sanjiang Dong Autonomous Prefecture are the crystallization of wisdom of Han and Dong ethnic groups in the development of Chinese architecture. Guangxi is a sea of folk songs, with a rich heritage of ballads. Weddings, birth ceremonies, funerals, and harvest festivals all provide opportunities for ethnic minorities to dress up in bright traditional clothes and sing to their heart's content. Zhuang medicine, Yao medicine, Miao medicine, and Dong medicine have all developed special folk prescriptions. Embroidery, brocade, and wax printing, as well as pottery, engraving, and inscription of the ethnic minorities from Guangxi enjoy a high reputation across the PRC.

Most dialects of the Chinese language spoken in **Yunnan** belong to the southwestern subdivision of the Mandarin group, and are very similar to the dialects of neighboring Sichuan and Guizhou provinces. In addition to the local dialects, most people speak Putonghua, commonly called "Mandarin." Yunnan's ethnic diversity is reflected in its linguistic diversity. Languages spoken in Yunnan include Tibeto-Burman languages, such as Bai, Yi, Tibetan, Hani, Jingpo, Lisu, Lahu, and Naxi; Tai languages like Zhuang, Bouyei, Dong, Shui,Tai Lü, and Tai Nüa or northern Lao dialect; as well as Hmong-Mien languages. The Naxi, in particular, use the Dongba script, which is the only pictographic writing system in use in the world today. The Dongba script was mainly used to provide the Dongba priests with instructions on how to carry out their rituals: today the Dongba script features more as a tourist attraction. Yunnan is well known for the emergence of three major ancient cultures: the Ancient Dian Culture, centered around Dianchi Lake from the Pre-Qin Period (221–207 B.C) to the Han Dynasty (25–220 A.D),

■ **Upper:** Shwedagon Pagoda, Yangon, Myanmar. **Lower:** Street cooking in Mandalay, Myanmar.

epitomizes the culmination of the bronze age civilization in Yunnan; the Cuan Culture, which rose slightly later in the valley of the Panjiang River, embodies the cultural development of this province in the middle ages; and the Nanzhao-Dali Culture, which formed and fully developed around Er Hai Lake.

The people of the **Lao PDR** are almost all Buddhists and perhaps more than elsewhere Buddhist practices permeate life and society, influencing their arts and literature as well as the architecture of the country's many temples. The main language is Lao, from the Tai linguistic group, but about half the population do not speak Lao, but one or more of the languages, such as Khmu and Hmong, of the many ethnic minority groups scattered around the country.

Traditional music is performed on the khene, a long reed instrument resembling pan pipes but blown through a single transverse pipe. The national musical instrument, it generally accompanies Lao Lum extemporaneous singing or lyrical storytelling.

The main Lao food staple is sticky rice, which has cultural and religious significance and is so ubiquitous that it is believed to have originated in the Lao PDR. Sticky rice forms the basis of the Lao meals and is served with the most characteristic Laotian dish, the larb, made from slices of meat or fish marinated in a spicy sauce. Another staple is tam mak hoong or tam som, a salad made primarily from unripe, or green, papaya with spices.

Myanmar is another predominantly Buddhist country, but people of other beliefs, such as Christianity, Hinduism, Islam or animist beliefs live side by side and it is not unusual to see pagodas, churches, mosques, and temples in one neighborhood. Spirit worship exists with Buddhism, as these minor gods are also believed to be disciples of the Buddha's teachings. The Bama or Myanmar are the majority race, inhabiting the central zone with Shan, Kayin, Kachin, Kayah, Chin, Rakhine, and Mon; their sub-races live in mountainous regions closer to the borders or near the long coastline.

People in Myanmar adore festivities and there is a saying that Myanmar celebrates a festival each month. Pagoda festivals are like country fairs and Nat ceremonies are accompanied by a lot of music, dancing and feasting. Apart from the pagoda festivals, the nationalities each have their new years and harvests to celebrate. Families celebrate their sons' entry into the Buddhist Order for a few days or weeks, and daughters are pampered with equally lavish ceremonies to have their ears pierced. Myanmar dress for males consists of a collar-less white shirt with an over

coat and longyi—a sarong-like piece of cloth. Myanmar ladies prefer silk but fine cotton dresses are also very popular for all ages.

Myanmar food has its own special identity. Although it draws on its neighbors, Myanmar food is neither as hot as Thai, nor as spicy as Indian, nor does it resemble Chinese cooking much except in the stir-fry vegetables. The meal is arranged around rice with accompanying dishes of fish, meat, or fowl cooked in an onion and garlic based gravy. Monhinga, the thick fish broth and thin rice noodles, is probably Myanmar's most famous national dish. Running a close second is the highly popular ohn no kauk swe, the coconut-based chicken soup and noodles. Mondhi, particularly from Mandalay, is Myanmar's answer to spaghetti; and kyar zan chet is a chicken broth and vermicelli soup with chunks of chicken, dried mushrooms, and coriander.

Thailand's culture is also based largely on Buddhism, but it incorporates influences from what are now the neighboring countries of Cambodia and Myanmar, as well as more distant, enduring cultures of India and the present PRC. As in other GMS countries, the architecture, arts, and literature all reflect a strong Buddhist tradition and this influence is carried through into daily life. The Thai language is from the Tai-Kadai language group, which is closely related to languages spoken in these neighboring countries and cultures. The largest minority language is the Lao dialect of Isan, used in the northeastern part of the country.

The first thing that visitors to Thailand may notice is the traditional welcome with the words *Sawasdee khrap* by men and *Sawasdee ka* by women, while bowing the head with hands together, the extended fingers pointing upward. Thai cuisine, with its distinctive spices and sauces and use of limes and lemon grass, has become world famous. Thai dishes are almost invariably based on jasmine rice, an aromatic rice that is the main Thai staple food.

Viet Nam differs from most of the other GMS countries in its incorporation of Confucian values and ethics, including ancestor worship, having long been influenced by Chinese civilization to the north. Still, about 85% of the population are Buddhists, with some 8% Christian, and the remainder a variety of other religions. Vietnamese culture is said to be among the oldest in Southeast Asia, probably derived mainly from the ancient Bronze Age Dong Son culture. Vietnamese life revolves around the nuclear and extended family. It is not uncommon for three generations to be living together under one roof.

The ao dai, meaning long dress, or a two piece garment, is the most recognizable traditional dress seen in Viet Nam, and though western style clothes are popular, this beautifully styled outfit is

Upper: School girls at an orchid display at Siam Paragon shopping mall, Bangkok, Thailand. **Lower:** Buddhist Temple in the Grand Palace, Bangkok, Thailand. Buddhism is the major religion across the subregion.

■ **Upper:** Enjoying food al fresco in Ho Chi Minh City, Viet Nam. **Lower:** Rice planting, Viet Nam. Activities associated with rice farming form the basis of much of the subregion's cultures.

still actively worn throughout the country during work, weddings, and national celebrations.

Recently voted by health experts as the world's healthiest food, Vietnamese cuisine mixes grilled meats, fresh vegetables, cold noodles, and all kinds of seafood dishes, spiced with tamarind and chili. Available at all hours of the day, Vietnamese food can be eaten as snacks, in street-side stalls, in budget restaurants, and in hotels. In many cases only the price is the difference because often the tastiest foods come from the most basic kitchens. Soups play a large part in northern cuisine. Pho, Viet Nam's chicken soup, is made with white vermicelli noodles, sliced beef or chicken, bean sprouts, chopped peanuts, hot broth, and mint leaves. Most of the food eaten in central Viet Nam has some link to the imperial kitchens of the Nguyen emperors in Hue. Many of the spices, techniques, and vegetables come straight from the tables of the emperors themselves. In the south, with the lush Mekong Delta so close, the fruit is very fresh and durians, pineapple, mango, and star fruit all come into play in dishes as they come into season, with a choice of many flavors of seafood dishes.

There are several popular forms of folk music. And the 1955–1975 Viet Nam War led to the penning of many patriotic songs that have become anthems for the people.

Poverty and Environment

Poverty has commonly been measured in terms of income. But now there is universal agreement that its dimensions far transcend this traditional definition. Poverty is now seen as a deprivation of essential assets and opportunities to which every human is entitled. All people should have access to basic education and primary health services. They must be able to sustain themselves by their labor and be reasonably rewarded for it, besides having some protection from financial shocks.

Beyond income and basic services, however, individuals and societies are also poor—and tend to stay poor—if they have no say in decisions that shape their lives. For this reason, poverty is better measured in terms of basic education, health care, nutrition, water, and sanitation, as well as income, employment, and wages. Such measurements also help to account for other important, but intangible, factors, such as feelings of powerlessness and lack of freedom to participate.

Over the first decade of this century, the Greater Mekong Subregion (GMS) has achieved both impressive growth of output per person and large reductions in absolute poverty incidence. Poverty reduction in the GMS is strongly related to growth of real gross domestic product (GDP) or gross national income (GNI) per person. During 2000–2010, economic growth and reduction in poverty incidence were enjoyed by all the GMS countries to a varying extent. The rate of poverty reduction in the GMS may rise over the coming decade. If past overall rates of GDP growth per person can be maintained, growth will become more poverty-reducing, given the structural changes that seem to be consistent with global economic restructuring.

Upper: Forest clearing in the Cardamom Mountains, Cambodia. **Lower:** Basket weaving using grass, a livelihood of villagers from the Karen ethnic group in the Western Forest, Thailand.

■ Girl assisting her family to make charcoal in Champasak, Lao PDR.

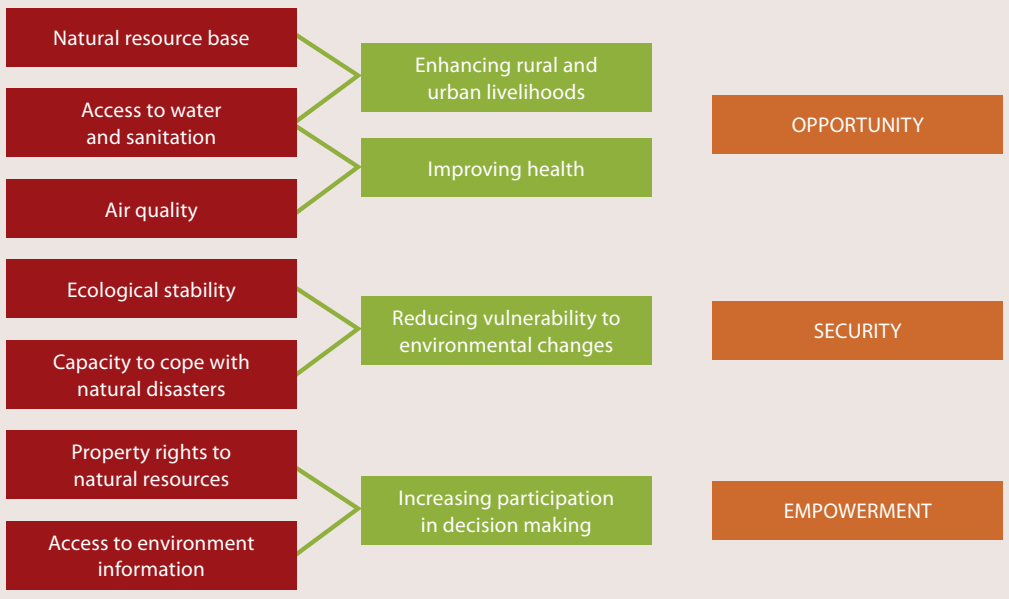
Links between Poverty and the Environment

There is a great deal of literature on the links between poverty and environment. The World Bank has introduced a useful, although simplified, way of examining these links, which shows how different environmental factors affect aspects of poverty and well-being in a given set of circumstances. Links between poverty and environment vary depending on such factors as governance systems, the role of civil society, gender relations, and property regimes. These links are depicted and discussed in the following diagram:

Environment, Livelihood, and Opportunity

The environment provides sustainable livelihoods to many people, giving them ways to improve their well-being. Maintenance of a sound natural environment is important, especially to poor people who depend on it—partly or fully—for subsistence and livelihood. Poor countries still depend heavily on agricultural and natural resource exports, such as rice, coffee, timber, and minerals. Thus, it is the poor, with their limited assets and greater dependence on common property resources, who suffer first when the natural environment is degraded. This is true in

Environmental Links to Poverty Reduction



the subregion, where 60%-80% of the populations live in rural areas and depend on agriculture for income and sustenance. In places where the environment has deteriorated, their livelihoods and future opportunities have been undermined.

Swidden agriculture and increasingly short fallow periods have impaired soil quality and degraded arable land. In Viet Nam, intensive farming, the main source of livelihood of the rural people, has pushed the country to the limit of its arable land, which constitutes only 20.3% (2009) of its total land area. The arable land per capita is now down to 0.073 hectares (2009), one of the smallest ratios in the world. Within the subregion, Cambodia has the biggest ratio, about 0.279 hectares (2009) per person.

Forests have been degraded or destroyed over extensive areas in some parts of the subregion. Government-sanctioned timber harvesting, illegal logging, and land clearing for agriculture have drastically reduced forests in Thailand and Viet Nam to about a third of the land area. Cambodia, Lao PDR, and Myanmar have larger remaining natural forest cover, averaging more than half of the total land area. Generally, these countries supply the timber needs of Thailand, Viet Nam, and Yunnan Province, PRC. This relationship is mutually beneficial to these two groups of countries. But, in the greater scheme of things, the shrinkage of forests disproportionately affects the poor, and among these, women and children are particularly affected. Most spend an inordinate amount of time and energy on their traditional activities of collecting fuel, fodder, and water. If resources near their homes are already exhausted they may have to walk long distances. Such women have less time to earn an income and take care of their children; and their school-age children spend fewer days in school.

Environment, Health, and Opportunity

Good health influences the productivity of a person. Many perceive poor health as a core dimension of poverty, since one must be healthy to earn a living and expand one's opportunities.

The major environmental causes of poor health are unsafe water and sanitation; exposure to disease carriers; dirty air inside the home and in urban areas, particularly in overcrowded slums; and exposure to toxic substances. These account for one fifth of illnesses and deaths in the developing world.

Respiratory infections (from indoor and outdoor air pollution) and diarrhea (from inadequate hygiene, water supply, and sanitation) are the two leading causes of death within the poorest fifth of the world's population. In the subregion, while there are no data on morbidity or mortality rates associated with respiratory infection, the use of traditional fuels by most households, especially in Cambodia and the Lao PDR, indicates exposure to indoor air pollutants. Malaria, usually related to the presence of stagnant water, also disproportionately affects the poor.

Environment, Vulnerability, and Security

Besides being prone to ill health, the poor are increasingly exposed to environmental degradation. They tend to live in precarious housing, often in environmentally vulnerable areas, such as floodplains or steep mountain slopes, where the risk from natural disasters like floods, landslides, and severe weather is great. They also become vulnerable when overexploitation destroys the ecology of the environmental resources on which they depend. The reported pesticide pollution of Tonle Sap Lake in Cambodia, for instance, will potentially affect not only the sustainability of livelihoods but, most importantly, health.

Environmental degradation is accompanied by more frequent and more severe natural disasters. For example, mangrove degradation in Viet Nam has heightened the effect of typhoons on coastal communities. Meanwhile, weather extremes (severe storms, extended droughts, etc.) are becoming more frequent. Destructive floods in Cambodia, Myanmar, and Thailand have largely been attributed to extensive tree cutting. The poor are made even more vulnerable by the insufficient capacity of government to predict and respond to these increasing natural disasters.

In the fight against poverty, the subregion as a whole has made strides in economic and human development in the past 3 decades. Incomes have increased, poverty has dramatically declined, and notable improvements have been achieved in key social indicators. These improvements have been hailed as major dividends of peace.

Upper: Poor family living in a hut by Tonle Sap at Chong Kneas, Cambodia.
Lower: Forest clearing for farming in Lao PDR.

Upper: Rubbish clogs a drainage canal in a peri-urban slum area of Phnom Penh, Cambodia. **Lower:** Fisher with throw net in Tonle Sap, Cambodia.

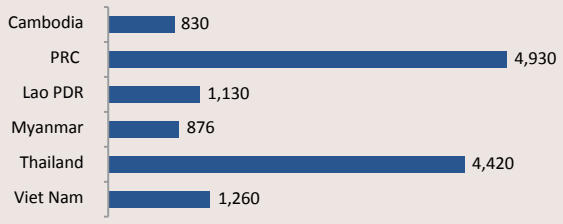
The Poor

There are still pockets of poor people in the subregion, both in urban and rural areas and income disparities are on the rise. The rural people are often farmers, landless laborers, fishers, or agricultural workers dependent on such natural resources as soil, fish, and forest products for subsistence and income. They are mostly from ethnic minorities—the poorest and socially most vulnerable groups. Typically, they live far from the economic mainstream in remote areas, upland areas, and fragile ecosystems. They lack secure title to their land and other resources, are poorly educated, and have limited livelihood alternatives. They rely on a dwindling base of both renewable and nonrenewable resources, and must contend with pressures caused by population increase, resource extraction, and development. Women and children, particularly girls, tend to have less access to scarce resources. Their contributions are not generally reflected in their rights and control of resources. They tend not to be represented in decisions or to have influence in matters that concern them.

The poor are often difficult to reach when it comes to development. Bad roads keep them from transporting their goods to markets. Basic social services often do not reach the remote places where they live. They have no part in important political and economic decisions that affect them. Moreover, governance and institutions in rural hinterlands are usually fragile and biased against them. Living on marginal land, they are often vulnerable to financial shocks and have no means of coping.

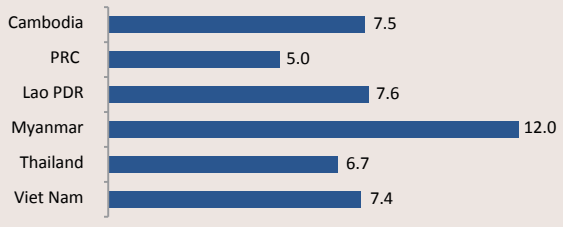
Over the long term, poverty will be reduced only if the environment continues to provide services and resources that people need and if resources are used in a way that is conducive to long-term development. Recent studies recommend four main ways to reduce poverty and ensure environmental sustainability: improving governance, protecting and expanding the environmental asset base of the poor, improving the quality of economic growth by including environmental concerns, and reforming international policies in a way that helps poor countries.

Gross National Income per Capita ($), 2010-2011



Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Note: Myanmar data refers to 2010.
Source: World Data Bank. *World Development Indicators and Global Development Finance*. http://databank.worldbank.org/ddp/home.do?Step=1&id=4 (Accessed 20 July 2012). UNdata. A World of Information. Databases. http://data.un.org (Accessed 20 July 2012).

Share of Poorest Quintile in National Consumption (%), 2007-2010



Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Source: UNDP Myanmar. 2011. *Integrated Household Living Conditions Survey in Myanmar (2009–2010): MDG Data Report*. Yangon; United Nations. *Millennium Development Goals Indicators*. http://unstats.un.org/unsd/mdg/Data.aspx (Accessed 1 December 2011).

Progress toward the Millennium Development Goals

Eight goals for poverty eradication and development to be achieved by 2015 were set out by heads of States at the Millennium Summit of the United Nations in September 2000. Some of the goals have more than one target. These goals have been accepted as indicators of development progress. They measure the efforts of the developing countries, of the developed countries that fund development programs, and of the multilateral institutions that help countries carry out the programs.

The Millennium Development Goals

Goal 1: Eradicate Extreme Poverty and Hunger

Goal 2: Achieve Universal Primary Education

Goal 3: Promote Gender Equality and Empower Women

Goal 4: Reduce Child Mortality

Goal 5: Improve Maternal Health

Goal 6: Combat HIV/AIDS, Malaria, and Other Diseases

Goal 7: Ensure Environmental Sustainability

Goal 8: Develop a Global Partnership for Development

The environment is at the heart of these Millennium Development Goals (MDGs). The seventh goal in particular is intended to ensure environmental sustainability by mainstreaming the environment in policies and programs, reversing environmental degradation, and improving access to environmental services. Achieving this goal would help achieve other goals; conversely, achieving other goals would help ensure environmental sustainability.

The following section describes the status of some of the targets under the various goals and steps the countries still have to take to achieve the goals.

Goal 1: Eradication of Poverty and Hunger

The basic indicator used for poverty mapping is "the proportion of people living below the consumption-based poverty line." In this measurement, poverty is expressed in terms of a person's consumption of food and basic necessities. The poverty line represents the minimum value of the daily consumption of goods and services needed to sustain an average adult. People whose consumption falls below this level are considered to be poor.

Each country uses a different methodology to determine the poverty line. Because of this, caution is needed in making comparison between countries. The incidence of poverty in the subregion varies significantly. Not surprisingly, it is consistently higher in rural areas than in urban areas. And it tends to be highest in remote areas, uplands, and watersheds, where most of the ethnic minority groups live.

Target 1.A: Halve, between 1990 and 2015, the proportion of people who earn less than $1 a day.

Poverty has been significantly reduced in the subregion, particularly in Viet Nam where the poverty rate of 14% in 2010 was only about half the rate in 2000. However, the overall GMS poverty incidence was around 15% in 2009–2010; 49 million people in the subregion are still poor.

Upper: Village children near Xepian National Protected Area, Lao PDR. **Lower:** Carrying sand from the Ayeyarwady River, Myanmar.

Upper: Village land-use planning in Champasak, Lao PDR. **Lower:** The children of a poor family, Champasak.

Poverty Incidence and Poverty Reduction in the GMS

GMS Entity	Poverty Incidence		Level of Rural and Urban Poverty Incidence (%)			Average Annual Rate of Total Poverty Reduction	
	Value (%)	(year)	Rural (%)	Urban (%)	(year)	Value (%)	(period)
Cambodia	25.8	(2010)	34.5	11.8	(2007)	1.55	(2004–2010)
PRC							
Guangxi	7.5	(2010)	—	—	—	0.43	(2001–2007)
Yunnan	14.1	(2010)	—	—	—	1.55	(2001–2010)
Lao PDR	27.6	(2009)	31.7	17.4	(2008)	1.18	(2003–2008)
Myanmar	25.6	(2010)	29.2	15.7	(2010)	1.30	(2005–2010)
Thailand	8.1	(2009)	10.4	3.0	(2009)	1.43	(2000–2009)
Viet Nam	14.2	(2010)	17.4	6.9	(2010)	0.65	(2004–2010)

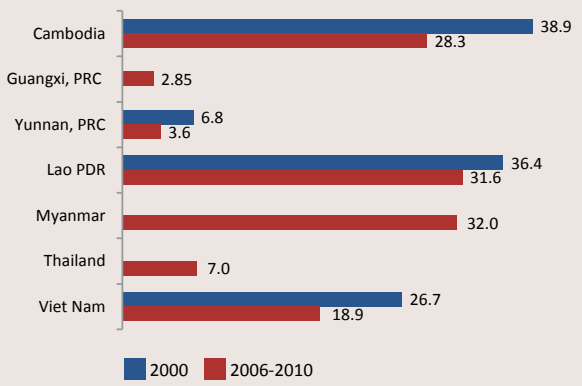
GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic, - = not available, PRC = People's Republic of China.
Source: ADB. *Asian Development Outlook*, various years. http://beta.adb.org/publications/series/asian-development-outlook; Guangxi Bureau of Statistics; Royal Government of Cambodia. 2010. *Achieving Cambodia's Millennium Development Goals*. Phnom Penh; UNDP Myanmar. 2011. *Integrated Household Living Conditions Survey in Myanmar (2009–2010): MDG Data Report*. Yangon; United Nations. *Millennium Development Goals Indicators*. http://unstats.un.org/unsd/mdg/Data.aspx; Yunnan Poverty Alleviation Office; Viet Nam Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi.

Target 1.C: Halve, between 1990 and 2015, the proportion of people who suffer from hunger.

Declining trends in the number of undernourished children roughly indicate progress toward this target. Almost a third of children aged below 5 years in Cambodia, Lao PDR, and Myanmar are still malnourished. A fourth of the population of Cambodia and Lao PDR takes in less than the 2,100 calories a day recommended by the World Health Organization.

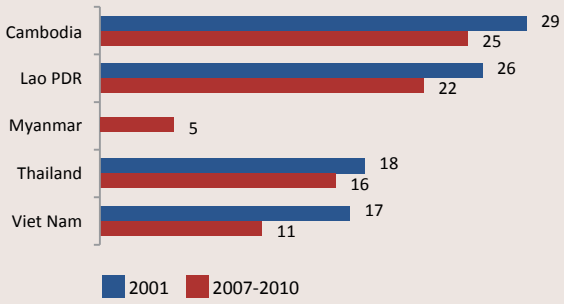
Tackling this problem requires nutrition education, micronutrient supplementation and fortification, higher status and better education for women, increased government commitment to health and nutrition, and an effective health infrastructure. Achieving the goal also requires the sustainable management of agricultural systems, forests, and other natural resources that provide subsistence and livelihood resources to the vast majority of the poor in the subregion. An early warning system may also help ward off natural hazards that can compromise long-term welfare by forcing affected households to sell assets or use their savings.

Underweight Children under 5 Years (%), 2000 and 2006-2010



Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Note: 2000 data are not available for Guangxi, Myanmar, and Thailand.
Source: Guangxi Bureau of Statistics. 2011. *Monitoring Report on Development Plan of Children in Guangxi 2001-2010*. Nanning; National Institute of Statistics, Directorate General for Health, and ICF Macro. 2011. Cambodia Demographic and Health Survey 2010; UN. 2010. *Viet Nam Factsheet for MDGs*. New York; UNDP Myanmar. 2011. *Integrated Household Living Conditions Survey in Myanmar (2009-2010): MDG Data Report*. Yangon; United Nations. *Millennium Development Goals Indicators*. http://unstats.un.org/unsd/mdg/Data.aspx (accessed 19 July 2012); Yunnan Bureau of Statistics. 2011. *Monitoring report on Developmental Plan of Women and Children in Yunnan 2001-2010*. Beijing.

Proportion of Population below Minimum Level of Dietary Energy Consumption (%), 2001 and 2007-2010



Lao PDR = Lao People's Democratic Republic.
Note: 2000 data not available for Myanmar.
Source: UNDP Myanmar. 2011. *Integrated Household Living Conditions Survey in Myanmar (2009–2010): MDG Data Report*. Yangon; United Nations. *Millennium Development Goals Indicators*. http://unstats.un.org/unsd/mdg/Data.aspx.

Goal 2: Achieve Universal Primary Education

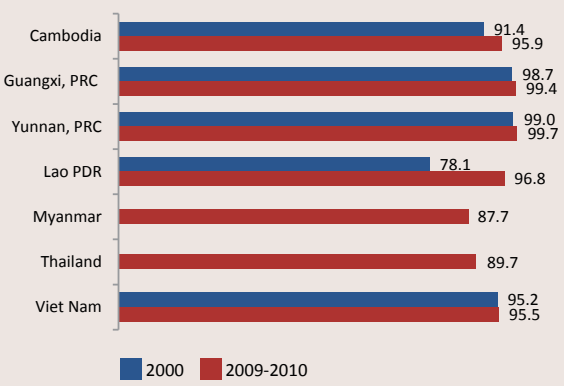
Target 2.A: Ensure that by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling.

Education is a powerful instrument for reducing poverty and inequality, improving health and social well-being, and laying the basis for sustained economic growth. It is essential for building democratic societies, and dynamic and regionally and globally competitive economies.

Primary school enrollment rates are improving in the subregion. Enrollment rates are high in Guangxi and Yunnan, PRC, and Viet Nam. Viet Nam has a higher primary enrollment ratio than Thailand, whose per capita income is many times higher. More funds for education would improve primary school enrollment rates in other countries.

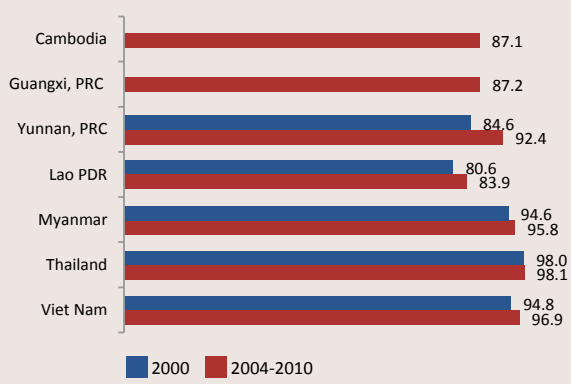
Literacy among the youth is high in the subregional countries, except the Lao PDR. It is an especially important goal in Thailand and Viet Nam, where industry contributes more to GDP and the labor force increasingly seeks employment outside agriculture.

Net Enrollment Ratio in Primary Education (%), 2000 and 2009-2010



Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Note: 2000 data not available for Thailand and Myanmar.
Source: Guangxi Bureau of Statistics. 2011. *Guangxi Statistical Yearbook 2011*. Beijing; UNDP Myanmar. 2011. *Integrated Household Living Conditions Survey in Myanmar (2009–2010): MDG Data Report*. Yangon; United Nations. *Millennium Development Goals Indicators*. http://unstats.un.org/unsd/mdg/Data.aspx; Viet Nam Statistical Office. 2011. *Education in Viet Nam: An Analysis of Key Indicators*. Ha Noi; World Data Bank. *World Development Indicators and Global Development Finance*. http://databank.worldbank.org/ddp/home.do?Step=1&id=4; Yunnan Bureau of Statistics. 2011. *Yunnan Statistical Yearbook 2011*. Beijing.

Literacy Rate among 15-24-Year Olds (%), 2000 and 2004-2010



Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Note: 2000 data not available for Cambodia and Guangxi. Yunnan data for 15 years old and above.
Source: Cambodia Ministry of Planning, National Institute of Statistics. 2010. *Cambodia Socio-Economic Survey 2009*. Phnom Penh; Guangxi Bureau of Statistics; UNDP Myanmar. 2011. *Integrated Household Living Conditions Survey in Myanmar (2009–2010): MDG Data Report*. Yangon; United Nations. *Millennium Development Goals Indicators*. http://unstats.un.org/unsd/mdg/Data.aspx. Yunnan Bureau of Statistics. 2011. *Yunnan Statistical Yearbook 2011*. Beijing.

Upper: Writing lessons at a village school, Champasak, Lao PDR. **Lower:** Computer classes in Kon Tum Provincial Ethnic High School, Viet Nam.

■ **Upper:** Flight attendant at Ha Noi airport, Viet Nam. There are increasing job opportunities for women in the tourism sector. **Lower:** Learning how to make souvenirs out of natural products, Tenasserim, Thailand.

Goal 3: Promote Gender Equality and Empower Women

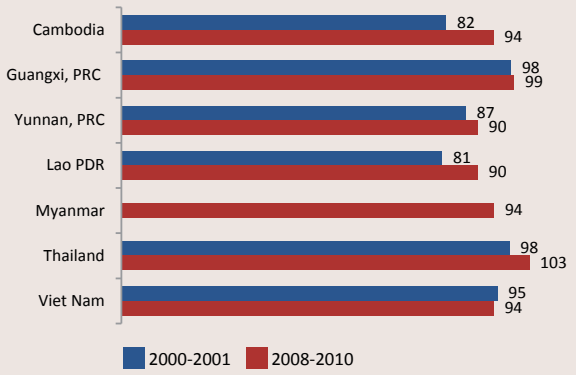
Target 3.A: Eliminate gender disparity in primary and secondary education, preferably by 2015, and in all levels of education no later than 2015.

The gap in enrollment between girls and boys has narrowed, most notably in Guangxi, PRC and Thailand. Cambodia, Myanmar, and Viet Nam are also showing improvements. In the Lao PDR and Yunnan PRC, however, there is a difference of 10% in the enrollment rates of girls and boys.

Equal access to education, employment opportunities outside agriculture, and political decision making will increase the productivity of women and thereby raise overall output and reduce poverty; promote gender equality within households, reduce fertility rates, and improve maternal health; and enable women to take better care of their children, increasing the chances that the latter will survive and be healthier and better educated.

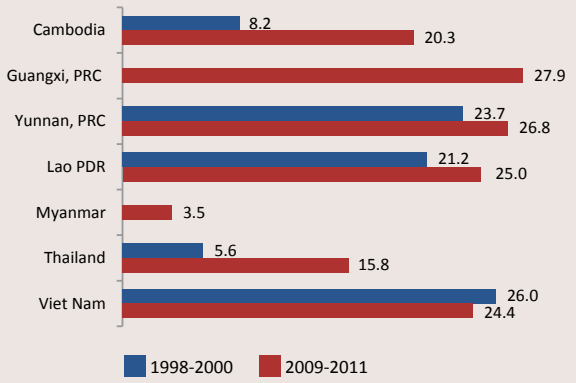
For many women in the subregion, access to education is constrained by time spent on gathering water and fuelwood. Making water and energy readily available will enable them to study and in the long run, avail of employment opportunities outside agriculture.

Ratio of Girls to Boys in Primary and Secondary Education (%), 2000-2001 and 2009-2010



Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Note: 2000 data is not available for Myanmar
Source: Chinese Educational Statistical Year Book 2000 & 2010; Guangxi Bureau of Statistics. *Guangxi Statistical Yearbooks*.Beijing; UNDP Myanmar. 2011. *Integrated Household Living Conditions Survey in Myanmar (2009–2010): MDG Data Report*. Yangon; Viet Nam Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi; World Bank.

Proportion of Seats held by Women in National/Provincial Parliament (%), 1998-2000 and 2009-2012



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Note: 2000 data not available for Guangxi, PRC and Myanmar.
Source: Guangxi Bureau of Statistics; Government of Viet Nam. Election Council. 2011. *Report on the Results of the Elections of Deputies to the 13th National Assembly and People's Councils at All Levels for the 2011-2016 Tenure*. Ha Noi; UNDP. 2011. Human Development Report 2011. New York; United Nations. *Millennium Development Goals Indicators*. http://unstats.un.org/unsd/mdg/Data.aspx; Yunnan Bureau of Statistics. 2011. *Yunnan Statistical Yearbook 2011*. Beijing.

Goal 4: Reduce Child Mortality

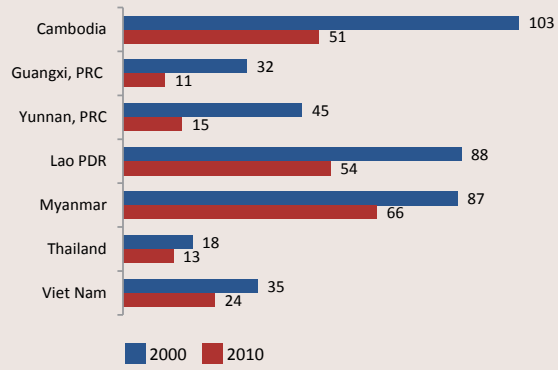
Target 4.A: Reduce by two thirds, between 1990 and 2015, the under-5 mortality rate.

Most infant deaths are traced to unhealthy conditions around the time of birth and lack of skilled midwives and attendants. Among young children, especially the chronically malnourished, the common killer diseases are pneumonia, diarrhea, malaria, and measles. Immunization programs, as well as oral rehydration therapy, antibiotics for pneumonia, and better economic and social conditions, have caused a significant drop in infant and child deaths in the last 25 years. Child mortality is a powerful indicator of a country's overall health.

Infant mortality has been substantially reduced in Guangxi and Yunnan, PRC; Thailand; and Viet Nam, but not in Cambodia, Lao PDR, and Myanmar. These countries require more persistent effort and funding support.

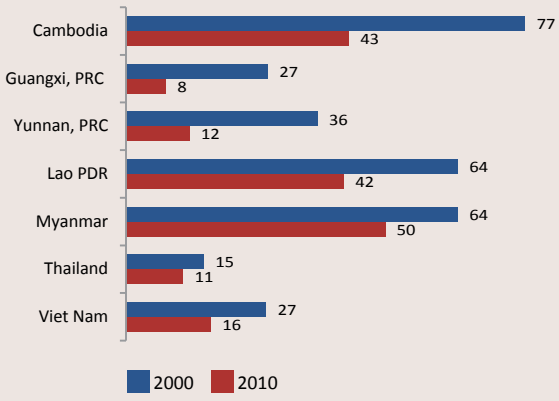
Average life expectancy is now an impressive 76 years in Guangxi and close to 75 years in Thailand and Viet Nam. But life expectancy in high-income countries is still at least 5 years longer.

Under 5 Years Mortality Rate per 1,000 Live Births, 2000 and 2010



Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China. Source: Guangxi Bureau of Statistics. 2011. *Monitoring Report on Development Plan of Children in Guangxi 2001–2010*. Beijing; United Nations. *Millennium Development Goals Indicators*. http://unstats.un.org/unsd/mdg/Data.aspx; Viet Nam Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi; Yunnan Bureau of Statistics. 2011. *Monitoring report on Developmental Plan of Women and Children in Yunnan 2001-2010*. Beijing.

Infant Mortality Rate per 1,000 Live Births, 2000 and 2010



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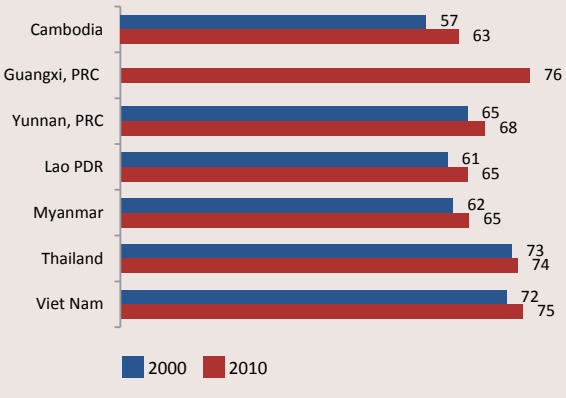
Life Expectancy at Birth (Years), 2000 and 2010

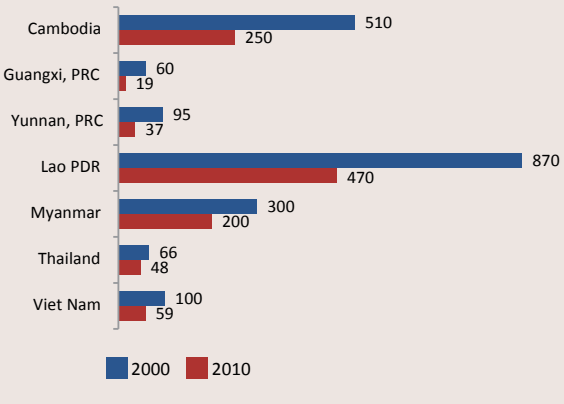


Guangxi National Economy. Statistical Analysis. http://www.gxtj.gov.cn/show.asp?typid=81&id=9483,2005 data:http://www.eai.nus.edu.sgCWP74.pdf; UNDP.2011. *Human Development Report 2011*. New York; World Data Bank. *World Development Indicator and Global Development Finance*. http://databank.worldbank.org. Accessed on 20 July 2012; *Yunnan Statistic Year Book 2011*.

Goal 5: Improve Maternal Health

Overall, maternal health in the subregion has improved. But in 2010, the maternal mortality rate was an order of magnitude above that of Singapore. Fewer pregnancies, adequate nutrition especially during pregnancy and childbirth, safe sex practices, and better health care in general would further reduce maternal mortality rates.

Maternal Mortality Ratio per 100,000 Births, 2000 and 2010

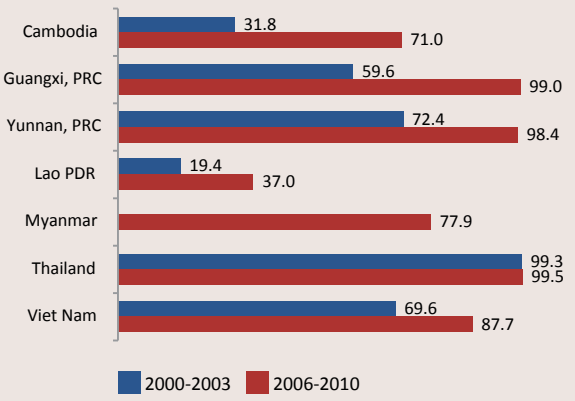


Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China. Source: Guangxi Bureau of Statistics. 2011. *Monitoring Report on Development Plan of Children in Guangxi 2001–2010*. Beijing; United Nations. *Millennium Development Goals Indicators*. http://unstats. un.org/unsd/mdg/Data.aspx; Yunnan Bureau of Statistics. 2011. *Yunnan Statistical Yearbook 2011*. Beijing.

Upper: Mother and child care, Viet Nam. **Lower:** Mother and child from the Katu ethnic minority in the Central Annamite Mountains, Viet Nam.

■ **Top:** Hmong family in Lao PDR. **Middle:** Poor family living by the Ayeyarwady River in Myanmar. **Bottom:** Solid waste in a Phnom Penh slum area, Cambodia.

Births Attended by Skilled Health Staff (%), 2000-2003 and 2006-2010



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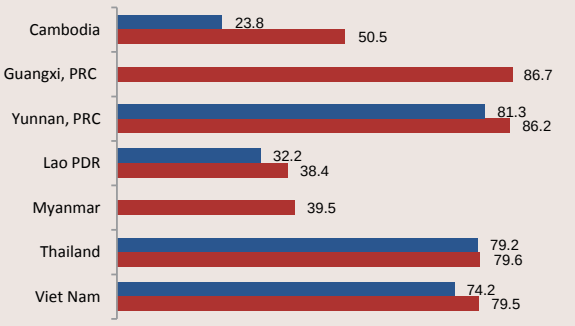
Note: 2000 data not available for Myanmar.
Source: National Bureau of Statistics of China. 2010. *China Health Statistical Yearbooks 2004 and 2011*. Beijing; Guangxi Bureau of Statistics. 2011. *Monitoring Report on Development Plan of Children in Guangxi 2001–2010*. Beijing; UNDP Myanmar. 2011. *Integrated Household Living Conditions Survey in Myanmar (2009–2010): MDG Data Report*. Yangon; United Nations. *Millennium Development Goals Indicators*. http://unstats.un.org/unsd/mdg/Data.aspx; World Bank.

Contraceptive Prevalence Rate among Women Aged 15-49 (%), 2000 and 2005-2010



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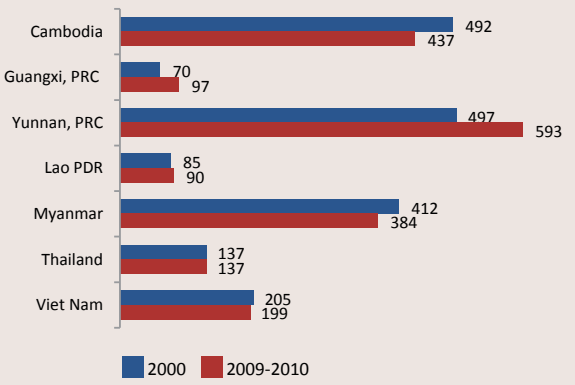
Note: 2000 data not available for Guangxi and Myanmar.
Source: Guangxi Bureau of Statistics. 2010. *Monitoring Report on Developmental Plan of Woman in 2009*. Beijing; National Institute of Statistics, Directorate General for Health, and ICF Macro, 2011. Cambodia Demographic and Health Survey 2010; UNDP Myanmar. 2011. *Integrated Household Living Conditions Survey in Myanmar (2009–2010)*; World Bank; Yunnan Bureau of Statistics. 2011. *Monitoring report on Developmental Plan of Women and Children in Yunnan 2001-2010*. Beijing.

Incidence of Tuberculosis (TB) per 100,000 Persons, 2000 and 2009-2010



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Source: National Bureau of Statistics of China. 2010. *China Health Statistical Yearbook 2010*. Beijing; Guangxi Public Health Department; United Nations. *Millennium Development Goals Indicators*. http://unstats.un.org/unsd/mdg/Data.aspx; Yunnan Tuberculosis Prevention and Control Plan 2002-2010.

Goal 6: Combat HIV/AIDS, Malaria, and Other Diseases

Target 6a: Have halted by 2015 and begun to reverse the spread of HIV/AIDS.

HIV is most prevalent in Cambodia and Myanmar at nearly twice the rate of occurrence in Thailand, and is least common in Lao PDR. In addition to appropriate government policies and respect for the reproductive rights of women, developing countries should make available generic alternatives to expensive patented drugs.

Target 6c: Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases.

Fatal cases of tuberculosis and malaria can be prevented, but treatment is inaccessible to thousands of people in the subregion. In 2010, tuberculosis was most prevalent in Cambodia, Myanmar, and Yunnan, where it afflicted more than 400 out of every 100,000 persons (0.4% of the population).

Goals 4, 5, and 6 focus on health improvement and urge governments to improve the delivery of health care services and address the causes of ill health. Considering that 20% of the burden of diseases in developing countries can be attributed to insufficient and unsafe water, poor sanitation, carriers like mosquitoes, indoor and outdoor air pollution, and other environmental conditions, dealing with environmental causes of death and disease is highly cost-effective, yielding other lifestyle benefits as well.

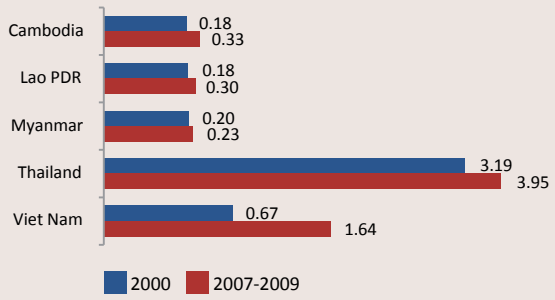
Goal 7: Ensure Environmental Sustainability

Target 7a: Integrate the principles of sustainable development into country policies and programs and reverse the loss of environmental resources.

Everywhere, experience is similar—the poorer countries contribute the least to carbon dioxide emissions but suffer the most from their effects.

To achieve sustainable development, countries should integrate environmental concerns into their development plans at the national, regional, sector, or project levels. Global warming from carbon dioxide emissions, among others, is a universal concern. High-income countries produce such emissions in proportions far in excess of their share of the world's population. Even so, in 2009, nearly 431 million tons of carbon dioxide, about 1.4% of the worldwide total, came from the subregion excluding Guangxi and Yunnan PRC. Thailand contributed 63% of this amount; Viet Nam, about 33%; Myanmar, about 3%; and Cambodia and the Lao PDR together, 1.5%.

Carbon Dioxide Emissions per Person (ton), 2000 and 2007-2009



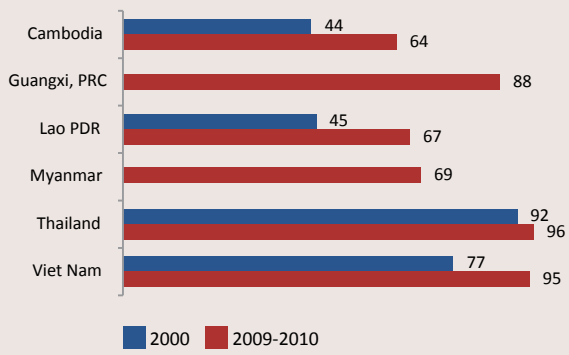
Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Source: *United Nations. Millennium Development Goals Indicators*. http://unstats.un.org/unsd/mdg/Data.aspx.

Target 7c: Halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation.

Safe water was accessible to more people in most subregional countries except Yunnan, PRC in 2010 than in 2000, but not yet for about 39 million people, increasing their risk, especially children, of potentially fatal diseases, such as diarrhea, malaria, and cholera.

The subregion is well endowed with freshwater resources. Except for some areas in Thailand and elevated areas of the river headwater in the PRC, rainfall averages more than 1,000 millimeters yearly. To supply the water needs of the poor, governments must urgently review the competing uses of water, especially in light of the expected growth in demand from industry. In Thailand, for instance, about 90% of water is for agriculture, which contributes a relatively small 11.6% to GDP, and only 7% is used for domestic purposes.

Proportion of Populaton with Accesss to Improved Water Source (%), 2000 and 2009-2010



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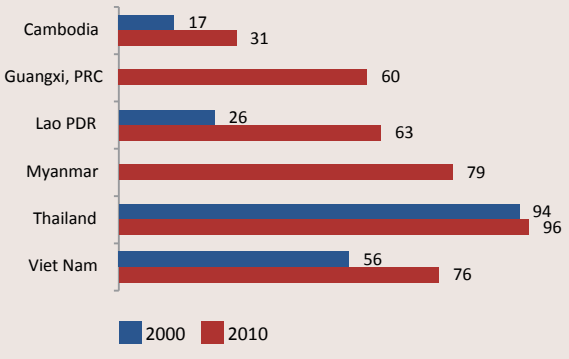
Note: 2000 data not available for Guangxi and Myanmar.
Source: Guangxi Bureau of Statistics. Monitoring Report on Development Planning of Children in Guangxi, 2007 and 2009. Beijing; UNDP Myanmar. 2011. *Integrated Household Living Conditions Survey in Myanmar (2009–2010): MDG Data Report*. Yangon; United Nations. *Millennium Development Goals Indicators*. http://unstats.un.org/unsd/mdg/Data.aspx.

Upper: Forest nursery in the Tenasserim mountains, Thailand. **Lower:** A family enjoys freshwater access through a development assistance project, Cambodia.

In 2010, 69 million people in the subregion excluding Yunnan, PRC had no access to improved sanitation. This is in addition to the problem of access to clean water, adequate housing, and problems of peace and order. Myanmar, Thailand, and Viet Nam have made significant improvements. Guangxi and the Lao PDR still need to improve access to sanitation. Cambodia lags behind the rest and faces the biggest challenges.

■ Children of the Khmer Daeng ethnic minority in the Cardamom Mountains, Cambodia.

Proportion of Population with Access to Improved Sanitation (%), 2000 and 2010



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Note: 2000 data not available for Guangxi, PRC and Myanmar.
Source: Addressing climate change in Guangxi; UNDP Myanmar. 2011. *Integrated Household Living Conditions Survey in Myanmar (2009–2010): MDG Data Report*. Yangon; United Nations. *Millennium Development Goals Indicators*. http://unstats.un.org/unsd/mdg/Data.aspx.

Goal 8: Develop a Global Partnership for Development

To achieve the first seven goals, industrial countries must reduce emissions of gases that induce climate change and of substances that deplete the ozone layer; and finance biodiversity, land improvement, sanitation, and slum-upgrading projects. Developing countries, for their part, must cofinance actions to combat desertification; together with developed countries, bear the opportunity cost of land in protected areas; abstain from using ozone depleting substances; and finance water supply infrastructure. The same can be said of investment needed to improve sanitation facilities for 69 million people in the subregion.

This goal ensures that global action creates an environment where each person can realize his or her potential. Development assistance may be necessary to help some countries achieve their targets, and sustain the efforts of those that are doing well.

Geology

Geology

The Greater Mekong Subregion has a diverse geographic landscape that includes mountains, plateaus, and limestone karsts, fast-flowing rocky mountain streams, lowlands, fertile floodplains, and deltas.

The evolving geology of the Greater Mekong Subregion (GMS) is best seen by the development of the Mekong River. About 40 million years ago, its precursor drained into the sea roughly where the Red River now flows. Over time, the rise of the Himalayas with uplifting, folding and faults, turned much of the mountains' drainage southward through steep gorges that appeared perhaps 13 million years ago and by 8 million years ago, formed the present course of three rivers—Thanlwin (Salween), Mekong, and Yangtze—running down parallel sutures. The Mekong followed a line of faults through southwestern Yunnan, an area still high in seismic activity, indicating that movements of the blocks are continuing.

Below this area, the Mekong crosses the Indosinia block, which has been stable since the Jurassic. There was a wide inland sea during the Upper Mesozoic. It is probable that the Mekong at this time was flowing directly south and to the west of the Khorat Plateau, joining what was to become the Chao Phraya River. However, during the late Cretaceous and early Tertiary, uplift in northern Viet Nam formed the Red River rift and Indosinia became warped, with northeastern Thailand, including the Khorat plateau area, and adjoining parts of the Lao PDR remaining low; the inland sea left salt deposits 250 meters thick in this region. Much of what is now Cambodia was lifted and has weathered to expose basement granite. The uplifting caused block faulting in northern Thailand resulting in flat basins and steep mountain ranges.

Upper: A spectacular bend in the Yangtze River in northern Yunnan Province, PRC. **Lower:** Monks stand on coastal slab formations made of fossil shells in Ban Laem Pho, Krabi Province, Thailand.

■ Sediments color the upper Mekong River in Yunnan Province, PRC.

Subsequently, in the Cenozoic, there was much vulcanism as well as block movement, accompanied by climate changes and sea level change, particularly affecting southern Cambodia and southern Viet Nam. It was only about 600,000 years ago that basaltic areas of the Annamites between Viet Nam and the Lao PDR, and in northeastern Thailand and Cambodia were formed and dictated the present structure of the Mekong River in the area, including the Khone Falls.

The lower part of the Mekong River has also been influenced by tectonics in the Cenozoic and some stretches can be seen to follow these recent fault lines. It is believed that subsidence in the Tonle Sap basin in Cambodia perhaps within the last 12,000 years, drew the Mekong River eastward away from its former Chao Phraya connection and into the Tonle Sap basin. Tonle Sap itself is only about 5,000 years old.

Finally, the Mekong Delta began to form only 6,000–7,000 years ago when sea level rose to its present level after a rise of some 130 meters over the preceding 12,000 years, since the last glacial maximum period.

Soils

While the evolution of the Mekong countries created basic similarities in their geological structure, local vulcanism and water and sediment flows over millennia, as well as sea level changes, modified and overlaid these structures, resulting in wide differences in the present soils around the subregion.

Cambodia can be divided into three regions on the basis of the age and general origins of soils: (i) regions that retain their original parent material, such as the Cardamom and Central Annamite mountains; (ii) regions that are covered by ancient alluvial or colluvial plains; and (iii) regions that receive annual alluvial sediments, such as the Tonle Sap floodplain. Sandy surface soils are widespread throughout the country except the soils fringing the Tonle Sap, those of the alluvial plains along the major rivers (especially the Mekong), and soils developed on basalt. Substantial areas of these sandy, high permeability soils are used for lowland rainfed rice production. However, these soils have high water conductivity, such that rainwater drains quickly from the rice fields causing significant nutrient leaching and exposing rice crops to drought.

In the Guangxi Zhuang Autonomous Region, there are 18 soil types; lateritic and red soil being the two major soil types, accounting for 65% of the total land area. Of secondary importance are yellow earth, paddy, purple, and limestone soils. The major nutrient disorders in cultivated soils are deficiencies of nitrogen, phosphorus, and potassium. Calcium, magnesium, and molybdenum are also deficient in the acidic soils. Acid soils account for two thirds of the total; calcareous soils account for the remainder.

The soil materials in Yunnan Province are mainly debris from mountains, argillite, quartz, acidic rocks, limestone, purple rock, and lake sediments. The main soil types are red soil, paddy soil, purple soil, and laterite. Over 70% of cultivated land is medium to low in productivity. Red soils developed from basalt are deficient in potassium and phosphorus, with the exception of some soils near urban areas that are showing signs of phosphorus accumulation.

Above left: Alluvial soils around Bagan pagodas, Myanmar. **Above right:** One of the many curious rock formations visible in the Sam Pan Bok (3,000 holes) area, Ubon Ratchathani, Thailand, during the dry season when Mekong River levels are low.

Soils in the Lao People's Democratic Republic (Lao PDR) can be grouped into (i) those of the floodplains formed from alluvium deposited by rivers, and which are either sandy or sandy clay and neutral to slightly acidic; (ii) upland soils derived from crystalline, granitic, schistose, or sandstone parent rocks, generally more acidic and much less fertile than floodplain soils; (iii) areas of laterite (leached and iron-bearing) soils in the southern Lao PDR; and (iv) basaltic soils of the Bolovens Plateau.

Soils in Myanmar have been closely studied, with some 24 types recognized. Among them are red-brown forest soils in tropical evergreen forests and wet tropical monsoon forests mostly at altitudes of 300–1,300 meters; widespread yellow-brown forest soils of wet tropical monsoon forests at altitudes of 100–450 meters; and yellow-brown mountain forest soils at higher altitudes. Red earths occur at around 1,000 meters and mountain red earths replace them at higher altitudes. Mountain sod soils are found in the Mount Popa area and are the best soils for forestry purposes. Lateritic soils and laterites are found below 100 meters. Light cinnamon soils occur along the belt surrounding the central dry zone; red-brown savanna soils predominate in the dry zone along with gravelly savanna soils; and dark cinnamon soils occur at relatively wet sites. Dark compact savanna soils are mostly found in flat, even terrain and alluvial in the dry zone. Meadow soils are the best soils for rice farming.

Alluvial deposits in river valleys contain the most fertile soils in Thailand and are replenished annually with sediment washed down by rivers in the rainy season, especially nourishing the delta floodplain of the Chao Phraya River, but these rich alluvial soils are also found in the relatively flat basins in the northern mountains, on scattered lands along the Mun and Chi rivers on the Khorat Plateau, and on much of the coast. Soils elsewhere tend to be relatively infertile, highly leached laterites. Stony and shallow soils are typical of the hills and mountains of northern Thailand. Shallow sandy loams of low fertility cover a large part of the Khorat Plateau. Soils along the main rivers are more fertile, and alluvial loams of high fertility are found along the Mekong River. The central plain rice-growing area and the delta of the Tha Chin and Chao Phraya rivers has clayey soils of high to moderate fertility that are mostly flooded during the rainy season. Higher areas on the edges of the plain are generally well-drained soils of high to moderate fertility and suitable for intensive cultivation.

Northern Viet Nam is characterized by reddish soils, the result of heavy monsoonal rains washing rich humus down from the highlands, leaving slow-dissolving alumina and iron oxides that give the soil its red color. The soils of the Red River Delta vary: some are fertile and suitable for intense cultivation, while others lack soluble bases. However, construction of dikes to prevent flooding has deprived the delta's rice fields of enriching silt they once received. The Mekong Delta in southern Viet Nam is considered to be typical of the clayey alluvial soils. Sandy soils are widely distributed in the coastal central provinces. The many steep slopes and deforested landscapes, especially in the highlands and northwestern regions, are very susceptible to soil erosion during heavy rains. The eroded topsoil is carried away and deposited as silt in rivers, lakes, and estuaries. Potential soil erosion of up to 3,200 tons per hectare per year affects about 23 million hectares, or some 70% of the country's land area.

Upper: Limestone quarry in Saraburi Province, Thailand. **Lower:** Sand mining in river, Koh Kong, Cambodia.

Mineral Resources

The subregion contains thousands of occurrences of base and precious metals, industrial minerals, and construction materials. The high geological and economic potential of mineral commodities has been confirmed by the inventories of geology and mineral resources undertaken by the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) Secretariat and published in the ESCAP Mineral Atlas volumes for Cambodia, Lao PDR, Myanmar, Thailand, and Viet Nam; and recent inventories of mineral resources in Yunnan Province, PRC. Also, in the case of the Lao PDR, donor assistance provided for the preparation of a Mineral Exploration and Development Plan in the early 1990s. This resulted in an excellent geological and mineral occurrence map, which gave a boost to further mineral exploration in the Lao PDR.

Mining Sector Share of GDP (%)

Country	2000	2010
Cambodia	0.24	0.62
Lao PDR	0.20	7.42
Myanmar	0.59	0.91
Thailand	2.37	3.42
Viet Nam	9.65	10.86

Lao PDR = Lao People's Democratic Republic.
Source: ADB. 2011. *Key Indicators for Asia and the Pacific 2011*. Manila.

The potential for subregional development of mineral resources has been given impetus by new mining legislation in Cambodia, Lao PDR, Myanmar, and Viet Nam; and changes to national mining legislation in the PRC and Thailand. The resulting new policies and regulations have opened the subregion to foreign investment. Mineral development and production throughout the GMS are increasing and beginning to make significant contributions to national income in most countries.

Detailed information on mineral resources in Cambodia is scarce and the mineral potential is generally unknown. Small deposits of gold exist in the northern provinces. There is only artisanal and small-scale production at present. Gemstones, the major source of mineral wealth, are being recovered from several deposits. It is generally believed that the potential for gemstones is underdeveloped.

There is an extensive lateritic bauxite deposit at Chlong Leu in northwestern Cambodia with good potential for development. Among industrial minerals, limestone and dolomitic limestone have potential for further development. Kaolin and other clays occur frequently, but little is known about their quality and size of deposits. High-grade phosphorite occurs at Phnom Totung, but known reserves are only 78,000 tons. Other phosphorite deposits occur in the area surrounding Tuk Meas and in the Battambang area.

In 2009, Cambodia produced mainly industrial minerals, such as sand and gravel and crushed stone for domestic consumption by the construction industry, and limestone for cement production. The mineral industry of Cambodia is likely to continue to be dominated by the production of industrial minerals. Exploration for metals is expected to increase in the near future as a result of recent gold and base-metal mineralization.

About 120 million tons of new bauxite reserves were found in Guangxi in 2007. Currently, the proven reserves of bauxite in Guangxi are about 1 billion tons, making the region one of the PRC's

biggest bauxite sources. State-owned enterprises have diversified their core business into other sectors, such as rare-earth companies in Guangxi and copper companies in Yunnan Province. By 2010, Guangxi secured a major rare-earth concentrates production quota from the central PRC Government.

Yunnan's reserves of aluminium, lead, zinc, and tin are the largest in the PRC, and there are also major reserves of copper and nickel. It is the PRC's leading tin producer and has large deposits of iron, coal, lead, copper, zinc, gold, mercury, silver, antimony, bauxite, and sulfur.

The Lao PDR's main resources are barite, coal, copper, gemstones, gold, gypsum, iron ore, lead, silver, tin, and zinc; also there is considerable potential for discovery of substantial additional mineral resources of iron ore, potash, and rock salt. The Government is promoting further exploration for coal, copper, gemstones, gold, iron ore, lead, potash, tin, and zinc.

At present, tin and gypsum are the main minerals produced in the Lao PDR, followed by barite, coal, construction materials, gemstones, gold, limestone, and zinc. Both tin and gypsum are produced by state mining enterprises. Tin concentrate is exported to Malaysia for smelting and refining, while gypsum is used in the domestic cement industry as well as exported to Viet Nam.

Barite, gemstones (sapphire, amethyst, zircon, topaz, beryl, and garnet), and coal are also produced mainly by the Lao PDR's state mining enterprises while construction materials and limestone (for the local cement industry) are mainly produced by local companies. Small-scale mining of gold and gemstones also takes place.

Foreign companies are involved in the production of zinc in the Lao PDR, which is exported to Thailand for smelting and refining, and gold. Mining companies are exploring for copper-gold and copper deposits and it is expected that in the near future more privately owned gold/copper mines will become operational. There is also considerable interest by foreign companies in the production of gemstones.

Myanmar produces 10 metallic and 15 nonmetallic minerals, in addition to jade and gemstones. The main metals are copper, iron ore, zinc, lead, tin, wolfram, silver, and gold. The main nonmetallic minerals are limestone, coal, gypsum, and barite. However, production is low. Recent exploration by foreign companies through joint ventures with government enterprises has focused on gold, copper, diamonds, coal, and barite. In 2009, Myanmar, produced a variety of mineral commodities, including cement, coal, copper, lead, natural gas, petroleum, petroleum products, precious and semiprecious stones, tin, tungsten, and zinc.

In 2010, oil and gas exploration activities continued to increase, mainly as a result of the many exploration projects that started in 2008 and 2009. Business ties between Myanmar and the PRC are likely to strengthen as a result of the agreements and projects that the two countries have committed to in the oil and gas sector, such as the construction of oil and gas pipelines that will connect the two countries.

Upper: The Stone Forest, made of weathered limestone, Yunnan Province, PRC. The forest is part of the South China Karst Complex (see satellite image, page 83). **Lower:** Closed quartz mine on the western forest border of Myanmar and Thailand.

Thailand produces 44 mineral commodities. The most important are lignite, limestone, gypsum, zinc, kaolin, dolomite, feldspar, and potash. There is potential to develop more zinc mines on deposits near Mae Sot. Gold also has more potential. Thailand's reserves of rock salt, potash, coal, limestone, dolomite, diatomite, kaolin, and gypsum are large. There are also reserves of gemstones, primarily ruby and sapphire. From 2009 to 2010, Thailand's mineral (including mineral fuels) production increased by 5.2% and manufacturing (which included mineral-related manufacturing) increased by 13.9%. Cement, crude steel, tin and natural gas production is also increasing.

Viet Nam's mineral deposits with the greatest potential include lateritic bauxite, rare earths, coal, apatite, construction materials, kaolin, and silica sand. Tin, tungsten, gold, titanium minerals, chromite, iron ore, copper, nickel, zinc, lead, uranium, bentonite, pyrophylite, and graphite are also considered to have some potential for development.

Construction materials are exploited on a large scale in Viet Nam. Limestone and clay are widely exploited and the reserves are large. Near Lao Cai, a large phosphate deposit has good potential for development. Lateritic bauxite deposits in the south are believed to be large, although it is uncertain if the deposits are economic.

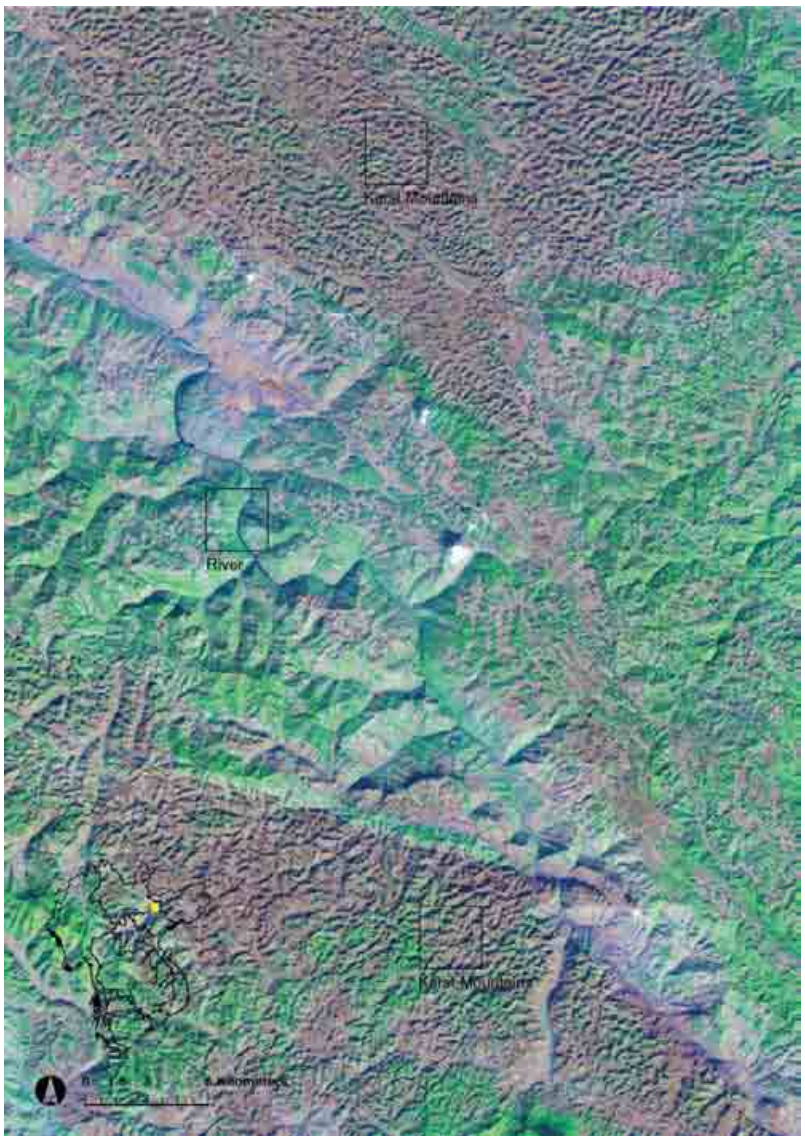
Soil Types of the Greater Mekong Subregion

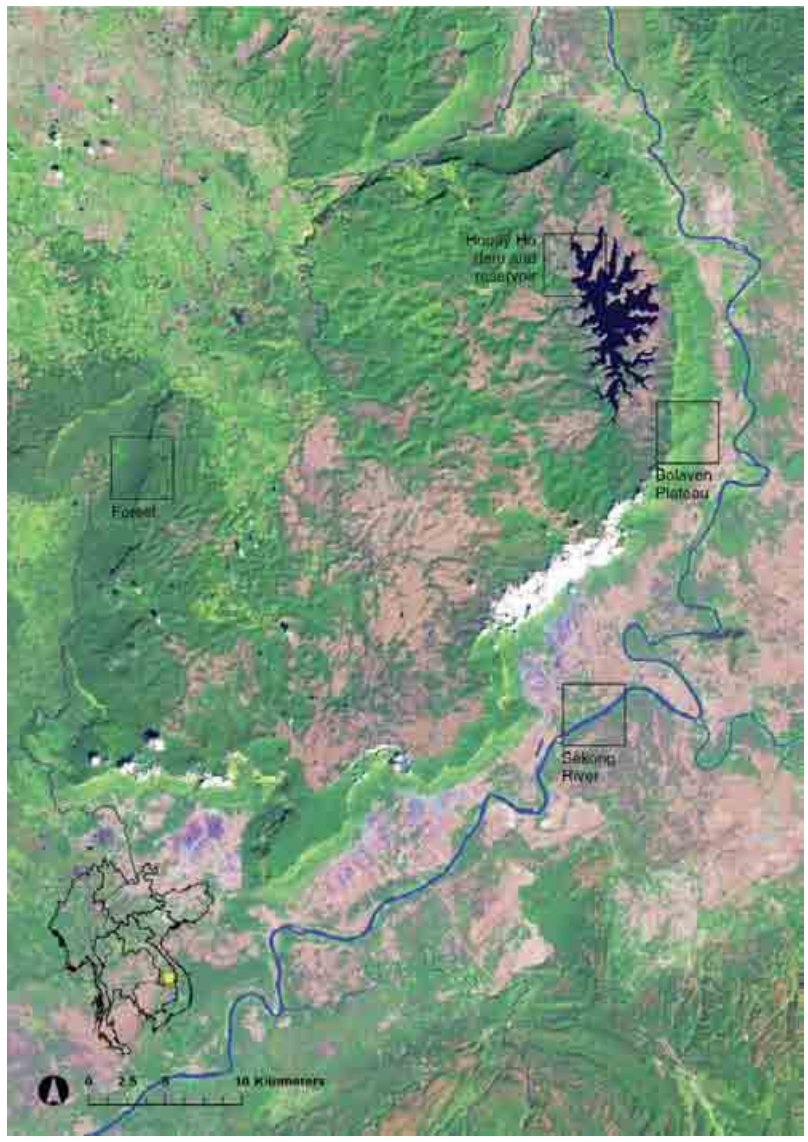
Soil type

- Af - Ferric Acrisols
- Ag - Gleyic Acrisols
- Ao - Orthic Acrisols
- Bc - Chromic Cambisols
- Bd - Dystric Cambisols
- Bf - Ferralic Cambisols
- Bh - Humic Cambisols
- Fa - Acric Ferralsols
- Fo - Orthic Ferralsols
- Fr - Rhodic Ferralsols
- Gd - Dystric Gleysols
- Ge - Eutric Gleysols
- Gh - Humic Gleysols
- I - Lithosols
- Jc - Calcaric Fluvisols
- Je - Eutric Fluvisols
- Jt - Thionic Fluvisols
- Lc - Chromic Luvisols
- Lf - Ferric Luvisols
- Lg - Gleyic Luvisols
- Nd - Distric Nitosols
- Nh - Humic Nitosols
- Od - Dystric Histosols
- Re - Eutric Regosols
- Vp - Pellic Vertisols
- Zg - Gleyic Solonchaks
- WA - Water bodies
- GL - Glaciers
- Tectonic feature (contact, rift, fault, step)

0 125 250 500 Kilometers

Boundaries are not necessarily authoritative. Data source: GMS EOC, UN FAO DSMW, USGS, UN FAO GAUL, NASA SRTM.





Upper: Karst mountain peaks of Jinxiu County, Guangxi, PRC, shrouded in mist. **Lower left:** Satellite image of the South China Karst Complex in Guangxi, a bizarre landscape resulting from the chemical weathering of limestone. The area is rich in biodiversity and is a UNESCO World Heritage Site; **Lower right:** Satellite image of Bolaven Plateau in the Lao PDR, the remainder of an old volcano, rich in mineral deposits.

■ **Top:** River gold mining, Central Viet Nam. **Middle:** A rough (left) and cut (right) ruby from Myanmar. **Bottom:** Girl in Mogok, Myanmar, with plate of red spinels, ruby-like gems found in Myanmar and Viet Nam.

There is some small-scale and artisanal exploitation of gold in Viet Nam and recently, gemstones, primarily rubies and sapphires, were discovered. In recent years, mineral production has increased, mainly for refined copper, cement, crude steel, anthracite, crude petroleum, and natural gas. Viet Nam's mining sector is expected to be dominated by the bauxite, coal, and oil and gas industries for the coming years, mainly as a result of many new exploration projects and discoveries.

Gemstones in the GMS. Throughout the GMS, two gemstones stand out: rubies and sapphires, among the most common and prized gems found in jewelry around the subregion.

The best sapphires are said to be found in Cambodia and Thailand. The blue of the sapphire is due to the presence of iron and titanium in the crystal structure and different colors are the result of inclusion of various other elements. Traditionally, it is believed that sapphire is the stone of the spirit and can help calm the mind and help improve relationships. Sapphires are also supposed to bring luck in love, career, and in achieving fame.

The deep red of rubies is due to traces of chromium and Thailand's rubies are considered to be the best quality in the world. Rubies are mined in the border area of Thailand and Myanmar and in the provinces of Chantaburi, and Trad. Thailand is also one of the world's largest producers of precious stones.

River Basins and Wetlands

River Basins

The Greater Mekong Subregion (GMS) has six major river basins of which four are transboundary—the Ayeyarwady (or Irrawaddy), Thanlwin (or Salween), Mekong (or Lancang), and Red (or Hong). The other two, the Chao Phraya and Pearl, are wholly within national territories. Apart from the Chao Phraya, these rivers originate in the mountainous terrain of the southwestern People's Republic of China (PRC). The Ayeyarwady and Thanlwin drain into the Andaman Sea, while the Mekong, Red, and Pearl drain into the South China Sea and the Chao Phraya into the Gulf of Thailand. The combined catchments of these six rivers stretch over the majority of the subregion's land area.

Agriculture is the primary use of water across the GMS, ranging from roughly 65% in the PRC to 95% in Viet Nam. Growth in agricultural production has more than doubled in the last two decades, with important implications for current and future water demand and water quality. Still, rainfed agriculture predominates; irrigated agriculture in the subregion remains relatively low, ranging from 7% of total cropland in Cambodia to 31% in Viet Nam.

The largest irrigated areas are found in the large deltas and low-lying floodplains of the Ayeyarwady,

River Basin Characteristic	Ayeyarwady (Irrawaddy)	Thanlwin (Salween)	Chao Phraya	Mekong (Lancang)	Red (Hong)	Pearl
GMS countries in sub-basin	PRC (Yunnan); Myanmar	PRC (Yunnan); Myanmar; Thailand	Thailand	PRC (Yunnan); Myanmar; Lao PDR; Thailand; Cambodia; Viet Nam	PRC (Yunnan); Lao PDR; Viet Nam	PRC (Yunnan and Guangxi)
Source	Myanmar (May Kha and Mali Kha rivers, Kachin) and PRC (Du Long River, Xizang Autonomous Region)	PRC (Xizang Autonomous Region)	Northern Thailand	PRC (Qinghai Province)	PRC (Yunnan)	PRC (Yunnan)
Length (kilometer)	2,170	2,400	980	4,909	1,149	2,210
Basin area (square kilometer)	413,710	271,914	178,785	795,000	169,000	409,480
Average annual discharge (cubic meter/second)	13,000	1,659	718	14,500	4,239	10,591
River mouth	Gulf of Martaban, Andaman Sea	Gulf of Martaban, Andaman Sea	Gulf of Thailand	South China Sea	Gulf of Tonkin, South China Sea	South China Sea

GMS = Greater Mekong Subregion, Guangxi = Guangxi Zhuang Autonomous Region of the PRC, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China, Yunnan = Yunnan Province of the PRC.
Sources: Water Resources eAtlas, *Watersheds of the World*. http://iucn/themes/wani/eatlas/index.htm; Mekong River Commission. 2010. *State of Basin Report 2010*. Vientiane. http://www.mrcmekong.org/publications/reports/basin-reports/; Viet Nam Ministry of Agriculture and Rural Development. Red River Basin Organization. www.rrbo.org.vn

Upper: Transporting market produce, Inle Lake, Myanmar. **Lower:** Artisanal fishing on the Nam Song River, Vang Vieng, Lao PDR.

Major River Basins
of the Greater Mekong Subregion
Basin
Ayeyarwady
Thanlwin
Chao Phraya
Mekong
Red
Pearl
Sittaung
Yangtze
Other
Sub-basin
Main river
Major lakes
0
125
250
500 Kilometers
Boundaries are not necessarily authoritative
Data source: UN FAO AGLW Hydrological basins of Southeast Asia, UN FAO GAUL, NASA SRTM
Red River
Pearl River
Mekong
Chao Phraya
Thanlwin
Ayeyarwady
Sittaung
Song Ma
Song Con
Nam Theun
Nam Ngum
Nam Mae Ing
Nam Mae Kok
Nam Kham
Nam Ou
Nam Khan
Nam Suong
Nam Ca
Nam Mo
Se Kong
Se San
Se Pok
Sre Pok
Sesan
Sekong
Upper Tonle Sap
Lower Tonle Sap
Saigon
Mekong Delta
Da Nhim
Da Lat
Song Ba
Song Cai
Song Da
Song Ma
Song Chu
Song Bu
Song Lo
Song Gam
Song Xian
Song Hong
Song Ca
Song Chay
Song Lam
Song Ngan
Song Ca
Song Giang
Song Buong
Song Con
Song Cau
Song Thai Binh
Song Kinh Thay
Song Thuong
Song Luc Nam
Song Thuong

Chao Phraya, Mekong, and Red rivers. Although they make up only 10% of the total land area, they produce roughly half of the subregion's production. Complex waterworks are used to direct and retain monsoon floodwaters. Overall, agricultural withdrawals are only a fraction of total renewable resources, but demand for agricultural water is increasing and the strongly seasonal patterns of rainfall and irrigation demand mean that seasonal shortages are increasingly common.

Withdrawals of surface water for industrial, municipal, and domestic use are relatively small in comparison with that for agriculture, although competition is growing, particularly in rapidly expanding urban areas. The constraints in water supply are generally related to the lack of treatment and distribution systems rather than limits of raw water.

Although hydropower accounts for relatively little water consumption, existing and expanding hydropower development is probably the largest driver of change for water resources and aquatic ecosystems in much of the subregion, because water is stored in reservoirs in the wet season and released in the dry season.

Water quality in most of the subregion is generally good but degradation occurs in all of the deltas, associated with high population densities and still inadequate domestic and industrial wastewater treatment. Agricultural chemical loadings are significant in the Chao Phraya, Mekong, and Red rivers. Irrigation-induced salinity affects parts of northeastern Thailand and the central Lao PDR. Soil erosion, particularly in upland areas, also affects water quality downstream.

The subregion contains extensive and diverse aquatic ecosystems, comprising riverine floodplains, fresh- and brackishwater wetlands, and major lake systems, including Tonle Sap (Southeast Asia's largest freshwater lake) in Cambodia, Lake Inle in Myanmar, and large upland lakes in Yunnan Province of the PRC. Altogether there are 19 designated Ramsar Convention wetland sites in the GMS.

Consumption of fish and other aquatic animals is an important part of people's diets, and the bulk of consumption is from freshwater sources, including tributary and mainstem rivers, wetlands, reservoirs, and irrigated rice fields.

Concerns are heightening that the current level of capture fishing is not sustainable. Although the biomass of overall catches is stable or shows signs of rising, the larger migratory fish are declining compared to smaller migratory and non-migratory species, and the average size of fish is decreasing; these are signs of excessive harvesting. Ten of Cambodia's freshwater fish species are now listed as endangered. Further alteration of river flow regimes and disruption of fish migration as a result of agriculture infrastructure and hydropower development pose additional threats to freshwater fisheries in the GMS if not well managed.

Upper: Sprinkler irrigation in commercial farms, Tenasserim, Thailand. **Lower:** Artisanal fisher, Tonle Sap, Cambodia.

Upper: Land preparation near the Ayeyarwady River, Mandalay, Myanmar. **Lower:** Fish landing, Mandalay.

Ayeyarwady River Basin

Basin area (square kilometer)	413,710
Average population density (people per square kilometer)	79
Cities (100,000 or more people)	6
Land cover and use (% of basin area)	
Forest	56.2
Grass, savanna, and scrubland	9.7
Wetlands	6.3
Cropland	30.5
Irrigated cropland	3.4
Dryland	4.4
Urban and industrial	1.0
Degree of river fragmentation	High
Biodiversity status	79 fish species, 95 amphibian species, 0.6% protected area, IUCN classified 'data deficient'

Source: Water Resources eAtlas. *Watersheds of the World*. http://iucn/themes/wani/eatlas/index.htm

The Ayeyarwady River runs the entire length of Myanmar, with the basin covering 413,710 square kilometers, or roughly 61% of the total country area. It is the largest of Myanmar's five major rivers. The 2,170 kilometer river originates at the convergence of the May Kha and Mali Kha rivers in Kachin State. The headwaters of both these rivers originate in the southeastern Himalayas. The larger May Kha River is fast flowing and not navigable, while the Mali Kha is navigable upstream despite a few rapids. Further downstream, three main tributaries—the Chindwin, Shweli, and Myitnge—enter the Ayeyarwady as it meanders through a central dry plain past the country's second largest city of Mandalay. The river then narrows and flows between forest-covered mountain ranges. Finally, the Ayeyarwady drains into the Andaman Sea through several distributaries including the Pathein River and the smaller Yangon River which flows beside Myanmar's former capital city. The delta formed by the river covers 69,600 square kilometers.

Due to monsoon rains, which occur between mid-May and mid-October, the volume of the Ayeyarwady and its tributaries varies substantially year-round. The discharge fluctuates between a high of 32,600 and a low of 2,300 cubic meters per second, with an average discharge of 13,000. Water levels vary greatly between seasons with records showing a level difference of 9.66 to 11.37 meters between the highest point in August and the lowest in February. The Ayeyarwady carries a high concentration of sediment and is one of the world's largest in terms of suspended load. Although data are scarce, estimates of sediment flux are in the order of 260–360 million tons per year.

The Ayeyarwady is Myanmar's most important commercial waterway, with year-round transport being possible for about 1,300 kilometers of the river's length. More than 3,200 kilometers of navigable waterways exist in the delta via a system of interconnecting canals. Large quantities of teak are floated down the river and are a major export. Rice cultivation predominates in the fertile delta, producing nearly 60% of country's total rice production.

Data on capture fisheries in the Ayeyarwady River basin are limited, but it is home to 79 known fish species and could have inland fish resources similar to those in parts of the Mekong. Near Mandalay, the river supports the Irrawaddy dolphin, one of only four species of river dolphins in the world. The Irrawaddy dolphin is considered critically endangered, with an estimated remaining population in the river of only 59 individuals. Loss of prey due to disturbances in fish migration patterns, degradation of water quality, and change in river hydrology caused by upstream development pose a serious threat to this dwindling population.

Marshes, lakes, rivers and streams, and mangrove forest in the lower section of the delta provide important nesting and feeding grounds for many species of resident and migratory birds. The delta is home to several species of large mammal (including the Asian elephant, Malayan Sambar, hog deer, and wild boar), the estuarine crocodile, and sea turtles.

Myanmar is endowed with abundant water resources. However, with an increasing population and expanding economic activity, there is increasing pressure on both surface water and groundwater. Total utilization of the country's water resources is currently about 3% of potential, of which 90% of withdrawals are by the agriculture sector while industry and domestic demand represents less than 10% of total water use. Available data on water quality status and trends in the Ayeyarwady indicate that some deterioration of surface water quality is occurring, mainly related to agricultural chemical loadings, untreated urban wastewater discharges, and sedimentation.

Hydropower development on the Ayeyarwady main stem has considerable potential, including for export to neighboring GMS countries, but also poses a significant threat to fisheries, riverbank agriculture, and floodplains. Some dams exist on tributaries to the Ayeyarwady. The largest development is the 3,200 megawatt Myitsone Dam at the confluence of the May Kha and Mali Kha tributaries. Construction was suspended in 2011. Upstream there are plans to build six dams on the May Kha and Mali Kha rivers with combined generating capacity of 13,360 megawatts. Unless adequate mitigation measures are developed, these dams will damage the ecosystems of both the pristine May Kha river and the Ayeyarwady downstream.

Top: Boat transportation on the Ayeyarwady River, Myanmar. **Middle and Bottom:** Mandalay port on the Ayeyarwady River.

■ Upper Thanlwin River in Yunnan, PRC.

Thanlwin River Basin

Basin area (square kilometer)	271,914
Average population density (people per square kilometer)	22
Cities (100,000 or more people)	1
Land cover and use (% of basin area)	
Forest	43.4
Grass, savanna, and scrubland	48.3
Wetlands	9.5
Cropland	5.5
Irrigated cropland	0.4
Dryland	0.1
Urban and industrial	0.5
Degree of river fragmentation	Medium
Biodiversity status	143 fish species, 47 fish endemics, 92 amphibian species, 2.2% protected area

Source: Water Resources eAtlas. *Watersheds of the World*. http://iucn/themes/wani/eatlas/index.htm

The transboundary Thanlwin River basin covers a total area of 271,914 square kilometers, of which 53% is in the PRC, 42% in Myanmar, and the remaining 5% in Thailand. Stretching 2,815 kilometers, the Thanlwin is the second longest river in Southeast Asia after the Mekong River. Originating in the Himalayas in the Tibetan Plateau at 4,000 meters above sea level, the river drains a narrow and mountainous watershed extending south through Yunnan, along Myanmar's eastern Shan and Kayah states, forming the border between Myanmar and Thailand, then passes through Myanmar's Kayin and Mon states before discharging into the Gulf of Martaban in the Andaman Sea. Numerous major tributaries, including the Pang, Teng, Pawn, Hka, and Hsim rivers join the Thanlwin River as it makes its way south. The river is only navigable in the final

■ Thanlwin River at Mae Sam Laep, Thailand.

89 kilometers from the mouth, where the channel deepens and widens sufficiently to accommodate larger vessels. Average annual discharge at the mouth is 1,659 cubic meters per second.

In the PRC, the river runs parallel to the upper reaches of the Mekong and Yangtze rivers in an area designated by the United Nations Educational, Scientific and Cultural Organization (UNESCO) as a World Heritage site for its rich biodiversity. In Myanmar and Thailand, the topography is mountainous, with long river valleys and varied habitats that support rich, unique Indo-Burmese fauna. The river is home to at least 143 fish species, of which a third are endemic, that migrate between the Thanlwin and its tributaries; and a high diversity of turtles.

The basin supports a population of approximately 7 million people and is an integral part of the people's livelihoods and culture. At least 13 different ethnic groups inhabit valleys and floodplains along the river and its tributaries in Myanmar and Thailand, in addition to ethnic groups living along the river in Yunnan. Although deeply incised, with steep canyon walls and rapid currents for most of its length, the river widens about 240 kilometers from its mouth and flows through agricultural valleys before spreading out into the small delta at Mawlamyaing. The most populated section of the basin is the fertile floodplain area of the delta.

Estimated total water withdrawals from the Thanlwin in 2000 were 33.23 cubic kilometers, of which 89% was for agriculture, 10% for municipalities, and 1% for industry. Approximately 91% of total water withdrawals come from surface water. Total irrigated area in the basin is estimated at 400,000 hectares, of which 50% is in Myanmar, 42% in the PRC, and 8% in Thailand.

Hydropower development in the basin has to date been confined to tributaries but there are plans for large-scale main stem development in the upper section of the river. In the PRC where it is called the Nu River, a cascade of dams has been proposed. Several proposed dams are situated in the world heritage site "Three Parallel Rivers Protected Area", posing a threat to biodiversity. A series of 5 large dams is also planned further downstream on the Thanlwin River and its tributaries, namely: the Hatgyi, Tasang, Wei Gyi (Upper Thanlwin Dam), Dagwin (Lower Thanlwin Dam), and Upper Thanlwin.

Mining and deforestation, including shifting cultivation in upper reaches of the Thanlwin River, increase sediment flows, reduce storage capacity of reservoirs and raise the bed level in the lower reaches of the river. Development of industry and increasing population density are contributing to deterioration of water quality.

■ **Upper:** Chao Phraya River at Bangkok, Thailand. **Lower:** Temple flooded by overflow from the Chao Phraya River in Thailand, 2011.

Chao Phraya River Basin

Basin area (square kilometer)	178,785
Average population density (people per square kilometer)	119
Cities (100,000 or more people)	3
Land cover and use (% of basin area)	
Forest	35.4
Grass, savanna, and scrubland	11.1
Wetlands	8.4
Cropland	44.7
Irrigated cropland	12.5
Dryland	15.7
Urban and industrial	9.2
Degree of river fragmentation	High
Biodiversity status	222 fish species, 34 fish endemics, 78 amphibian species, 11.7% protected area

Source: Water Resources eAtlas. *Watersheds of the World*. http://iucn/themes/wani/eatlas/index.htm

The Chao Phraya is the most economically important basin in Thailand, stretching 980 kilometers in length and covering 30% of the country's land area. The basin catchment area is 178,785 square kilometers, of which 14,000 are in the low-lying delta. The river's headwaters originate in the mountainous terrain of the northern part of the country and consist of four large tributaries, the Ping, Wang, Yom, and Nan rivers, which meet to create the Chao Phraya at Nakhon Sawan. The river then flows southward through a large alluvial plain before splitting into four channels, the Tha Chin, Noi, Lop Buri, and Chao Phraya rivers.

The Pasak River joins the Chao Phraya at the ancient capital of Ayutthaya. The main river system passes through the capital city, Bangkok, situated at its downstream end. The expanse of the Chao Phraya and the Tha Chin rivers and their distributaries, forms the Chao Phraya delta, which is bisected by canals that serve both for irrigation and transportation.

Extensive canals have been built to exploit the agricultural potential of the floodplain since the 1800s. The first of a number of irrigation dams, the Rama VI dam on the Pasak River was completed in 1924 and was followed by a number of other tributary and main stem dams, such as the Bhumibol Dam on the Ping River, the Sirikit Dam on the Nan River, and the Chao Phraya Dam at Chainat.

About 40% of the Thai population live in the Chao Phraya basin, and two thirds of the national gross domestic product are generated by development activities in the basin. The mountainous upper region is characterized by agriculturally productive valleys, while in the lower region, highly productive alluvial plains predominate. This area has extensive irrigation networks, including about 3,000 small dams to store monsoon flows, permitting extensive exploitation of the basin's vast agricultural potential. The agriculture sector accounted for 12% of Thailand's gross domestic product in 2009.

Although average discharge from the Chao Phraya is 718 cubic meters per second, the

discharge fluctuates widely with maximum average discharge spiking to 5,960 cubic meters per second. Floods are a natural phenomenon in the basin; extreme events were experienced in 1942, 1983, 1995, and most recently in 2011 when areas of Ayutthaya and outer Bangkok were inundated for weeks with the loss of more than 500 lives and major impact on industries, agriculture, and tourism. Factors that worsen the flood peak and duration include a decline of flood retention areas and the confinement of flood plains due to increasingly intensive agricultural development, as well as rapid urbanization and industrial growth around Bangkok. Some parts of Bangkok have experienced land subsidence of 1 meter over a 25-year period, due to overpumping of groundwater; further subsidence was reduced substantially after pumping controls were introduced in the mid-1990s.

The lowland areas of the Chao Phraya watershed in central Thailand are designated as freshwater swamp forest, a tropical and subtropical moist broadleaf ecoregion. These forests have been extensively reduced through conversion to agriculture, predominantly rice cultivation, and urban development. Habitat loss has affected numerous freshwater fish, birds, and mammals that had previously been abundant in the inland and coastal areas of the basin. The remaining wetlands, including those in the Khao Sam Roi Yot National Park, provide habitats for breeding and wintering bird populations.

While conditions in the upper and central Chao Phraya and upper Tha Chin are considered fair, water quality in the lower Chao Phraya and lower and central Tha Chin is deteriorating due to increasing discharges from domestic, industrial,

and agricultural sources. Water quality in the Ping, Wang, Yom, and Nam rivers is also deteriorating, associated with urban, industrial, and agricultural loadings and, more generally, the rapid development occurring in provinces.

Over the past decade, Thailand has established river basin committees for the 25 basins across the country, including the Chao Phraya, composed of local administrative body representatives, water users, local nongovernment organizations, government officials, and private sector delegates. Collectively, they are responsible for dialogue among stakeholders in the basin to identify solutions to water-related issues and to act as a coordinating body with government.

■ **Upper:** Flooding from the Chao Phraya River in Bangkok, Thailand, 2011. **Lower:** Residents wading and using boats during the Bangkok flood.

■ Floating Market at Nga Nam in the Mekong Delta, Viet Nam.

■ **Upper:** Sunset on the Mekong River.
Lower: Tonle Sap, Cambodia.

Mekong River Basin

Basin area (square kilometer)	805,604
Average population density (people per square kilometer)	88
Cities (100,000 or more people)	9
Land cover and use (% of basin area)	
Forest	41.5
Grass, savanna, and scrubland	17.2
Wetlands	8.7
Cropland	37.8
Irrigated cropland	2.9
Dryland	0.8
Urban and industrial	2.1
Degree of river fragmentation	Medium
Biodiversity status	1,200-1,700 fish species, 62 fish endemics, 162 amphibian species, 4 Ramsar sites, 5.4% protected area

Source: Water Resources eAtlas. *Watersheds of the World*. http://iucn/themes/wani/eatlas/index.htm

The Mekong River is 4,909 kilometers in length from its source on the Tibetan Plateau (Xizang) in the PRC to its mouth at the Mekong Delta in Viet Nam. The basin has an area of 795,000 square kilometers, extending over six countries—the PRC (21%), Myanmar (3%), the Lao PDR (25%), Thailand (23%), Cambodia (20%), and Viet Nam (8%). The upper region, known as the Lancang River, stretches some 2,000 kilometers with a drainage area of 165,000 square kilometers. The Lancang and tributaries in Yunnan are confined by narrow, deep gorges, where the river rapidly descends nearly 4,500 meters as it flows through the province. Approximately 90% of the elevation drop occurs in the PRC. As it approaches the Lao PDR border the river widens and slows. Average annual runoff from the Lancang is 74 cubic kilometers, contributing 14%–16% of the average total annual flow of the Mekong River of 460 cubic kilometers at its mouth, but up to 30% of the dry season flow.

On leaving the PRC, the Mekong River forms the border between Myanmar and the Lao PDR, then between Thailand and Lao PDR. The contribution from the PRC throughout the year has a major influence on flow regimes and water levels in the Mekong River in northern Thailand and the Lao PDR, in addition to the significant amount of water added downstream from the large left bank tributaries in the Lao PDR (Nam Ou, Nam Khan, and Nam Ngum rivers) and the Mun and Chi right bank tributaries in Thailand. Upstream of Luangprabang, the river continues within the Lao PDR then again forms the border with Thailand before entering the Lao PDR. At Si Phan Don, just before entering Cambodia, the river divides into a 9 kilometer wide array of braided channels and drops over the Khone Falls into Cambodia and later into southern Viet Nam, where it flows via a complex delta system into the South China Sea.

The lower Mekong basin has 21 sub-basins with more than half of its main stem flow being contributed by tributaries entering from the Lao PDR. The Mekong Delta begins in Phnom Penh, where the river divides into its two main distributaries, the Mekong and the Bassac. The

■ The upper Mekong River in Yunnan, PRC.

Mekong then divides into six main channels and the Bassac into three channels, to form the Nine Dragons of the outer delta in Viet Nam. Average river discharge is 14,500 cubic meters per second, peaking to an annual mean average of 39,000 cubic meters per second as a result of extreme seasonal variations in flow. Flows from year to year are highly variable as demonstrated by the range of flood peak discharges measured at Kratie in Cambodia—from about 77,000 cubic meters per second in 1978 to 34,000 in 1992. Severe flooding with return periods of 30–40 years was experienced along the main stem in northern Thailand and the Lao PDR in 2008 while in 2000, almost 900 people were killed and 2.5 million hectares of agricultural land were affected in Cambodia and Viet Nam. Flash flooding in tributary rivers has similarly caused extensive loss of life and damage. Early 2010 saw a widespread subregional drought affecting Yunnan and the northern Lao PDR and Thailand, and low levels in the Mekong halted commercial and tourist river transport.

Cambodia's Tonle Sap forms part of a unique hydrological system in the Mekong complex. The Mekong River and Tonle Sap are connected by the 120 kilometer Tonle Sap River, which reverses its direction of flow as water levels in the Mekong rise and fall. From July to the end of October, when the level of the Mekong is high, water flows into the Tonle Sap River, which fills the lake, increasing its size more than four-fold from 2,600 to about 10,500 square kilometers at its maximum. In November, when the level of the Mekong drops below the threshold point, the Tonle Sap River reverses its flow and water flows from the lake back into the Mekong River.

The Mekong River Basin maintains diverse and exceptionally productive ecosystems. Basin fauna include 14 critically endangered species, 21 endangered species, and 29 vulnerable species. The basin is home to one of the world's most diverse fisheries, of more than 1,300 species of fish that support a capture fishery of about 2.3 million tons per year valued at some $2 billion. These high annual fish yields are under pressure from human-induced activities, including overfishing, fragmentation and reduction of floodplains, and the blockage of fish migration by hydropower development both on tributaries and proposed for the main stem. There are approximately 400 deep pools in the Mekong that act as refuges for fish populations in the dry season.

The basin population was approximately 70 million in 2007. Population density is comparatively low, averaging 88 inhabitants per square kilometer, although there is considerable variability between countries. There are over 100 different ethnic groups living in the basin, making it one of the most culturally diverse regions in the world. It is predominantly a rural basin; roughly 85% of the people rely on agriculture, forestry, and fishing for their livelihoods. Agriculture in Thailand and Viet Nam is intensively developed. Total irrigated area in the lower basin is roughly 4 million hectares, of which Viet Nam accounts for 41%, Thailand 30%, the PRC 12%, Cambodia 8%, the Lao PDR 7%, and Myanmar 2%. The river is also of great importance for fisheries, especially in the Lao PDR, Cambodia, and Viet Nam, where local communities are highly dependent on fish for food security. Large-scale fishing and aquaculture have expanded rapidly, especially in Viet Nam.

Overall water quality in the upper part of the Mekong River Basin is classified as good. Of the 17 surface water stations monitored in

■ **Upper:** Transporting produce to market, Nga Nam, Viet Nam. **Lower:** Floating houses on the lower Mekong River at Chau Doc, Viet Nam.

Mekong River Commission

The Mekong River Commission (MRC) is an intergovernmental agency, the only one that works directly with the governments of Cambodia, Lao PDR, Thailand, and Viet Nam on their common specific interests—joint management of shared water resources and sustainable development of the Mekong River. The MRC aims to ensure that the Mekong's water is developed in the most efficient manner that mutually benefits the four countries and minimizes harmful effects on people and the environment in the lower Mekong basin.The MRC plays a key role in regional decision making and the execution of policies in a way that promotes sustainable development and poverty alleviation. The MRC has adopted a number of rules and procedures, such as the Procedures for Water Quality, to provide systematic and uniform information. It also acts as a regional knowledge hub on key issues related to the Mekong.

2009, 88.2% were considered acceptable for drinking water and as fish habitat, 5.9% were acceptable for agricultural use, and 5.9% were considered extremely polluted. Water quality and ecological health conditions in the lower Mekong River Basin are monitored routinely and annual status reports are issued by the Mekong River Commission. Quality is generally good, although localized pollution occurs from agricultural, industrial, and urban sources. Nutrient concentrations continue to remain within acceptable levels for aquatic life and humans, despite elevated values near major urban centers, in tributaries draining predominantly agricultural sub-basins, and in the delta. Chemical oxygen demand progressively increases with distance downstream, due to organic matter discharges from densely populated areas, and runoff from forested areas, agriculture, aquaculture, and industry.

Sediment and associated nutrients are important for the morphology of the Mekong River, particularly the delta, and for the capture fisheries. Data on sediment flows are limited but the total load has been estimated at up to 125 million tons per year of which 50% comes from the Lancang catchment, although this has been reduced since completion of hydropower dams. Another significant source of sediment is the transboundary "3S" (Sekong, Sesan, and Srepok) sub-basin.

Two subregional agreements exist for trans-boundary cooperation in the basin. The Mekong River Commission was established by treaty in 1995 signed by the four lower riparian countries for cooperation on the sustainable development of the basin. The PRC and Myanmar became active Dialogue Partners in 1996. For the upper basin, the Joint Committee for the Coordination of Commercial Navigation was established to cooperate on matters related to navigation improvements, safety, and river-borne trade between the upper (Lancang) and lower reaches of the river.

The Mekong River Basin has high hydropower development potential. Four large hydropower projects have been completed since 1992 on the upper reaches in the PRC, while another three large dams and a number of smaller ones are under construction or planned. Plans for another dam, the closest to the lower basin, have been dropped, reportedly due to concerns over the migration routes of fish to an upstream tributary.

Feasible hydropower projects in the lower basin have a total potential of 30,000 megawatts, of which 13,000 megawatts are on the Mekong main stem and the remainder on its tributaries. Existing hydropower projects on the tributaries in the lower basin have an installed capacity of 2,612 megawatts, with a further 3,574 megawatts currently under construction and agreements with private developers in place to carry out feasibility studies on more than 50 other projects. Environmental concerns include risks to ecosystems and biodiversity in the project areas and disruption to fish migration, habitats, and feeding grounds. Although not a major consumptive use of water, hydropower projects have resulted in rapidly fluctuating flows downstream, which, if not mitigated, cause disruption to river transport and fishing activity.

Since 1994, up to 12 run-of-the-river main stem dams have been proposed for the lower Mekong in the Lao PDR and Cambodia and some of these are reaching advanced stages of planning by private developers. Xayaburi, the first of these to be submitted to the Mekong River Commission for consideration under

its prior consultation procedure is a proposed 32 meter high 1,260 megawatt dam, to be located 150 kilometers downstream of Luangprabang. Member countries of the commission requested additional studies be undertaken to evaluate the extent of potential impacts, particularly on capture fisheries and livelihoods.

Upper: Riverside housing at Chau Doc, Viet Nam. **Lower:** Tending rice fields in the Mekong Delta, Viet Nam.

Sesan, Sre Pok, and Sekong (3S)- Largest Transboundary Tributary

The Sesan, Sre Pok, and Sekong river basins (3Ss) have a total catchment area of about 78,650 square kilometers and are collectively the largest tributary system to the Mekong. They extend through parts of Cambodia (33% of total basin area), the Lao PDR (29%), and Viet Nam (38%). The sources of the three rivers are in the Central Highlands of Viet Nam from where the Sekong flows through the Lao PDR before merging with the Sesan and Sre Pok. The Sesan and Sre Pok rivers flow from Viet Nam to Cambodia where the three rivers merge over a distance of about 40 kilometers before the confluence with the main stem of the Mekong River at Stung Treng. With a combined discharge of about 17% of the annual discharge of the Mekong, managing these basins requires innovative arrangements that involve the three countries to ensure sustainable management of land and water resources and equitable benefit sharing.

The 3S region is important for its biodiversity and natural resources, especially the fish and their connection with the Mekong. Changes in land use and forest cover put significant pressure on the rich terrestrial biodiversity. The national protected areas cover over 20% of the basin, but are under pressure themselves from illegal logging, encroachment, and the wildlife trade. Aquatic biodiversity and resources are threatened by changes in flows and water quality. All basins report declines in fish production from a combination of loss of habitat, fishing pressure, and illegal fishing methods. In the future this decline is expected to increase due to changes induced by hydropower dams, particularly for projects located near the confluence with the Mekong, which threaten to disconnect the extensive migratory fish habitats.

Distribution of the 3S sub-basins (square kilometer)

Sub-basin	Cambodia	Lao PDR	Viet Nam	Total
Se Kong	5,565	22,565	690	**28,820**
Se San	7,630	—	11,260	**18,890**
Sre Pok	12,780	—	18,160	**30,940**
Total	**25,975**	**22,565**	**30,110**	**78,650**
Total %	**33.0**	**28.7**	**38.3**	**100**

Source: ADB. 2008. *Sesan, Sre Pok and Sekong River Basins Development Study in Kingdom of Cambodia, Lao People's Democratic Republic, and Socialist Republic of Viet Nam*. (TA 6367 REG). Manila.

■ **Upper:** The Red River at Ha Noi, Viet Nam. **Lower:** Traditional fishing boats near the mouth of the Red River.

Red River Basin

Basin area (square kilometer)	170,888
Average population density (people per square kilometer)	181
Cities (100,000 or more people)	3
Land cover and use (% of basin area)	
Forest	43.2
Grass, savanna, and scrubland	15.5
Wetlands	5.4
Cropland	36.3
Irrigated cropland	3.9
Dryland	0.0
Urban and industrial	2.1
Degree of river fragmentation	—
Biodiversity status	180 fish species, 1 fish endemic, 140 amphibian species, 1 Ramsar site, 3.8% protected area

Source: Water Resources eAtlas. *Watersheds of the World*. http://iucn/themes/wani/eatlas/index.htm

The Red River system is the second longest in Viet Nam. It is an international river system, originating in Yunnan and flowing 1,149 kilometers through northern Viet Nam into the Beibu Gulf (Gulf of Tonkin). The total basin catchment area is 169,000 square kilometers, of which 81,240 square kilometers are in the PRC, 1,100 in the Lao PDR, and 86,660 in Viet Nam. The main reach of the river commences at the confluence of the Da, Thao, and Lo rivers upstream of Ha Noi. Further downstream, the river forms a large delta covering an area of 14,788 square kilometers. Total annual flow volume to the Gulf of Tonkin is approximately 134 cubic kilometers, an average discharge of 4,249 cubic meters per second, of which 61% is generated in Viet Nam, and 39% in the PRC and the Lao PDR. Inflows to the river basin

■ Using river water to irrigate vegetable gardens in the Red River Delta, Viet Nam.

are unevenly distributed both spatially and temporally, leading to water shortages in the dry season and flooding in the rainy season.

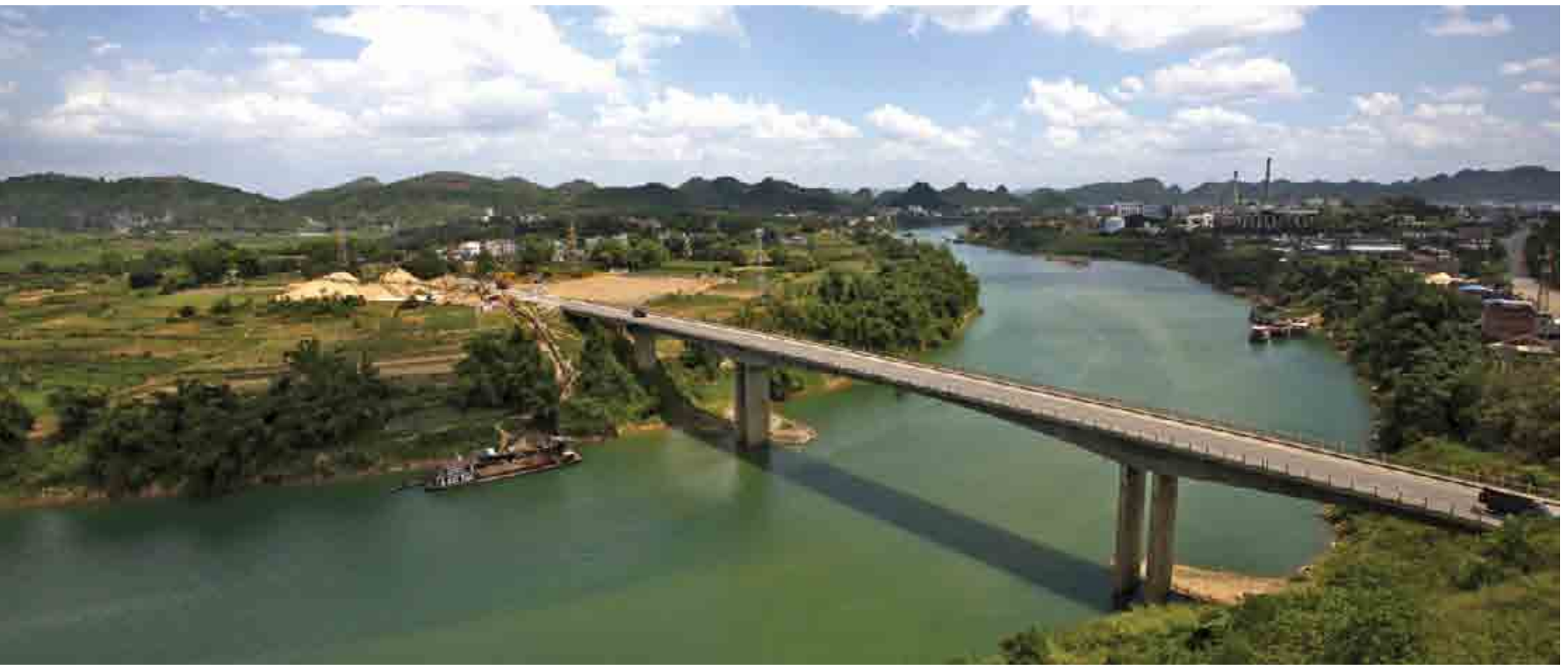
The estimated basin population is 28 million, of which 17.2 million live in the delta and 3.6 million in urban areas, including the main cities of Ha Noi and Hai Phong. The Red River Delta is one of Viet Nam's key economic regions, with agriculture playing an especially important role in the country's socioeconomic development. Other major economic activities in the delta include industry, services, and river transport. In the coastal region, rice cultivation is being replaced by brackishwater aquaculture. Water demand from industry, services, and municipal use is rising rapidly as industrial development intensifies and urban density increases.

The reddish-brown, heavily silt-laden water that gives the Red River its name supports extensive agriculture in the lower basin and delta. Irrigated agriculture is the primary water-use sector. Irrigation development in the delta represents approximately 37% of the total national irrigated area and encompasses roughly 4.5 million hectares of small, medium, and large irrigation schemes.

The Red River Basin supports rich freshwater and marine wetland biodiversity. About 50 aquatic species are harvested in the upper basin, including many fish, crabs, turtles, snails, and clams. Catches of fish and other aquatic species have been declining due to hindrance of fish migration, use of destructive fishing methods, and overfishing. The coastal zone of the delta supports a great biodiversity of fish and water birds, which are increasingly under pressure from dense human settlements and intense agricultural production. A Ramsar wetlands site has been designated at Xuan Thuy National Park to preserve 12,000 hectares of mangrove in the mouth of the Red River.

Water quality in the upper basin is considered generally acceptable, meeting national surface water standards for industrial and domestic uses. Although localized deterioration occurs near urbanized areas. Water quality in the lower basin, where the river flows through intensively cultivated, industrialized, and urbanized areas, progressively deteriorates. Industrial (from fertilizer producers, food and foodstuff processors, pulp waste, and textile producers) and domestic wastewater are the key contaminant sources, while suspended matter, organic matter, nitrates, and coliforms are the main pollutants. Localized heavy metal and toxic organic pollution occurs as a result of industrial effluent discharges. Agricultural runoff containing high fertilizer residue also causes localized pollution. Fertilizer and pesticide use in agriculture continues to increase, with fertilizer imports rising from 900,000 tons in 2000 to almost 3 million tons in 2008. Nationwide, wastewater discharges reached 3 million cubic meters per day by 2009. Biochemical oxygen demand in major rivers is increasing, with concentrations consistently exceeding standards during 2005–2009.

Three hydropower schemes have been developed in the Red River Basin, the 1,920 megawatt Hoa Binh and 2,400 megawatt Son La projects on the Da River and the 120 megawatt Thac Ba project on the Chay River. During the rainy season, there is some trade-off to hydropower generation because these reservoirs and the Day River barrage are operated by the Government to control flooding, particularly to protect the city of Ha Noi. Nine main irrigation reservoirs serve 60,000 hectares, representing about 6% of average annual flow. There is considerable potential for further storage development, particularly on the Da and Lo-Gam rivers.



■ Zuo River, a tributary of the Pearl River, in Guangxi, PRC.

Pearl River Basin

Basin area (square kilometer)	409,480
Average population density (people per square kilometer)	194
Cities (100,000 or more people)	4
Land cover and use (% of basin area)	
Forest	9.6
Grass, savanna, and scrubland	6.1
Wetlands	1.3
Cropland	66.5
Irrigated cropland	5.2
Dryland	0.0
Urban and industrial	5.3
Degree of river fragmentation	—
Biodiversity status	280-300 fish species, 120 fish endemics, 127 amphibian species, 1.1% protected area

Source: Water Resources eAtlas, Watersheds of the World (http://iucn/themes/wani/eatlas/index.htm)

The Pearl River Basin comprises an extensive river system in the southern PRC and northeastern Viet Nam. It is the largest river system in the southern PRC and the fourth largest in the country. The basin has a total drainage area of 409,480 square kilometers and consists of three main tributaries, the Xi Jiang, the Bei Jiang, and the Dong Jiang, that have in common the Pearl River delta. The Pearl River system extends 2,210 kilometers from its origin in Xi Jiang to the delta, making it the PRC's third longest river after the Yellow and Yangtze rivers, and the second largest in volume after the Yangtze. As well as referring to the system as a whole, the Pearl River name applies to a specific branch of the system—the widest distributary within the delta, flowing through the major city of Guangzhou before forming a large bay in the southeast of the delta that separates Macau and

■ **The Li River, a tributary of the Pearl River lined with karst formations, Guangxi, PRC.**

Zhuhai from Hong Kong, China. The river is named for the pearl colored shells found on the river bottom as it flows through Guangzhou. Average annual discharge into the South China Sea is 10,591 cubic meters per second.

The Pearl River is situated in the PRC's humid south-southwest agro-climatic region. It has a subtropical monsoon climate that allows for year-round agriculture, with rice being dominant in the lowlands. Agriculture is the main user of the river's water in the PRC, with an estimated 65% of water withdrawals for agriculture, followed by 23% for industrial, and 12% for municipal uses. With annual precipitation exceeding 1,000 millimeters, the region is classified as a supplementary irrigation zone. Irrigation is still necessary for rice, especially to improve cropping intensity, and supplementary irrigation may be required for upland crops.

The PRC has established a water quality classification system based on water use and human and aquatic life protection targets. Based on this classification, water quality is monitored at 17 stations in the southwestern rivers. Overall quality of the Pearl River is considered good, with 85% of monitoring stations meeting the standard for drinking water and as fish habitat, 12% meeting the standard for industrial use, and 3% primarily in tributaries being considered extremely polluted. Water quality degradation is typically most prominent as rivers flow through large cities, where discharge of organic materials causes increased concentrations of various pollutants.

Ayeyarwady Delta, Myanmar
The Ayeyarwady Delta with its dense network of rivers, has a floodplain ideal for rice production.

Tonle Sap, Cambodia
Tonle Sap, the Great Lake, is the largest freshwater body in Southeast Asia, harboring Cambodia's major source of protein for over 2 million people.

Upper: Nam Ngum River, Lao PDR. **Lower:** Members of the Intha ethnic minority who live and fish on Inle Lake, Myanmar.

Wetlands

Wetlands are among the most productive ecosystems, comparable with rain forests and coral reefs. Wetlands vary enormously in size and character, from tiny village ponds to lakes, bogs, marshes, and rivers. A source of great biodiversity, wetlands also support numerous species from all major groups of organisms, from microbes to mammals. Wetlands serve as habitats for fish and wildlife, naturally improve water quality, store floodwater, protect shorelines against erosion, provide opportunities for recreation and aesthetic appreciation, and yield natural products for human consumption at little or no cost. Protecting wetlands, in turn, reduces flood damage and preserves water quality, thus protecting health and safety. The biggest wetland in the subregion, apart from the large rivers, is Tonle Sap.

Cambodia

Seasonal and permanent wetlands make up more than 30% of the area of Cambodia. They include the Mekong River and its floodplain, Tonle Sap and its floodplain, the Stung Sen River, and the coastal estuaries of Stung Kep and Koh Kapic in Koh Kong. Three sites in the country have been proposed for inclusion in the Convention on Wetlands of International Importance (commonly known as the Ramsar Convention), particularly as Areas of Importance for Waterfowl. These sites are:

- Boeng Chhmar and its associated river system and floodplain of Tonle Sap,
- the middle stretches of the Mekong River north of Stung Treng, and
- Koh Kapic and its associated islets in Koh Kong Province.

Koh Kapic is an area of around 12,000 hectares on the western part of the Cambodian coastline near the border with Thailand. Most of Koh Kapic is in the Peam Krasaob Wildlife Sanctuary, which was made a protected area in November 1993 by the Royal Decree on the Creation and Designation of Protected Areas.

Tonle Sap. Tonle Sap, or Great Lake, is situated in the center of the Cambodian central plain, which has an elevation of 10–30 meters above sea level and covers about 6% of the country. The lake is connected to the Mekong River through the 120

Wetlands Defined

Under the Convention on Wetlands (Ramsar, Iran, 1971) "wetlands" are defined by Articles 1.1 and 2.1 as shown below.

Article 1.1 states "For the purpose of this Convention wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres."

Article 2.1 provides that wetlands "may incorporate riparian and coastal zones adjacent to the wetland and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands."

kilometer Tonle Sap River. The two rivers join at the Quatre Bras near Phnom Penh, after which the river immediately branches into two arms, the larger main Mekong and the smaller Bassac River. Further downstream these two arms are reconnected to form two equal channels as they start to fan out to form the delta, discharging into the South China Sea.

The vast floodplain of Tonle Sap supports one of the most productive inland fisheries in the world, and was declared a UNESCO World Biosphere Reserve in 1997.

The volume of water stored yearly in the lake is about 72 cubic kilometers, draining an area of 85,000 square kilometers, 10.7% of the total drainage area of the Mekong River. Tonle Sap contributes 6.4% of the average annual flow of the river.

The lake varies in dimensions seasonally, between 160 and 300 kilometers long and between 35 and more than 100 kilometers wide, its surface area from 2,600 to about 10,500 square kilometers, and its volume from about 1.3 to 75 cubic kilometers.

The extent of the lake expansion varies from year to year depending on flows from upstream and this has an influence on fish catch. Tonle Sap accounts for about 60% of Cambodia's inland fisheries production. More than 1.2 million people in the Tonle Sap area depend on fishing for their livelihood.

The rise in water levels at the beginning of the flood season triggers many migrating fishes to move from the dry season habitats just below the Khone Falls, e.g., in deep pools along the Kratie–Stung Treng stretch, toward their floodplain habitats in southern Cambodia and the Mekong Delta in Viet Nam.

Maintaining the natural reverse flow of the Tonle Sap River at an acceptable level is so important that it is formally recognized in the Mekong River Commission's Agreement on Cooperation for the Sustainable Development of the Mekong River Basin. The extent to which dams in the Mekong basin affect downstream wetlands by changing the flood regime is reported in the MRC's analysis of basin development scenarios.

Guangxi Zhuang Autonomous Region

Thickly criss-crossed by rivers, Guangxi is rich in water resources. It is estimated that the surface water flowing in the region amounts to 188 cubic kilometers, about 7% of the PRC's total flow. The three largest water systems running through the region are the Pearl (Zhujiang), Yangtze, and Duliu rivers. Other extensive wetlands exist and include 10 nature reserves. Of particular interest are coastal wetlands.

Shankou Mangrove Wetland. Shankou Mangrove Wetland, covering 8,000 hectares, is located southeast of Hepu County. It has a north tropical marine monsoon climate and is the most representative and best preserved natural mangrove zone in the PRC. It includes a 4,000-hectare Ramsar Convention wetland of international importance, consisting of a mangrove forest and its ecosystem, which contains many species of mangroves, all of great value. Besides the mangroves, there are abundant marine organisms, such as various algae and pearl oysters, as well as many nationally protected bird species. The site also supports a number of vulnerable and endangered species, including a dugong, which is under state protection.

Upper: The flooded forest of Tonle Sap, Cambodia. **Lower:** The lesser adjutant, sometimes seen around Tonle Sap, Cambodia.

■ Lugu Lake, Yunnan, PRC.

Guangxi Beilun Estuary Wetland. Guangxi Beilun Estuary Wetland, situated at the extreme southwestern coast of mainland PRC, covers 3,000 hectares and is also a Ramsar Convention protected wetland of international importance. It contains mangrove forest and intertidal mudflats on the Belium River, the boundary river between the PRC and Viet Nam, which also lies on the East Asian - Australasian Flyway, an important migration corridor for some migratory bird species. The reserve contains semi-closed bays, open estuary coasts, and sandy beaches with mangrove vegetation that provide habitat for 187 bird species, including vulnerable and endangered species. The site plays a substantial role in shoreline protection, alleviating floods caused by typhoons and resisting tidal impact.

Yunnan Province, People's Republic of China

Yunnan has several large natural lakes in the catchment of the Mekong River. Of these, two are protected as nature reserves: Dian Chi, the largest lake in the catchment and eighth largest lake in the PRC, is a nationally important lake in Kunming. Er Hai Lake is second largest in area although bigger in volume due to its greater depth. Nearly comparable in size is Fuxian Lake and there are several minor lakes of environmental and cultural importance.

Dian Chi Lake. Dian Chi Lake is a large, freshwater fault lake located on the Yunnan-Guizhou Plateau in Kunming, 1,886 meters above sea level and covering over 309 square kilometers. It is 39 kilometers long from north to south, and the average depth is 5.3 meters. It is the eighth largest lake in the PRC and the largest in Yunnan Province.

Er Hai Lake. Er Hai is situated at 1,974 meters above sea level. The north-south length of the lake is 40 kilometers and the east-west width is roughly 7–8 kilometers. Its area is 251 square kilometers, making it the second largest highland lake of the PRC, after Dian Chi Lake. Its circumference reaches 116 kilometers with an average depth of 10.6 meters and a total storage capacity of 2.7 cubic kilometers. The lake is sandwiched between the Cangshan Mountains to the west and Dali City.

Fuxian Lake. Fuxian Lake stretches out through Chengjiang, Jiangchuan, and Huaning counties in Yunnan , spanning an area of 217 square kilometers. The storage capacity of 20.6 cubic kilometers is the largest in Yunnan; as well as the third largest lake in area in Yunnan, it is the deepest lake, at 158.9 meters—making it the second deepest freshwater lake in the PRC after Tianchi Lake, a volcanic body of water in Changbai Mountain in northeastern PRC.

Lugu Lake. Lugu Lake is an alpine lake at an elevation of 2,691 meters located in the North West Yunnan plateau bordering Sichuan Province. Surrounded by mountains, it is the highest lake in Yunnan and contains islands, peninsulas, bays, and beaches. The lake's shores are inhabited by many ethnic groups, such as the Mosuo, Norzu, Yi, Pumi, and Tibetan. The most numerous are the Mosuo (or Moso) people, said to be a sub-clan of

the Naxi People with an ancient family structure considered as "a live fossil for researching the marital development history of Human beings" and "the last quaint Realm of Matriarchy." Lugu Lake is called the "mother lake" by the Mosuo people.

The Lao People's Democratic Republic

The major wetlands in the Lao People's Democratic Republic are the Mekong River, Khone Falls–Siphandon (60 square kilometers), Xe Pian–Xe Khampho (300), Bung Nong Ngom complex (30), Xe Kong Plains (350), Xe Champhone (240), Nong Luang (90), and the Nakai Plateau (l00). These areas have not yet been officially designated for protection.

Beung Kiat Ngong. Beung Kiat Ngong Wetland in Champasak Province is an important wetland complex within the Xe Pian National Protected Area; the Dong Hua Sao National Protected Areas covers an area of 2,360 hectares and includes swamps, lakes, and marshes. It is the only place in the Lao People's Democratic Republic where peatland areas are found. The tributary of the Xe Khampho River supports up to 300 fish species and is important for fish spawning, providing a migratory path upstream during the wet season. During the dry season it acts as a sanctuary for many fish species. Aquatic habitats are home to freshwater tortoises, such as the vulnerable Malayan snail-eating turtle, and the site is important as a feeding area for waterbirds that occasionally also nest there. The site is important for flood control and maintaining groundwater. Local residents engage in subsistence and commercial fishing, growing rice, and harvesting wild vegetables and nontimber forest products, including over 350 species of medicinal plants. Threats include peat extraction for fertilizer, unsustainable fish harvesting, and conversion of marsh areas into rice fields.

Ngong Xe Champhone. Ngong Xe Champhone Wetlands in Savannakhet Province form a large plain consisting of marshes, swamps, and flooded woodland forest; it is an outstanding and rare example in the Lao People's Democratic Republic of a river with many oxbow lakes, deep pools, and mats of dense floating vegetation. It supports the largest population of the critically endangered Siamese crocodile in the country and protects other species, such as the endangered elongated tortoise. As the water level recedes during the dry season, crocodiles and fish migrate to permanently flooded deep ponds and marshes. Fish use the site as a spawning area and as a migration path during the wet season. Local people engage in rice farming, communal fishing, and raising cattle and water buffalo. Traditional management systems, such as sacred areas and local taboos, play an important role in the protection of some parts of Xe Champhone wetlands and their resources. Threats to the site include conversion for agriculture, collection of crocodile eggs, and disturbance to crocodile hatching areas due to flooding caused by the construction of weirs.

Myanmar

Myanmar has extensive mangroves in the Ayeyarwady Delta and other coastal areas. Lake Indawgyi is the largest lake in the country and features a large wildlife sanctuary. Lake Inle, the next largest, is also considered to have outstanding significance for biodiversity.

Indawgyi Lake. Indawgyi Lake, located in the Kachin State of Myanmar, is one of the largest inland lakes in Southeast Asia. The lake measures 13 kilometers east to west, and 24 kilometers north to south. There are over 20 villages around the lake. The predominant ethnic groups living around the lake are the Shan and the Kachin, who mainly practice agriculture. Half of the site is covered by mixed deciduous forest and 30% is wetland. Evergreen forest (riverine), mixed deciduous forest (bamboo), and hill forest (pine forest), are other forest types of the site. At least 165 types of trees and medicinal plants, 38 mammals, 448 birds, 41 reptiles, 34 amphibians, and 50 butterflies are present in the site. The area is an International Bird Area with some 10 threatened bird species, including the critically endangered white-rumped vulture and the nearly threatened hooded treepie, endemic to Myanmar.

Inle Lake. Inle Lake is one of The Association of Southeast Asian Nations' heritage sites; vast as well as picturesque, the lake measures 22 kilometers long and 10 kilometers' wide, located 900 meters above sea level in the hilly Shan State in eastern Myanmar; it is one of the country's

Upper: Monastery on Inle Lake, Myanmar. **Lower:** Khone Falls on the Mekong River, Lao PDR.

■ **Upper:** Artisanal fishers with basket nets on Inle Lake, Myanmar. **Lower:** Navigating through weeds and water lilies at Inle Lake, Myanmar.

main tourist attractions. It is famous for its scenic beauty and the unique leg rowing of the Inthas, the native lake dwellers. Aquatic animals are highly endemic, to an unusual degree, in this relatively shallow lake. The key resource of the site is a large population of many migratory and resident birds (175 species have been recorded), besides native aquatic plants and freshwater fishes. Some 170,000 people live spread out in 400 villages around the lake, many on floating islands of vegetation. The lake has been modified through land reclamation. Floating gardens built in many places have transformed the lake surface into a series of canals. Runoff of pesticides and fertilizer from the gardens, combined with sewage from surrounding communities and sedimentation from cattle grazing, poses a potential threat to this ecosystem. An estimated 310,000 tons of sediment enter the lake each year from 29 creeks flowing through the watershed area. In 2010, the depth of Inle Lake reached its lowest point in 50 years due to weather variability and unsustainable practices of natural resource use. An unprecedented surge in temperature in the summer of 2010, deforestation in the watershed, eutrophication, and overuse of chemical fertilizer and insecticides, in addition to the heavy sedimentation, have resulted in the decrease of the Inle Lake area by about one quarter.

Thailand

Rapid industrialization has reduced Thailand's important wetland ecological systems. To protect its remaining wetlands, the country has signed the Ramsar Convention. The Thale-Noi Non-Hunting Area, Khao Sam Roi Yod National Park, and Bung Boraped are considered wetland sites of international importance, and Thale-Noi has been placed under the protection of the Ramsar Convention.

Songkhla Lake. Songkhla Lake is the largest natural lake in Thailand, located on the Malay Peninsula in the southern part of the country. The lake covers an area of 1,040 square kilometers and borders the provinces of Songkhla and Phattalung. The southern part becomes a 380-meter wide strait flowing into the Gulf of Thailand at the city of Songkhla. This part contains brackishwater while the northern part consists of freshwater. Connected to Songkhla Lake are the Phru Khuan Khi Sian wetlands and Thale Noi Lake, located just north of Thale Luang, one of the few surviving intact freshwater wetland ecosystems in Thailand. Among the specific wetland types found here are marsh, melaleuca (also termed "paperbark") swamp forest, rice fields, and swamp grasslands. They have been protected as a Ramsar wetland since 1998, and are part of the larger Thale Noi Non-Hunting Area, created in 1975. A small population of endangered Irrawaddy dolphins is

found in the lake; they are threatened by extinction from the overfishing and pollution of the lake.

Sam Roi Yod Wetland. Sam Roi Yod (literally, "mountain with 300 peaks") is a national park in the Pranburi and Kuiburi districts of Prachuap Khiri Khan Province. It is home to at least 116 species of birds (residents and winter migrants), 24 species of fish, and many species of reptiles and amphibians, as well as insects and plants. Although relatively small (98 square kilometers), the park has a vast array of habitats—from limestone mountains, rocky shores, and sandy beaches to mangrove forests, mudflats, and marshes, including islands. One particularly important and fertile habitat is the nearshore marine ecosystem, a refuge for the endangered serow. A freshwater wetland with an area of 30 square kilometers just west of the national park also supports an abundant biodiversity. It is home to at least 50 plant species and 349 kinds of animals, of which at least 28 are found only in this marsh. There are 21 villages in the vicinity with more than 3,600 households, whose members depend on the marsh for their livelihood. The park is threatened by disputes among local people over landownership and land claims within its boundary. In an attempt to solve the conflicts, the Government cancelled all landownership documents within the boundary of the national park. But other problems—encroachment of land for agriculture and shellfish farms, wastewater release from communities and factories, and basin agriculture—have appeared. The Government has called for cooperation with the surrounding communities in joint activities that could make the park more valuable for all.

Viet Nam

Viet Nam has a great diversity of wetland habitats: large estuarine and delta systems with extensive mangrove swamps and tidal mudflats, immense seasonally flooded plains with rice paddies and melaleuca forests, many small offshore islands, large coastal brackishwater lagoons, salt pans, many freshwater lakes, and numerous rivers and streams. By far the largest wetland area is the Mekong Delta in the south, with its elaborate network of river channels and vast areas of rice fields, mangrove forests, melaleuca forests, and tidal mudflats. In the central part of Viet Nam, most of the significant wetlands are coastal lagoons. In the north, there are numerous lakes in the Red River Basin and extensive mudflats and mangrove swamps in its delta.

Mangroves in the Mekong Delta. The Nam Can mangrove forests and U Minh Ha melaleuca forests of Ca Mau Province stretch

Waterfall in Sai Yok National Park, Thailand.

■ **Upper:** U Minh Thuong wetland, Viet Nam. **Lower:** Fruit bats in U Minh Thuong wetland.

250 kilometers along the coastline of the southernmost tip of Viet Nam. These areas protect the coast from erosion and create a 5,200 square kilometer coastal ecosystem that is rich with marine life.

The Dat Mui Nature Reserve is in this ecosystem. Natural mangrove forest originally covered the site but was mostly destroyed by war and later conversion to fishponds and agricultural land. The now-abandoned fishponds support extensive areas of recolonizing mangrove forest. There are also extensive mudflats that are sites for colonization by mangroves.

On the western coast of the Ca Mau Peninsula is the Bai Boi Protection Forest, which is proposed as a nature reserve. Bai Boi is also composed of abandoned fishponds and extensive mudflats that are being recolonized with mangroves, which also help to protect coastal areas from tropical storms.

Can Gio Wetland, Ho Chi Minh City. The Can Gio Biosphere Reserve is a mangrove-dominated 757 square kilometer area between Ho Chi Minh City and the sea that is highly valued for its biological diversity and provides the "green lungs" for the country's largest urban area. More than 200 species of animals and 52 species of plants have been identified in the area. At least 35 bird species have been recorded in the Can Gio forest. In the past, the mangrove forest of Can Gio sheltered various wild animals, such as tigers, panthers, and crocodiles. Now there are only monkeys, deer, wild boars (including some newly found herds), otters, reptiles, and amphibians.

After severe damage three decades ago, Can Gio's ecosystem has been restored to some extent. This marks the first time that an entire rehabilitated ecosystem has been designated as a biosphere reserve. However, many challenges remain. Local communities in Can Gio earn much less than those in other parts of the country, especially nearby Ho Chi Minh City. Education levels are still low and environmental awareness rudimentary.

Ba Be Lake, Bac Kan Province. Ba Be, the biggest natural lake in Viet Nam, is located in the Cho Ra-Ba Be-Cho Don karst terrain. Ba Be Lake has a water area of about 500 hectares spread out over 8 kilometers and is a part of the Ba Be National Park. The Ba Be Lake remains permanently filled with water in contrast to other such lakes that contain water only in the wet season. Ba Be Lake is recognized as one of the 20 special freshwater lakes in the world that need protection. Ba Be National Park is recognized as a heritage park of the Association of Southeast Asian Nations. The park covers an area of 23,340 hectares. The terrain is mostly limestone rocks with a few earth hills of medium to abrupt slope. Three river flows discharge water into the lake, which has an average depth of 20–25 meters and a maximum of 35 meters. The lake bed contains submersed grottoes, which are ideal habitats for many aquatic animals.

Seas and Coasts

The Greater Mekong Subregion (GMS) sits atop a chain of land masses extending southward to Australia, that effectively separate the tropical waters of two of the world's major oceans, the Indian and the Pacific. As the waters of these oceans approach land, their currents and physical and chemical characteristics become modified by the presence of the continental shelf, the land, and freshwater from rivers and runoff. Thus, on the west coast of the GMS, the Indian Ocean becomes the Andaman Sea and Gulf of Martaban facing Myanmar and southwestern Thailand, while in the east, the Pacific Ocean forms the South China Sea facing Viet Nam, and the waters of Beibu Gulf facing northern Viet Nam and Guangxi Zhuang Autonomous Region of the People's Republic of China (PRC), and the Gulf of Thailand facing Cambodia and Thailand.

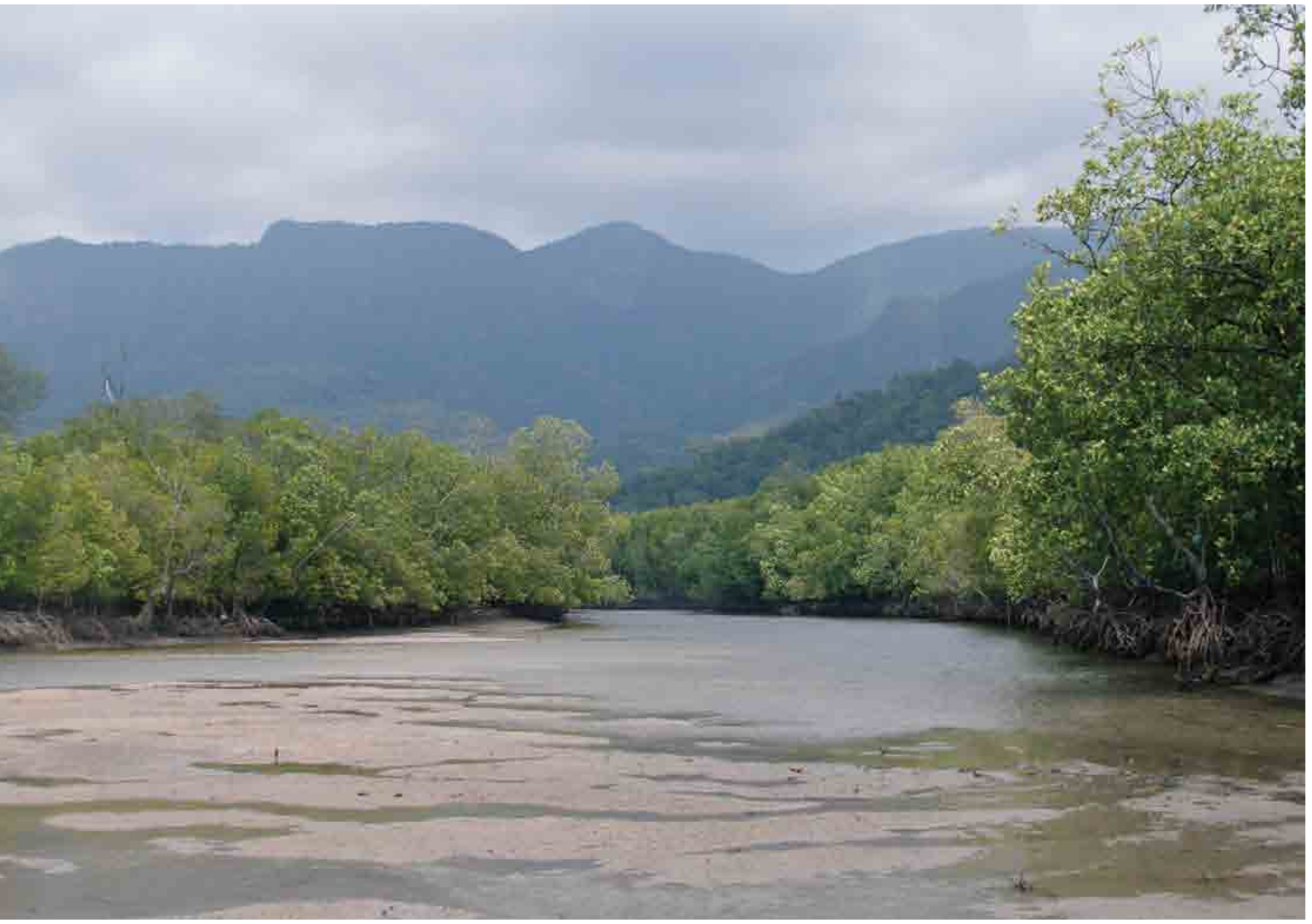
While these seas and gulfs have unique biophysical properties, their waters share much of their biodiversity due to much earlier tectonic events, the gradual separation and reshaping of the parts of the ancient megacontinent of Gondwana. Up until about 25 million years ago, the Indian and Pacific oceans were joined across a wide expanse and tropical marine fauna had free access to both sides of the present subregion. Subsequent movements of the earth's crust closed much of this passage apart from further south in the Malacca Straits and gaps between the Indonesian islands and New Guinea. When the last ice age began, as more water became locked up in ice, sea level began to fall, reaching a minimum level 18,000 years ago (the last glacial maximum), when the present GMS, Malaysia, and Indonesia formed a single land mass; even the Malacca Straits and most of the gaps between the Indonesian islands and New Guinea were dry land.

Andaman Sea

The Andaman Sea is a narrow water body lying between the coast of Myanmar and Thailand in the east and the Andaman and Nicobar Islands in the west, with a pointed tip in the Gulf of Martaban in the north and stretching to the top of Sumatra in the south, a length of about 1,200 kilometers. While traditionally a fishing ground criss-crossed by vessels trading along its shores, nowadays it is seeing increasing use in tourism due to its pristine coral reefs and many islands. The fishery and tourist infrastructure was severely damaged by a tsunami following a strong earthquake in the Indian Ocean in December 2004. The average depth of the sea is about 1,000 meters. More than 95% of the sea does not exceed 3,000 meters depth but, in a system of submarine valleys east of the Andaman-Nicobar Ridge, the depth exceeds 4,000 meters. The sea floor is covered with pebbles, gravel, and sand.

The northern and eastern parts are shallower than 180 meters due to the silt deposited by the Ayeyarwady River where it flows into the sea from the north through Myanmar. The climate and water

Upper: Lagoon waters near Lăng Cô, Thua Thien Hue Province, Viet Nam.
Lower: Idyllic beach at Ko Samui, Thailand.



■ Mangroves at Koh Tarutao in the Andaman Sea, Thailand.

salinity of the Andaman Sea are mostly determined by the monsoons of Southeast Asia. The average surface water temperature is 26–28°C in February and 29°C in May. Tides are semidiurnal (i.e., rising twice a day) with an amplitude of up to 7.2 meters. The coastal areas of the Andaman Sea are characterized by mangrove forests and seagrass meadows. Mangroves cover more than 600 square kilometers of Thailand's shores along the Malay Peninsula; seagrass meadows occupy an area of 79 square kilometers. Mangroves are largely responsible for the high productivity of the coastal waters. Their roots trap soil and sediment and provide shelter from predators and a nursery for fish and small aquatic organisms. They also protect the shore from the wind and waves, and their detritus forms part of the aquatic food chain.

A significant part of Thailand's mangrove forests in the Andaman Sea was removed for construction of shrimp farms. Mangroves were also significantly damaged by the 2004 tsunami. They were partly replanted but their area is still gradually decreasing due to human activities, including wastewater discharge from coastal industry, shrimp farms, and other forms of coastal development, as well as fishing using trawl nets, push nets, and dragnets. The 2004 tsunami affected some of the seagrass area along the Andaman Sea through siltation and sand sedimentation.

Within the sea, to the east of the main Great Andaman island group, lies Barren Island, the only active volcano associated with the Indian subcontinent. This island-volcano is 3 kilometers in diameter and rises 354 meters above the seal level. Its activity resumed in 1991 after a dormancy of almost 200 years. The island was formed by the ongoing subduction of the India Plate beneath the Andaman island arc, which forces magma to rise in this part of the Burma Plate. The most recent eruption, which still continues, began on 13 May 2008. The volcanic island of Narcondam, which lies further to the north, was also formed by this process. The Andaman Islands are around 90 kilometers away.

Gulf of Martaban

The Gulf of Martaban, forming the northern extremity of the Andaman Sea, is named after the port city of Moattama (formerly known as Martaban). The Thanlwin, Sittaung, and Yangon (or Rangoon) rivers empty into it. It has a tide-dominated coastline with a tidal range of 4–7 meters, the highest being at Elephant Point in the western Gulf of Martaban. During spring tide, the turbid zone covers an area of more than 45,000 square kilometers, making it one of the largest perennially turbid zones of the world's oceans. The edge of the highly turbid zone migrates back and forth by nearly 150 kilometers with every tidal

■ Scenic bay at Ang Thong, Koh Samui, Thailand, in the Gulf of Thailand.

cycle. The small port of Martaban, located at the mouth of the Thanlwin and across the river from Mawlamyine, is famous for its glazed pottery.

Gulf of Thailand

The Gulf of Thailand, formerly the Gulf of Siam, is an inlet of the South China Sea. Bordered by Thailand, Cambodia, and the southwestern edge of Viet Nam, the gulf's maximum width is 560 kilometers and it extends approximately 725 kilometers in length. The Gulf of Thailand is quite shallow along the coastal areas, which provide lucrative fishing grounds. Many rivers flow into the gulf, with the Chao Phraya being the most significant in Thailand. At the height of the last ice age, the Gulf of Thailand did not exist, due to the lower sea level, and was part of the Chao Phraya river valley. Being shallow, water exchange in the Gulf of Thailand is slow, and the strong water inflow from the rivers makes the gulf low in salinity (30.5–32.5 parts per thousand) and rich in sediments. Only at greater depths does water with a higher salinity (34 parts per thousand) flow into the gulf from the South China Sea, filling the central depression below a depth of 50 meters. The main rivers emptying into the gulf are the Chao Phraya (including its distributary Tha Chin River), Mae Klong, and Bang Pakong rivers, and to a lesser degree the Tapi River into Bandon Bay in the southwest of the gulf. Most of the streams, water channels, and rivers in southwestern Cambodia drain into the Gulf of Thailand.

South China Sea

Within the Greater Mekong Subregion (GMS), the South China Sea is part of the Pacific Ocean, located south of Guangxi Zhuang Autonomous Region, PRC, and east of Viet Nam. Major GMS rivers that flow into the South China Sea are the Pearl, Red, and Mekong.

The South China Sea is the second most used sea lane in the world; more than 50% of the world's annual merchant fleet tonnage passes through the Strait of Malacca, the Sunda Strait, and the Lombok Strait. Over 1.6 million cubic meters (10 million barrels) of crude oil a day are shipped through the Strait of Malacca, where there are regular reports of piracy, although much less frequently than before the mid-20th century. The region has proven oil reserves of around 1.2 cubic kilometers (7.7 billion barrels), with an estimated 4.5 cubic kilometers (28 billion barrels) in total. Natural gas reserves are estimated to be around 7,500 cubic kilometers (266 trillion cubic feet). This body of water also holds one third of the entire world's marine biodiversity, thereby making its ecosystems highly important.

■ A mountainous stretch of the coastline in Viet Nam.

Beibu Gulf and Hạ Long Bay

Beibu Gulf, also known as the Gulf of Tonkin, is a natural semi-enclosed gulf in the northwest of the South China Sea. It borders northern Viet Nam on the western side, and smaller areas of Guangxi in the north and Guangdong in the northeast, with the island of Hainan forming the eastern limit of the gulf. It covers an area of 129,300 square kilometers, with the depth of water averaging 42 meters and the deepest point at 100 meters. Haiphong in Viet Nam, and Beihai in Guangxi, PRC, are the chief ports. The Red River is the main river flowing into the gulf. Numerous small islands are located in the gulf, most of which are concentrated in the northwestern gulf. The largest islands are Bach Long Vi and Cat Ba of Viet Nam and Weizhou of the PRC.

Hạ Long Bay, a United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site, is located in northeastern Viet Nam; it is bordered on the south and southeast by Beibu Gulf, on the north by the PRC, and on the west and southwest by Cat Ba island. Cat Ba is the largest island in Hạ Long Bay and about half of its area is a national park, which is home to the highly endangered Cat Ba langur. The island has a wide variety of natural ecosystems, both marine and terrestrial, leading to incredibly high rates of biodiversity. Types of natural habitats found on Cat Ba Archipelago include limestone karsts, tropical limestone forests, coral reefs, mangrove and seagrass beds, lagoons, beaches, caves, and willow swamp forests. Cat Ba Island is one of the only populated islands in Hạ Long Bay, with roughly 13,000 inhabitants living in six different communes, and 4,000 more inhabitants living on floating fishing villages off the coast.

Coastal Zones

Cambodia, Myanmar, Thailand, Viet Nam, and Guangxi have large coastal zones with economically important areas and medium to large coastal towns containing millions of people. The coastal areas are characterized by the geologic nature of landforms, such as sandy beaches and dunes, coastal wetlands, rocky coasts, cliff coasts, and islands. These areas were formerly rich in both living and nonliving natural resources. During the last two decades, overexploitation of resources, population growth, and intensified developments in tourism, aquaculture, and industry have caused degradation of the resources.

Cambodia's coast is 435 kilometers long, with 69 islands. Administratively, the coastal zone includes two provinces of Koh Kong and

■ **Left:** Aerial view of Guangxi coast on Beibu Gulf. **Right:** Hạ Long Bay, Viet Nam.

Kampot, and two municipalities of Sihanoukville and Kep. Marine resources include coral reefs (28 square kilometers), mangrove forests (650 square kilometers), and seagrass beds (300 square kilometers), together with all the living organisms they contain. Cambodia's reefs are generally associated with offshore islands and rocky substrates. Main threats to the coral reefs are destructive fishing practices, anchor and trawling damage, overfishing, coastal development, agricultural run-off, and sedimentation. The recent practice of sand mining in rivers and along the coast is also affecting nearby reefs, as does land reclamation, mainly around the relatively urbanized areas of Sihanoukville and Kep, and areas that are being newly developed, such as near the naval base in Ream and the new port of Oknha Mong at Keo Phos. Although the reclamation is generally of a small scale, the impact on currents and the littoral transport processes may still be significant, particularly for adjacent areas of the coastline, which do not have any protection.

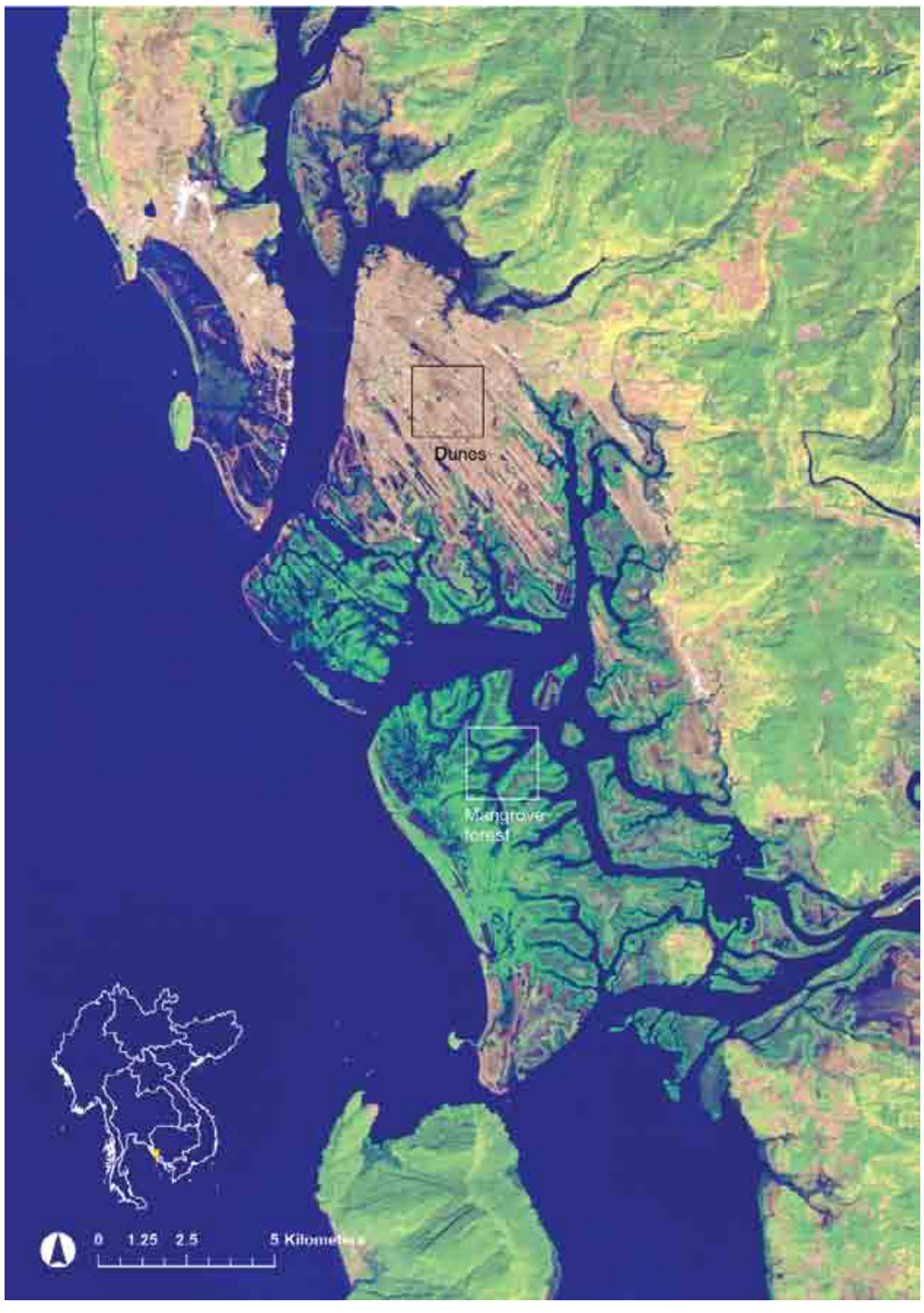
Guangxi is the only entity in the western PRC that has a coastline and an international border. Guangxi faces Beibu Gulf, serving as an important gateway for, and the most convenient passage between, southwestern PRC and Association of Southeast Asian Nations (ASEAN) countries. Scattered along the 1,595-kilometer coastline of Guangxi are 697 islands, with a total area of 67 square kilometers. Weizhou Island, the largest of these islands, covers an area of about 25 square kilometers. The coast also features numerous seaports. At present, there are 21 operational ports, the largest ones being Fangcheng, Beihai, and Qinzhou. All these ports have deep water, are protected from the wind and waves, and are close to Hong Kong, China; and other Southeast Asian countries. The ports have been given a strong role in the development strategy of the Guangxi government and will undoubtedly become the most active areas in terms of economic development in Guangxi and southwestern PRC.

Myanmar has a coastline of about 2,400 kilometers, which can be divided into three coastal regions: the Rakhine coastal region (from the mouth of the Naaf River to Mawtin Point, about 740 kilometers), the Ayeyarwady Delta and the Gulf of Moattama (Martaban) coastal region (from Mawtin Point to the Gulf of Moattama, about 460 kilometers), and the Thanintharyi coastal region (from the Gulf of Moattama to the mouth of the Pakchan River, about 1,200 kilometers) in the Bay of Bengal and the Andaman Sea. With several large estuaries, delta systems, and numerous offshore islands, Myanmar possesses a considerable diversity of coastal habitats, including coral reefs, mangroves, sandy beaches, and mudflats. The north-central part of the country is dominated by the vast delta of the Ayeyarwady River. Myanmar has the largest expanse of mangrove areas

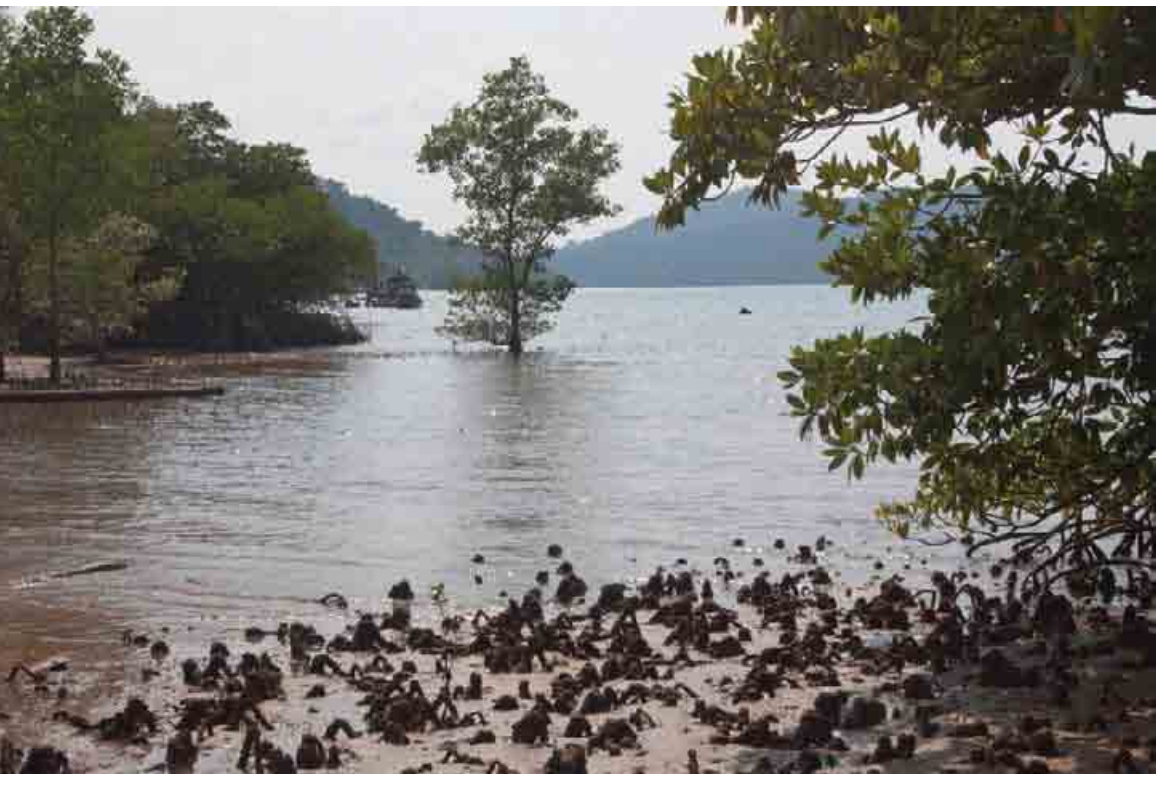
■ **Upper:** Sand mining at Koh Kong, Cambodia. **Lower:** Forest patrol around mangroves of Botum Sakor National Park, Cambodia.

in the subregion; mangrove forests are dominant in the Ayeyarwady, Thanintharyi, and Rakhine state/divisions. Shrimp aquaculture is also prominent in these areas. The chain of islands between the Ayeyarwady Delta and the Andaman Islands contains coral reefs, but they have been only minimally surveyed. Along the southern coast is a complex of forested offshore islands known as the Mergui Archipelago, where most of Myanmar's coral reefs are found. The Mergui reefs are thought to be similar in structure and diversity to the reefs around the offshore islands of Thailand.

Thailand is a littoral country with total coastal length of about 2,815 kilometers, which includes the Andaman Sea coast of 937 kilometers and the Gulf of Thailand coast of 1,878 kilometers. The Gulf of Thailand coast is usually classified into three parts: eastern coast, upper gulf, and western gulf. The coast of Thailand is characterized by beaches and sand dunes, coastal wetlands (tidal flat and marshes), rocky coasts, and cliff coasts. The Andaman Sea coast is dominated by small beaches, extensive and well-preserved tidal flats vegetated with mangrove forest, cliff coasts, and numerous islands, while the Gulf of Thailand coast contains long curving beaches, interspersed with raised beaches and dunes, and a variety of lagoons, tidal flats, and marshes. However, in the last two decades, the sandy beaches and dunes have become popular sites for development of industries, aquaculture, infrastructure, recreation, and tourism. Coastal mining for heavy minerals and tin was formerly prominent but most mines ceased operations after tin prices collapsed in 1985. However, the property boom in the early 1990s led to construction of tall hotel and condominium buildings close to the water's edge, obstructing public access to many beaches. Moreover, naturally accumulated sand and dunes



Above: Mangroves in water channels at Botum Sakor Park, Cambodia. **Left:** Satellite image showing mangrove areas in Koh Kong Province, Cambodia, 2010. Community-based mangrove restoration work under the Cambodian Nature Conservation and Protection Department has been ongoing in the area since 2006.



■ **Upper:** Sandy beaches of Nha Trang, Viet Nam. **Lower:** Low tide at Koh Chang, Thailand.

that once protected the inland area have been removed to improve the view and construct roads along the coast, resulting in accelerated erosion, land subsidence, and flooding. These problems have not only damaged the buildings and structures, but also at times led to confrontation between different interest groups in local communities.

Coastal wetlands, including tidal flats, mangrove forests, marshes, and lagoons, are well developed in both the Gulf of Thailand and Andaman Sea coasts. Some areas have been converted to shrimp farms, which has accelerated coastal erosion and caused seawater intrusion into adjacent rice fields and the coastal freshwater aquifer. Moreover, some wastewater is drained into the sea, affecting the seawater quality and biodiversity near the shore. Global warming and sea level rise will affect Thailand's coast. Subsidence of land in the Bangkok area has been caused by over-pumping of groundwater.

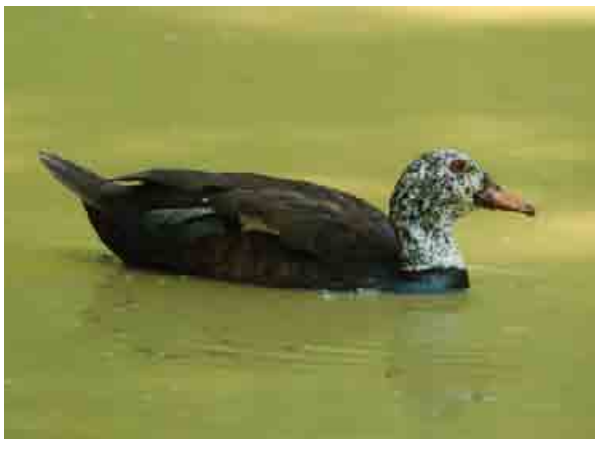
The coastline of **Viet Nam** extends through territories of 28 provinces and 7 cities (Ha Long, Vinh, Hue, Da Nang, Nha Trang, Quy Nhon, and Vung Tau). Narrow, flat, coastal lowlands extend from south of the Red River Delta to the Mekong River Delta. On the landward side, the Annamite Mountains rise precipitously above the coast, with spurs jutting into the sea at several places. Generally the coastal strip is fertile and rice is cultivated intensively. Viet Nam's coastal zone provides a diverse range of natural resources and favorable conditions for social and economic development, such as fisheries, aquaculture, agriculture, tourism, transportation, and urbanization. However, the ecosystems are highly vulnerable to such hazards as typhoons, storm surge, erosion, environmental pollution, global climate change and sea level rise, over-exploitation of resources, and other human activities (such as mangrove logging for shrimp farming and fuelwood, and waste disposal). These factors constrain sustainable use of coastal wetland resources.

Biodiversity

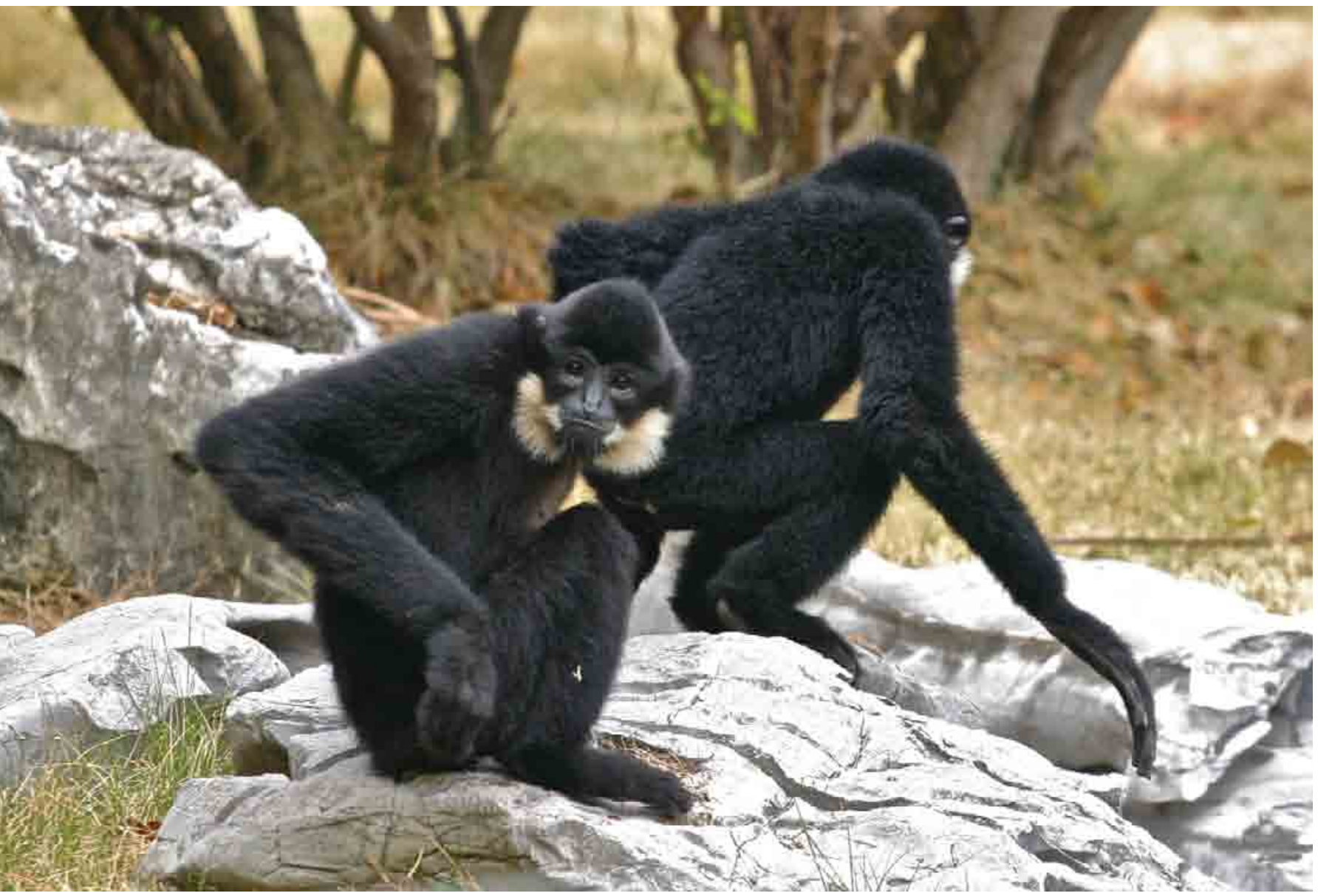
The Convention on Biological Diversity of 1992 defines biological diversity, or biodiversity, as the variability among living organisms from all sources including, among others, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; hence, the term includes diversity within species, between species, and of ecosystems.

Maintaining the biodiversity of plants and animals, which entails keeping enough habitat for their sustained existence, is important: we depend on many animals and plants for our own existence, not only as food but also as sources of enzymes, genes, chemicals, resins, and fibers that we can exploit to cure disease, provide raw materials, contribute to the provision of ecosystem services, and create economic wealth. If we are to continue to enjoy these and other benefits—such as aesthetic and recreational—we must also conserve the ecosystems, that is, the animals and plants and the habitats on which they depend.

The Greater Mekong Subregion (GMS) is one of the world's richest biodiversity hotspots and harbors several irreplaceable biomes. It has been estimated that between 1997 and 2010 over 1,500 new species were discovered in the GMS, which illustrates the diversity of ecosystems in the subregion. Many of these ecosystems are critically threatened—their fragility is demonstrated by the fact that a high proportion of the world's threatened species, as assessed by the World Conservation



Top: Asian elephants, Cambodia. **Middle:** Red Lacewing butterfly in Bach Ma National Park, Viet Nam. **Bottom:** White-winged duck, Western Forest, Thailand.



■ Francois' langur, Guangxi, PRC.

Union (IUCN), are located in GMS countries (from 1.2% in Yunnan to 3.1% in Viet Nam in 2005). Since the mid-1990s, there have been several significant studies to identify and delineate important biodiversity conservation areas in the GMS. The World Wide Fund for Nature (WWF) and IUCN have identified centers of plant diversity; WWF and the Wildlife Conservation Society have identified a suite of prioritized tiger conservation units; BirdLife has identified important bird areas in the subregion and expanded the concept to include key biodiversity areas; and WWF has identified ecoregions across the Indo-Pacific region, including several important (Global 200) ecoregions in the GMS.

Elephant corridors, tiger landscapes, Saola range, and gibbon habitat enrich biodiversity of the GMS. The forests of the GMS, home to many endemic species, stretch from Xishuangbanna in southern

Biodiversity defined

Biodiversity is of three general kinds: habitat diversity, species diversity, and genetic diversity. Each depends on the health of the other two.

Habitat diversity refers to the variety of places where life exists—coral reefs, old-growth tropical forests, grasslands, coastal wetlands, and many others. As the habitat disappears, many of the species it harbors also disappear. However, as has happened in the old-growth forests and coastal wetlands throughout the Greater Mekong Subregion, a habitat often does not disappear completely but dwindles to scattered patches.

Species diversity is what most people commonly understand as biodiversity. The species is the basic classification of living things that share common characteristics. The earth has about 1.5 million named and many more unnamed species. All in all, probably about 5–15 million species exist.

Genetic diversity is the varied mix of genes within species that allows plant and animal populations to adapt to changes in their environment. Genetic homogeneity, which occurs when a species'—be it elephant, tiger, or dolphin—population size becomes small, making the species far less adaptable and less likely to survive.

■ Wildlife survey in the Tenasserim Biodiversity Conservation Corridor, Thailand, by Wildlife Conservation Society staff.

Yunnan Province of the People's Republic of China (PRC), unique as a meeting place of northern and southern biotas of the region, sweep across northern Myanmar, linking with the elephant corridor into the Lao People's Democratic Republic (Lao PDR), and continuing into the rain forests of the Annamite Range in Viet Nam.

The Cardamom Mountains in Cambodia and the Indochina dry forests of the tri-border area between Cambodia, the Lao PDR, and Viet Nam are some of the most spectacular biodiversity-rich areas in the GMS. On the western flank of Thailand bordering with Myanmar, the Kayah-Karen Montane Rain Forests sweep down into Thailand's Western Forest Complex connecting to Kaeng Krachan and continuing on to the Peninsular Malaysian Montane Rain Forests.

In the northeast of the GMS, the karst landscape of Jingxi county in Guangxi Zhuang Autonomous Region of the PRC and Cao Bang Province in Viet Nam harbor the Cao Vit gibbon, one of the rarest apes in the world. Flanked by mountain ranges on the east and west, the mighty Mekong River flows from its origin in the Tibetan Plateau, through the headwaters in northern Yunnan down through Myanmar and the Lao PDR, bordering with Thailand into Tonle Sap's flooded forests in Cambodia to finally feed into the rich delta in southern Viet Nam before discharging into the sea; a journey of 4,900 kilometers providing resources and livelihoods to over 60 million people along its banks.

Ecoregions

The surface of our planet is composed of ecosystems—areas of land or bodies of water, or a combination of both, and the complex webs of life they support. The subregion is made up of many montane, forest, river, wetland, and marine ecosystems.

The concept of ecoregions—natural ecological communities with shared species, dynamics, and environmental conditions—offers a useful way of understanding the biodiversity of the ecosystems of the subregion and planning for their protection. To represent the original distribution of plants and animals on earth, the WWF has divided the entire planet into 867 terrestrial ecoregions, of which 40 are in the subregion.

In its Global 200 project, WWF selected approximately 200 ecoregions that are outstanding examples of biodiversity. Six terrestrial ecoregions fully within the subregion are in the Global 200 list: (i) Northern Indochina Subtropical Moist Forests, (ii) Annamite Range Rain Forests, (iii) Cardamom Mountains Rain Forests, (iv) Indochina Dry Forests, (v) Peninsular Malaysian Lowland and Montane Forests, and (vi) Kayah-Karen Montane Rain Forests. A seventh ecoregion, Eastern Himalayan Broadleaf and Conifer Forests, overlaps with the northwestern corner of Myanmar.

■ **Upper:** Intact rain forest canopy in the Bach Ma National Park, Viet Nam. **Lower:** Kaeng Krachan National Park in the Tenasserim Range, Thailand.

Forestlands

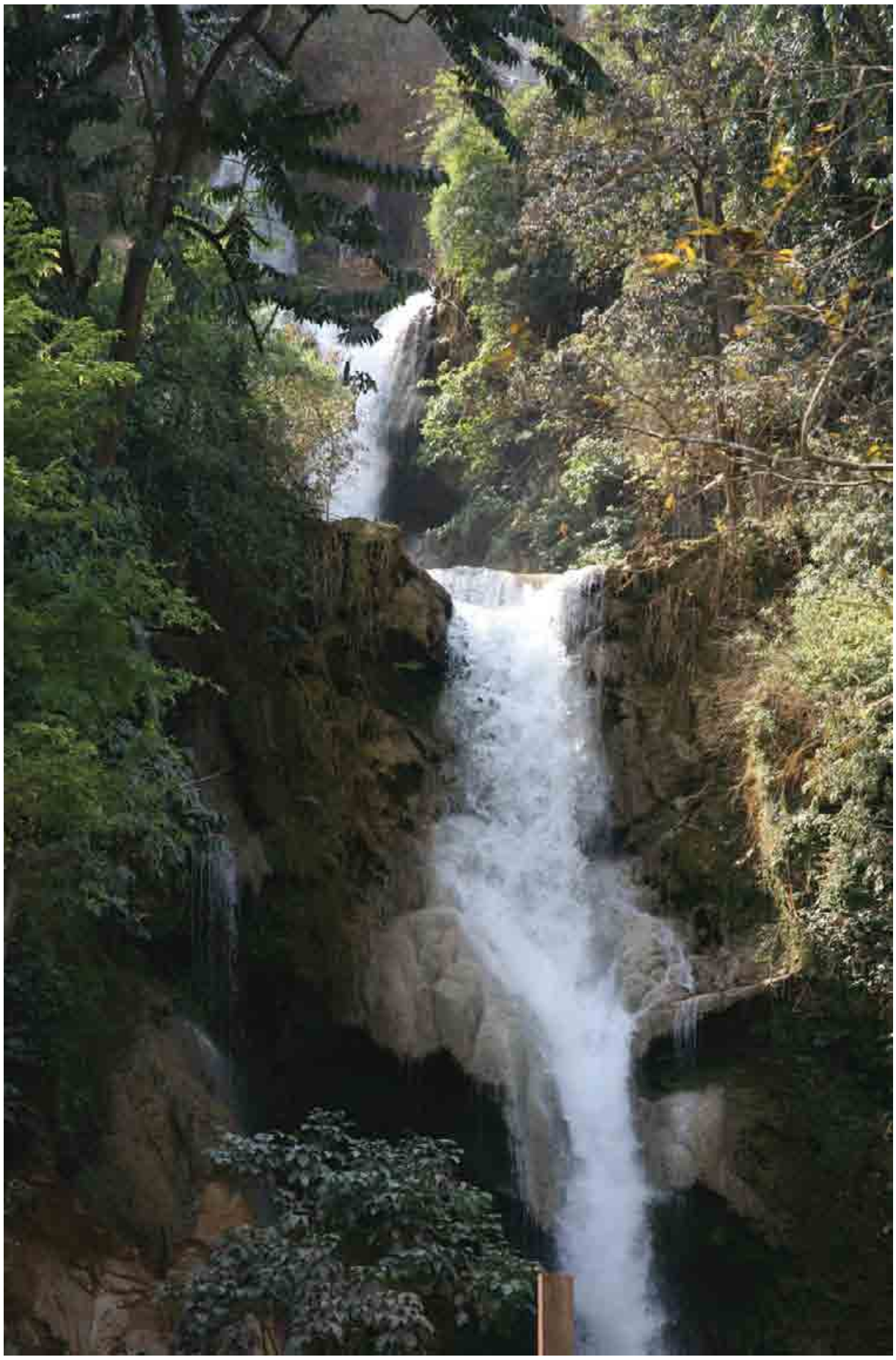
The forests of the GMS are simultaneously among the richest forests in the world for biodiversity and among the most threatened with destruction. Although more than 100 species per year on average have been discovered in the GMS since 1997, almost 6 million hectares of forest have been lost in the GMS countries, excluding the PRC, since 1997.

This richness in biodiversity is considered to be a result of the climate changes that took place during the last ice age, when sea levels were lower and tropical forest species were able to migrate and survive in the land that is now covered by sea between Thailand, Malaysia, and Indonesia, while more temperate forest species invaded the cooler mountainous areas. As the climate warmed, the tropical forest with all its associated biodiversity recolonized most of what is now the GMS. The recent more rapid phase in climate change attributed to human activities is also reported to be affecting the ecology of the subregion and changes in the frequency of storms and periods of drought combined with rising temperatures and melting of glaciers in the Himalayas, are all affecting the ecology of the subregion as well as agricultural productivity.

Forest Cover and Type, 2010

	Total Land Area	Primary Forest	Other Naturally Regenerated	Forest Plantation	Total Forest		Relative share of GMS forestland
Country	**'000 ha**	**'000 ha**	**'000 ha**	**'000 ha**	**'000 ha**	**%**	**%**
Cambodia	17,652	322	9,703	69	10,094	57.2	8.6
PRC							
Guangxi	23,670	—	—	2,573	13,427	56.7	11.4
Yunnan	39,414	—	—	3,268	18,177	46.1	15.4
Lao PDR	23,680	934	10,650	224[a]	11,808	49.9	10.0
Myanmar	65,755	3,192	27,593	988	31,773	48.3	26.9
Thailand	51,089	6,726	8,261	3,986	18,972	37.1	16.1
Viet Nam	31,008	80	10,205	3,512	13,797	44.5	11.7
Subregion	**252,268**				**118,048**	**46.8**	**100.0**

- = not available, ha = hectare, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
[a] including rubber plantation
Source: National Bureau of Statistics of China. 2011. *China Statistical Yearbook 2011*. Beijing; FAO. 2010. *Global Forest Resources Assessment 2010*. Rome. http://www.fao.org/forestry/fra/fra2010/en/; Guangxi Forestry Department. *Report on the State of the Environment, Guangxi*. Beijing.



Upper right: Rubber tree seedling in a new plantation, Champasak, Lao PDR.
Lower right: Flower of red torch ginger in the Western Forest area, Thailand.
Left: Kouang Xi Waterfall, Lao PDR.

At the opening of the 20th century, forests covered about three quarters of the land surface of Thailand and it is reasonable to assume that they covered a similar proportion of the lower Mekong Basin, in Cambodia, the Lao PDR, and parts of the central highlands of Viet Nam. The vast majority of the population lived in the Mekong, Chao Phraya, and Red River deltas and coastal plains and practiced irrigated agriculture, while a minority of "hill tribes" lived in small scattered communities in the hill areas and practiced mainly shifting cultivation.

Forestlands of the subregion are under pressure from population growth, agriculture, mining, and infrastructure development. The resulting conversion of forest has gradually altered the landscape. Current estimates of forestland indicate just how much change has occurred.

In 2010, about 46.8% of the subregion was classified as forestland. The proportion of forestland varies from country to country, with Cambodia and Guangxi being more than 50% forested; Yunnan, the Lao PDR, Myanmar, and Viet Nam more than 40%; and Thailand only about 37%. The subregion has about 118 million hectares of forestland remaining. Myanmar has about 27% of this total, and each of the other countries has between 9% and 16%.

■ ***Terminalia myriocarpa*, the dominant tree species in the ravine seasonal rain forest of Xishuangbanna, Yunnan.**

Forestlands in the subregion, except Guangxi, Viet Nam, and Yunnan, declined over the decade 2001–2010. Viet Nam invested heavily in afforestation including rubber and reforestation during this period; Guangxi and Yunnan put a moratorium on logging, allowed degraded secondary forest to bounce back, and also invested heavily in industrial plantations. Average annual rates of decline varied from 2.9% for the Lao PDR to 0.9% for Myanmar and 1.3% for Cambodia. The average annual rate of increase was 0.1% for the subregion overall. However, it is believed that deforestation rates in some parts of the subregion in the late 1990s may have been as high as 2% per year.

The Food and Agriculture Organization of the United Nations (FAO) 2010 forest resource assessments, which include reforested areas and plantation forest, show that plantation forest makes up about 21% of all forestland in Thailand and almost 25% in Viet Nam. These plantations are predominantly monocultures of fast growing species that contribute little to biodiversity. Great variation in the area of planted forests and rates of establishment are evident across the subregion. Within the Asia-Pacific region as a whole, 80% of the expansion in planted forest between 2005 and 2010 took place in the PRC, where establishment averaged 2 million hectares per annum. In Guangxi, expansion of planted forest averaged 230,000 hectares per annum between 2000 and 2010. An increase in plantation area is indicative of increasing demand for wood products, and a declining wood supply from and condition of the natural forests.

Forest Species

The dipterocarp forests of the GMS, covering parts of Cambodia, the Lao PDR, Myanmar, Thailand, and Viet Nam characteristically contain tree species like *Dipterocarpus dyeri, D. corbatus, D. Alatus, Anisoptera cochinchinensis, Hopea adorata, H. pierrei, Roherea vulgaris,* and

■ **Left:** Huge buttress of ***Tetrameles nudiflora*** **in Kaeng Krachan National Park, Tenasserim, Thailand. Right: Woody liana of *Ventilago calyculata*.**

Syzygium species; along with dryland forests and dry, deciduous dipterocarp forest species, such as *Dipterocarpus intricatus, D. obtusifolius, Shorea obtusa, Terminalia tomentosa,* and *Shorea siamensis*. Dry dipterocarp forests occur in shallow, often laterite, soils, and trees have a comparatively small diameter, the crown is not widely spread out, and trees reach heights of 8–25 meters. On the poorest and shallowest soils, trees are crooked and do not exceed 10 meters in height. In contrast, in the dry evergreen forests, two or three species tend to dominate, tree heights in the upper layer usually exceed 30 meters, tree density in the lower layer prevents most sunlight from penetrating to the ground, and there are climbers and lichens on tree stems. Some typical species of this forest type are *Hopea* species*, Pterocarpus pedatus, Dipterocarpus alatus*, and *Anisoptera* species.

Spectacular seasonally flooded forests occur around Tonle Sap, Cambodia. At higher elevations, 200–2,000 meters, there are coniferous forests in Kirirom in Cambodia and the Central and Northern Annnamites bordering the Lao PDR and Viet Nam, dominated by two pines (*Pinus kesiya* and *P. merkusii*) and sometimes other coniferous trees like *Cunninghamia* species. Bamboo is common in evergreen rain forests and deciduous stands from lowland to mountainous areas in Thailand and Viet Nam. Some species, such as *Bambusa stenostachya,* can tolerate flooding for up to one month. Coastal areas in GMS countries feature extensive mangrove forests, mainly of *Avicennia* and *Brugiera* species.

The tropical rain forests of Xishuangbanna in Yunnan are seasonal and stratified in three tree layers, reaching up to 35–45 meters high. Ravine seasonal forests are characterized by *Pometia pinnata,* large buttresses of *Tetrameles nudiflora*, and woody lianas of *Ventilago calyculata (denticulate)* Another famous tree species, *Shorea wantianshuea*, occurs in dipterocarp forests in this area, reaching 60 meters high.

Forest Ecosystem Services

Non-timber forest products (NTFPs). In Cambodia 70–90% of households are engaged in collection and trade in forest products in areas with evergreen and semi-evergreen forests, despite the pressure from logging and economic concessions. In addition fuelwood is widely collected throughout the region for domestic use and is the primary source of energy. Resin collection, hunting and other NTFPs accounted for almost half of household income in Mondulkiri, Cambodia and loss of the income from these trees due to logging or clearance for economic concessions was a major catastrophe for the households concerned. In Lao PDR, most villagers relied on NTFPs for their livelihoods, but that availability has been declining. Honey and herbs have retained their level of availability over the past three decades, leaves and fruit have declined slightly, birds and wildlife have declined more severely, and timber is no longer available. In Viet Nam, NTFPs provide about half the annual income for households living in or near protected areas in the Central Annamites, worth around $300.

Soil and water conservation. These services are site specific, since they depend on the proportion of an upper river basin that is protected from soil erosion and the current land use, which determine both the quantity of the soil loss that can be avoided and the scale of the overall impact on the seasonal distribution, quality and quantity of water supply within the river basin. In communes or villages located in the upper reaches of an important river basin, the management of the land will have a direct impact on the downstream river flow and water quality, but the magnitude of the benefit will vary from one commune or village to another. However, loss of topsoil due to erosion is an avoidable cost in the form of reduced agricultural output or increased input costs and to downstream water users in the form of increased suspended solids. These later take the form of increased siltation of reservoirs, increased damage to hydro-generator turbine blades, increased costs of water purification and increased costs for cleaning up after flash floods. As an example, for Huong Linh Commune in Viet Nam, it is estimated that reforestation of about 150 hectares will reduce the loss of soil by around 4,400 tons annually, with a replacement value of about $1,600 annually.

Carbon sequestration and climate change mitigation. These services are more easily quantified, since carbon has a market value and the quantity of carbon that can be sequestered can be assessed relatively easily. At the local level, as for example in Huong Linh Commune in Viet Nam with about 2,600 hectares of medium to low density forest, it is estimated that the value of the carbon sequestered will vary over time, but has an average value of about $2,200 annually. In the Lao PDR, at the landscape level within the Biodiversity

Previous page: Stilt roots in the limestone forest landscape in Xishuangbanna, Yunnan. **Upper:** Earning a living from non-timber forest products in Champasak, Lao PDR. **Lower:** Heavy silting of the Song Bung River in central Viet Nam.

Forest Cover in the
Greater Mekong Subregion, 2010
Major GMS forest ecoregions
Closed forest
Open or deciduous forest
Forest mosaic
Mangrove or swamp forest
No forest
0
125
250
500 Kilometers
Boundaries are not necessarily authoritative.
Data source: GMS EOC (Class aggregation based on ESA GlobCover V2.3), WWF Terrestrial Ecoregions, UN FAO GAUL, NASA SRTM

Conservation Corridor, prevention of further decline in about 150,000 hectares of intact forest and its protection to allow natural regrowth will result in a net sequestration of around 100,000 tons annually of carbon dioxide in the short term, rising to over 200,000 tons over the next two decades. In Mondulkiri Province in Cambodia, which still has a large forest area, carbon sequestration is relatively high, and protection of about 700,000 hectares will result in a net sequestration of around 300,000 tons of carbon dioxide annually in the short term, rising to over 1 million tons by 2020. With the current price of carbon dioxide conservatively taken at $5 per ton the annual value of the carbon sequestered is about $1.5 million, rising to over $5 million. The net present value of the carbon sequestered over the next 40 years at 12% is estimated at just over $180 million even with a very small differential in the rate of reduction of the forest, because of the large area.

Forest Cover

Forest cover maps help us assess and monitor changes in land use and forest cover over time. These maps underpin studies on biodiversity and conservation to gauge the sustainability of forest ecosystems.

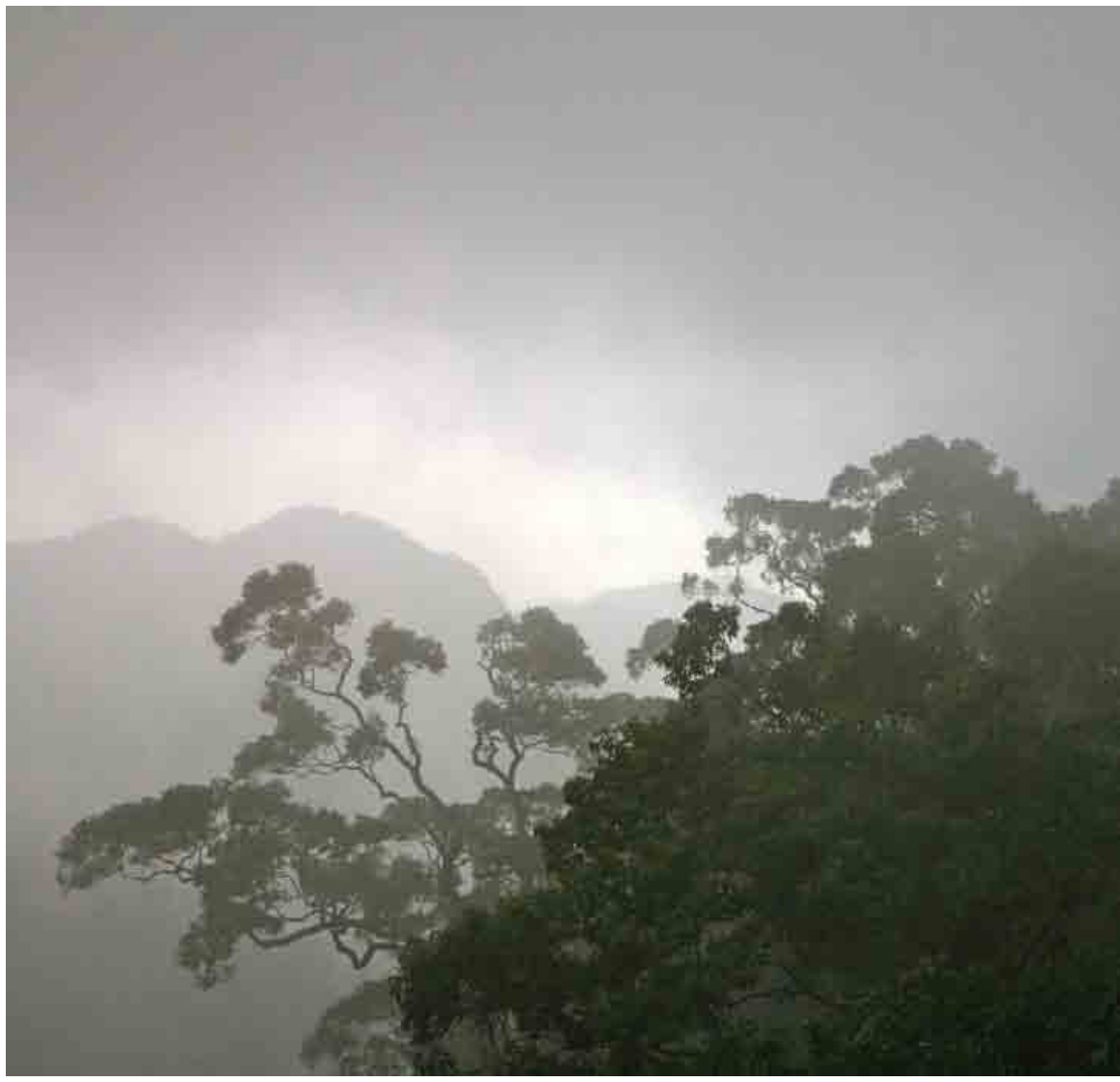
The subregional forest cover map is based on a global forest cover map for Asia produced by FAO during a global assessment of forest resources. The most recent assessment for the reference year 2010 was conducted to estimate forest area, forest conditions, and the rate of change in some important parameters, such as area and forest type. This forest cover map provides another perspective on forests in the subregion. It distinguishes between closed forest and open (and fragmented) forest. While large areas of closed forest still exist, these areas are interspersed with areas of fragmented forest. The main agricultural areas (Red River Delta, eastern Viet Nam, Mekong Delta, area around Tonle Sap, Khorat Plateau, Chao Phraya Delta, and much of the Ayeyarwady watershed) are clearly visible as "other land cover" on the map.

Forest Trends

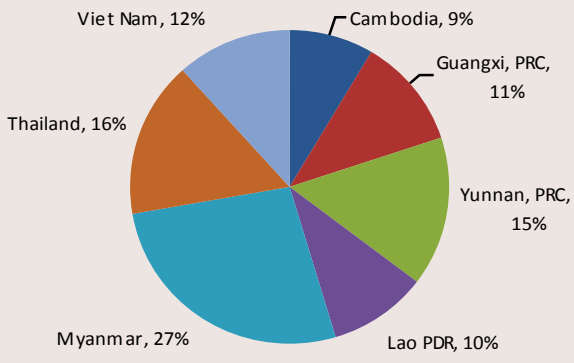
Country	Land Area '000 ha	Total Forest 2000 '000 ha	Total Forest 2010 '000 ha	Annual Forest Cover Change 2000–2010 Annual Change '000 ha	Annual Forest Cover Change 2000–2010 Annual Change rate %
Cambodia	17,652	11,546	10,094	-145	-1.3
PRC					
Guangxi	23,670	9,819	13,427	361	3.7
Yunnan	39,414	12,873	18,177	530	4.1
Lao PDR	23,680	16,532	11,808	-472	-2.9
Myanmar	65,755	34,868	31,773	-310	-0.9
Thailand	51,089	19,004	18,972	-3	0.0
Viet Nam	31,008	11,725	13,797	207	1.8
GMS	**252,268**	**116,367**	**118,048**	**168**	**0.1**

ha = hectare, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China

Source: FAO. 2010. *Global Forest Resources Assessment 2010*. Rome; Guangxi Forestry Department. *Report on the State of the Environment, Guangxi*. Beijing; Yunnan Bureau of Statistics. Yunnan Statistical Yearbooks 2001 and 2011. Beijing.

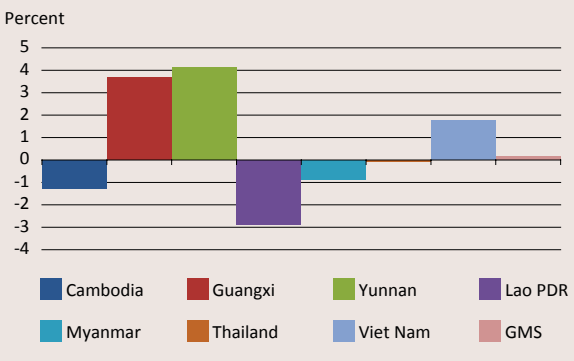


Relative Shares of GMS Forestland



GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China

Average Annual Percentage Change in Forestland Area, 2000–2010



GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic

Upper: Rain forests of the central Annamites, Viet Nam. **Lower:** Swidden cultivation on steep slopes near Luangprabang, Lao PDR.

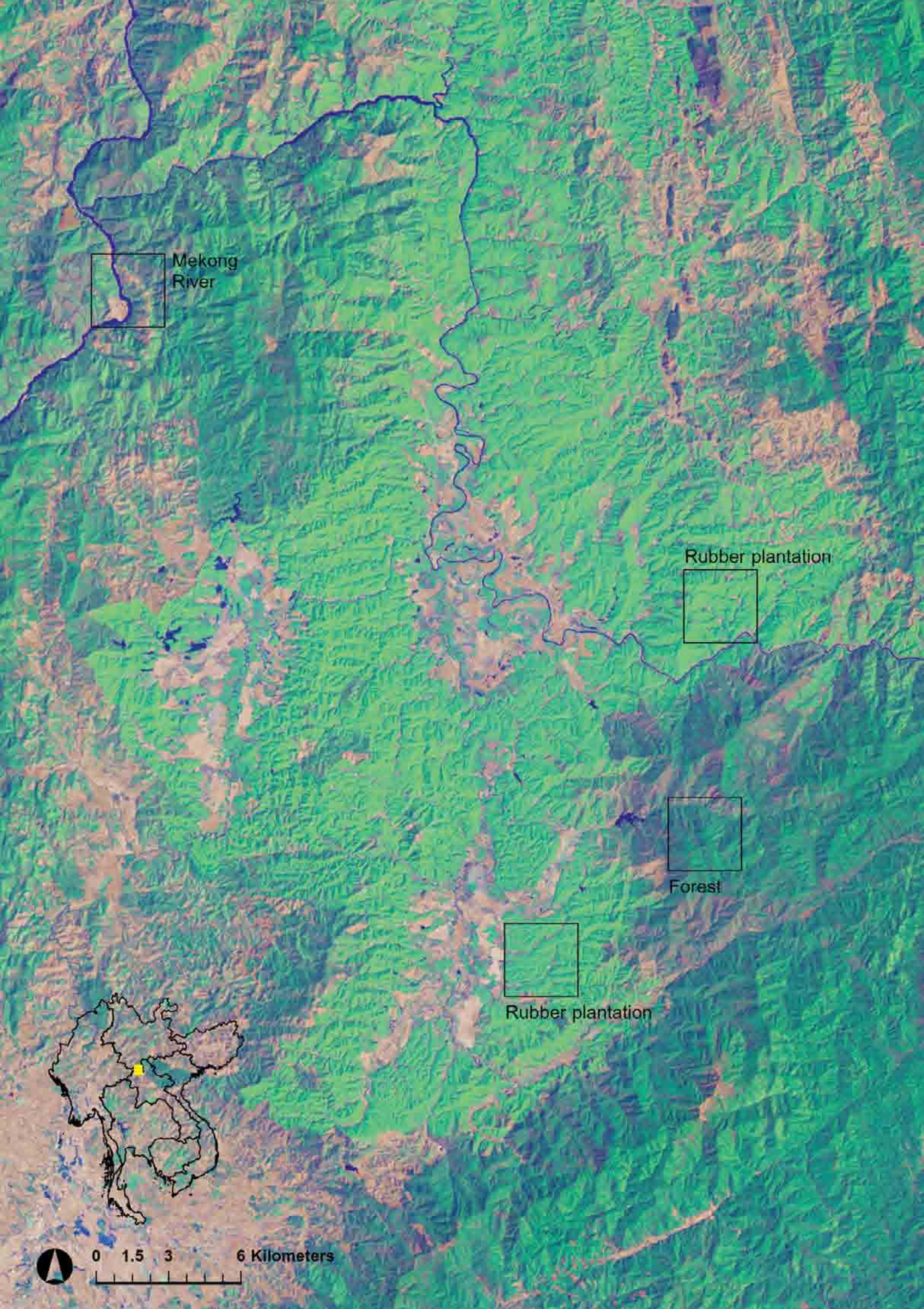
Mekong River

Forest clearing

Forest

Forest clearing

■ **Expansion of rubber plantations in Xishuangbanna, Yunnan, PRC, from 1988 (left) to 2011 (right).**


Mekong
River
Rubber plantation
Forest
Rubber plantation
0 1.5 3 6 Kilometers

Terrestrial Ecoregions of the Greater Mekong Subregion

Boundaries are not necessarily authoritative. Terrestrial ecosystem labels follow the spelling of the data source.
Data source: WWF Terrestrial Ecoregions, GMS EOC, UN FAO GAUL, NASA SRTM

0 87.5 175 350 Kilometers

Forest Ecoregions

Northern Indochina Subtropical Forests. The Northern Indochina Subtropical Forests are globally exceptional for their biological diversity. This ecoregion has the second highest species richness of mammals in Asia and has a diversity of tree species comparable to the humid tropical forests of Malaysia. The highest level of endemism of some plants, mammals, and birds can be found in this ecoregion. It has the richest and most intact subtropical forest in Asia.

The ecoregion extends across the northern Myanmar highlands, the southern part of Yunnan, where the tropical forests of Xishuangbanna are found, Thailand, the Lao PDR, and Viet Nam. An intricate system of hills and rivers stretches south of the Yunnan Plateau to include the middle catchment areas of the Red, Mekong, and Thanlwin rivers.

The whole of the northern subregion has a summer monsoonal climate and a yearly precipitation of 1,200–2,500 millimeters on average. Mean temperatures differ depending on elevation, but the hottest time of the year occurs before the rainy season, and the coldest in January. Frost forms at higher elevations, although infrequently. The cool winters and high elevation support the growth of montane plants. Well-developed montane deciduous forests are found on the Shan Plateau in northern Myanmar.

About 183 mammal species, 4 of them endemic and 5 near-endemic, and 707 species of birds, including the near-endemic short-tailed scimitar babbler, occur in this ecoregion.

Twenty-seven protected areas, totaling 15,948 square kilometers, make up 5% of the ecoregion. Most protected areas are small (590 square kilometers on average) and are found in northern Viet Nam. The biggest areas are mostly in the Lao PDR.

Land clearing for shifting cultivation, poppy farming, logging, and extensive illegal hunting for food and income pose the greatest threats to the biodiversity of this ecoregion.

Annamite Range Rain Forests. This ecoregion is composed of two of the WWF ecoregions—the Northern Annamites Rain Forests and Southern Annamites Montane Rain Forests. These forests, insulated by their unique geography from major climatic changes worldwide, sustain one of the world's rarest and most diverse ecosystems of plants and animals. The forests are situated along the border between the Lao PDR, Cambodia, and Viet Nam. In these relatively intact rain forests are several endemic species of mammals and birds and some endangered and threatened species. Four large mammal species discovered only in the last 20 years can be found in the area.

Upper: Big woody lianas in the rain forest of Xishuangbanna, Yunnan. **Lower:** A cultivated *Musa* (red flower musa).

■ **Top:** Gaur. **Middle:** Pileated Gibbon. **Bottom:** Sun Bear.

The saola, which belongs to a distinctive branch of the cattle and antelope family, was discovered in 1992; the large-antlered muntjac, a new deer species, in 1994; and another, smaller muntjac, the Annamite striped rabbit, in 1997, and the Laotian Rock-rat, member of a family formerly only known from ancient fossils, found in 2005. Globally, such discoveries are very rare events and to have six in such a short period in one area is truly exceptional. The forests are home to threatened species like the Indochinese tiger, the Asian elephant, and the douc langur. Some bird species, such as Edward's pheasant and the orange-necked partridge, both endangered, are found only in this ecoregion.

Threats to the biodiversity of the ecoregion come from increased legal and illegal logging, the construction of dams, agricultural expansion, mining, and intensive illegal hunting.

Cardamom Mountains Rain Forests. The Cardamom Mountains Rain Forests lie across the Cardamom Mountains and the Elephant Range, extending from southwestern Cambodia into southeastern Thailand. They are separated from other rain forests by the Khorat Plateau in Thailand to the north and east and by the Gulf of Thailand to the west. Although largely unexplored, this ecoregion is considered one of the most species-rich and undisturbed natural habitats in the subregion.

The mountains are very wet and rise from sea level to more than 1,500 meters, collecting moisture from the monsoon winds. Average annual rainfall can reach around 5,000 millimeters in some areas, resulting in a rain forest dense with plant life. At lower elevations, trees grow as high as 30 meters, allowing light to pass through to support a mid-canopy of palms and rattans. Shrubs, climbers, and lianas are abundant in the dense understory. The upper montane forests are less rich but sustain dwarf rain forest trees half as tall as those found at lower elevations.

More than 100 mammal species, none of them known to be endemic, thrive in the ecoregion. There are threatened species, the Asian elephant, the clouded leopard, the wild dog or dhole, the gaur, the banteng, the pileated gibbon, and the serow. Two bird species found nowhere else in the world are among the 450 bird species in the ecoregion.

Sixteen protected areas covering about 14,500 square kilometers, or 33% of the whole ecoregion, have been identified. Six of these areas—Aural, Phnom Bokor, Botum-Sakor, Roniem Daun Sam, Khao Ang Ru Nai (in Thailand), and Phnom Samkos—exceed 1,000 square kilometers. Phnom Samkos National Park is larger than 3,000 square kilometers. Phnom Kirirom in Cambodia is also in the Cardamom ecoregion.

The sparsely peopled forests of the Elephant Range and the Cardamom Mountains in Cambodia are rapidly seeing development of settlements, hydropower, mining, and cash crops in an industrial scale. Some large tracts of forests still remain relatively intact, but forest areas in southeastern Thailand have been greatly reduced and exist in only a few protected areas.

Illegal logging, even in the protected areas, threatens the ecoregion's biodiversity. Wildlife trade has also caused excessive capture of animals throughout Cambodia and Thailand. Construction of dams and roads, mining operations, and agricultural expansion are also taking their toll.

Indochina Dry Forests. This ecoregion is composed of two WWF ecoregions, the Central Indochina Dry Forests and Southeastern Indochina Dry Evergreen Forests. The dry, open, deciduous forests are interspersed with evergreen forest patches, where soils or rainfall permit it. Significant to some of the most characteristic large mammals and waterbirds are ponds and wet pastures of varying sizes.

The Central Indochina Dry Forests cover most of the center of the subregion, with its flat to slightly undulating terrain and hills generally no higher than 200 meters. The ecoregion stretches widely in Thailand, from the dry lower slopes in the northern part and the foothills of the Tenasserim Range to uplands of the Chao Phraya Basin and across the Khorat Plateau. It extends along the broad valley of the Mekong River and its tributaries in central and southern Lao PDR and over the seasonally arid, seasonally flooded plains of northern, eastern, and south-central Cambodia.

These forests support about 167 kinds of mammals, of which two species of Vespertilionidae bats are endemic. Moreover, there are many threatened large vertebrates characteristic of tropical Southeast Asia as a whole. These include Eld's deer, tiger, Asian elephant, gaur, banteng, wild water buffalo, serow, and other species like the pileated gibbon, the Indochinese silvered leaf monkey, dhole, Malayan sun bear, clouded leopard, and common leopard.

The more than 500 bird species in the ecoregion include threatened species, such as the green peafowl, the greater adjutant, the giant ibis and the white-shouldered ibis.

Sixteen protected areas, which cover more than 15,000 square kilometers, compose 6% of the ecoregion. Four (Phu Kao-Phu Phan Kham, Xe Piane, Phnom Prich, and Yok Don) exceed 1,000 square kilometers, and three (Kulen Promtep, Lomphat, and Mondulkiri Protected Forest) exceed 2,000 square kilometers. Most of these protected areas are in Cambodia and the Lao PDR and have intact natural habitat.

Under increased population pressure, forests in this ecoregion have been converted to farms and settlements. Forest fires are often set to clear

land for cultivation or for livestock pasture, and to make wildlife hunting easier. Parts of the ecoregion in Cambodia, the Lao PDR, and Thailand are threatened by hydropower development and growing tourism.

Peninsular Malaysian Lowland and Montane Forests. The Peninsular Malaysian Lowland and Montane Forests include two WWF ecoregions—the Peninsular Malaysian Rain Forests and Peninsular Malaysian Montane Rain Forests. They cover the montane forests in Peninsular Malaysia and the extreme southern part of Thailand. The ecoregion is warm and has abundant rainfall all year round. It is composed of many distinct montane habitats where the trees are smaller than those in the lowlands. Oaks and chestnuts dominate the lower elevations and rhododendrons can be found in the upper montane areas.

Most remaining forests of the ecoregion are found only in high, steep areas and only two thirds are still intact. Four protected areas comprise 5,120 square kilometers, or 30% of the whole ecoregion.

The ecoregion contains more than 200 mammal species, including nearly 100 bats and an endemic rodent species. There is also a tiger population consisting of 300–650 Indochinese tigers, highly threatened. The smallest rhinoceros, the Sumatran rhinoceros, is also found in these forests. This species was once scattered all over Southeast Asia but now the 500 or so of them that remain are believed to be found only in Borneo, Peninsular Malaysia, and Sumatra. Other endangered species living in these forests include the Malayan tapir, the Asian elephant, and the gaur.

More than 250 bird species are present in this ecoregion, of which 75 are found only in montane forests and two are classified as threatened: the mountain peacock-pheasant and the crested argus.

Intensive logging in both uplands and lowlands, despite the rugged terrain, endangers biodiversity in the area. Other threats are the conversion of lowland forest to farms and cities, tourism, and roads.

Kayah-Karen Montane Rain Forests. The Kayah-Karen Montane Rain Forests cradle a rich diversity of plants, birds, mammals, and amphibians. The ecoregion is one of the richest in forest animal life in the subregion, second richest in bird species, and fourth in mammal species. Even greater biological variety is expected when more of the ecoregion is surveyed.

This ecoregion lies in the northern part of the Tenasserim Mountain Range, on the border between Myanmar and Thailand. Most of it is rugged, folded, and composed of Paleozoic

Upper: Dry season water flows in a stream in the Cardamom Mountains, Koh Kong, Cambodia. **Lower:** Rufous-necked hornbill, a vulnerable species in the GMS.

Upper: The Biodiversity Conservation Corridor landscape in the Tenasserim Range, Thailand. **Lower:** Sarus crane, the largest flying bird species; vulnerable to extirpation in the GMS.

limestone with overhanging cliffs, sinkholes, and caverns. Plants and animals living in these forests have distinct characteristics and some are unique to the area.

The region has an average annual rainfall of 1,500-2,000 millimeters and a monsoonal climate with a warm, moist summer and a mild, dry winter. The Myanmar side (west-facing slopes) receives more rain than the Thailand side (east-facing slopes), and the difference between these areas is reflected in their vegetation. Forests in the west are abundant with deciduous and evergreen species while dry deciduous trees dominate the east side.

The ecoregion harbors 168 species of mammals, one of which, the tiny Kitti's hog-nosed bat, is endemic in the area, particularly in the limestone caves of western Thailand. This bat, weighing about 2 grams with an 8-centimeter wingspan, is the smallest mammal in the world.

The relatively intact and contiguous habitat in these forests makes them a potential area for the conservation of threatened species like the tiger. Most of Thailand's biggest wildlife reserves and several protected areas are in this ecoregion. Thailand's Huai Kha Khaeng Wildlife Sanctuary, which has an area of 2,575 square kilometers, is endowed with a high diversity of cat species, intact vertebrate communities, and intact lowland dipterocarp forests.

With 568 bird species, the ecoregion ranks high in avian diversity. Two species, the Deignan's babbler and the Burmese yuhina, are endemic in the area.

Almost one third of the forests has been cleared or degraded because of shifting cultivation and settlement. However, 20% of the ecoregion (23,500 square kilometers) is given over to 28 protected areas. These have an average size of 725 square kilometers, although some, like Thailand's Huay Kha Khaeng-Thung Yai Naresuan Reserve complex and Omgoy-Mae Ping-Mae Tuen Reserve complex, are much more extensive.

Fauna

Recent discoveries of new species (such as the saola, a forest dwelling ox, found in the Annamites in 1992) and the dedicated search for the elusive kouprey have captured the imagination of conservationists worldwide and heightened global awareness of the need to conserve the biodiversity of the subregion. Biological surveys continue to turn up new discoveries, emphasizing the region's high concentration of unique plants and animals. Some 549 new animals, including 15 mammals, were identified in WWF surveys in the subregion

from 1997 to 2007 and a further 63, including a new monkey species, in 2010. These surveys also highlight the fact that the subregion is home to some of the world's most threatened species. While a few have become extinct (such as Schromburk's deer, the pink-headed duck, and the white-eyed river-martin), most species are still relatively widespread in the subregion. However, wildlife populations are coming under high and increasing pressure from growing human populations, infrastructure development, and extraction for international markets. Many species of large mammals are extinct or close to extinction in several countries. These include the tiger, banteng, wild water buffalo, Eld's deer, and Javan and Sumatran rhinoceroses. Other threatened groups include large water birds (such as cranes, storks, ibises, and pelicans), pheasants, large foragers (hornbills, imperial pigeons), freshwater turtles, and large migratory fish.

Asian Elephant *(Elephas maximus)*. The Asian elephant is the largest land mammal species in the subregion, growing to about 6.5 meters long and 3 meters high. Adult males weigh about 5 tons; females, 3 tons. They live for about 40 years. While some significant populations are believed to survive, the species is nearing extinction in the wild in many areas. The animals need space, preferring tropical grassy plain and rainforest habitats. Deforestation and human encroachment have led to widespread habitat loss. Calves of Asian elephants are also kidnapped for use as beasts of burden, especially in the logging trade.

Banteng *(Bos javanicus)*. Considered one of the most beautiful kinds of wild cattle, the banteng is an endangered species found mostly in Cambodia, Myanmar, and Thailand. It looks similar to an ox, only larger. It has white "stockings" on its legs, a white rump, a white muzzle, and white spots above the eyes. The banteng prefers to live in open, dry, deciduous forest, although in Borneo, some dwell within evergreen forests. This huge animal is very timid and retiring and feeds at night in areas where humans encroach. Bantengs usually roam in herds of one bull and several cows and calves. Some bulls stay alone and join the herds only during the breeding season. Bantengs are known to be grazers but they also consume available leaves and fruits. They live up to 20–25 years.

A rapid decline in their population was observed in the early 1990s. By 2010, recent surveys in the Eastern Plains in Cambodia confirm previous estimates by IUCN (2000) of their numbers ranging between 5,000 and 8,000. Hunting and loss of habitat endanger their existence. Interbreeding with domestic and other cattle threatens the genetic integrity of the banteng.

Upper: Banteng, wild cattle species, Cambodia. **Lower:** Muntjac, Thailand.

■ **Upper:** The iconic and endangered Indochinese tiger in Huai Kha Khaeng Wildlife Sanctuary, Thailand. **Lower:** Red-shanked Douc (*Pygathrix nemaeus*).

Douc Langur *(Pygathrix)*. Douc langurs of the genus *Pygathrix* are native to Southeast Asia. Up until only a few years ago, two distinct taxa were recognized—the red-shanked and the black-shanked douc langur. Between August 1995 and January 1998, however, six male specimens of the new and distinctive grey-shanked douc langur *Pygathrix cinereus* were found, some confiscated by Vietnamese wildlife authorities and the others donated by private individuals and placed in Cuc Phuong National Park. The animals had evidently originated in the southeastern part of Viet Nam's Central Highlands where field primatologists had also identified wild populations of the same description in a region occupied by red- and black-shanked monkeys. Wild populations of the three doucs have been reduced to small numbers by habitat loss and hunting. While Cambodia and the Lao PDR may have more sizeable populations of the red-shanked and black-shanked douc, the newly discovered *Pygathrix cinereus* is known only from Viet Nam and is considered the most critically endangered species.

Indochinese Tiger *(Panthera tigris corbetti)*. The Indochinese tiger is found in Cambodia, southern PRC, the Lao PDR, Myanmar, Thailand, and Viet Nam. It is one of only five surviving tiger subspecies in the world, all of which are endangered. Only about 880–1,200 Indochinese tigers are left in the wild. Tigers thrive in remote forests and hilly, mountainous terrain. As predators, tigers also depend on other animals like wild pigs, cattle, and deer to survive. Habitat destruction, along with the loss of their prey species, threatens the tiger's survival. Another big threat comes from the ancient belief that a tiger's body parts can give humans the potency of this animal, driving a very high demand in the trade for traditional medicines.

Kouprey *(Bos sauveli)*. Its name literally means "forest bull" in Khmer, but the kouprey is more commonly known as the Cambodian forest ox, and is the Cambodian national animal. First discovered in 1937, the kouprey is a gray forest ox with frayed horns and a long dewlap. Koupreys are found in small numbers in northern and eastern Cambodia, and have also been known to exist in the southern Lao PDR, eastern Thailand, and western Viet Nam, although sightings anywhere are rare. Koupreys inhabit low, rolling hills with patches of dry forest, near denser monsoon forests. They live in herds of up to 20, grazing in open areas by night and entering the forest for shelter from predators by day.

The kouprey has always been rare. However, the destruction of its habitat by shifting cultivation, logging, and warfare, along with hunting and disease, has severely affected it. By 1970, there were fears that the species might have become extinct. At most, there could only be a few koupreys remaining, certainly less than 250 mature individuals.

Saola *(Pseudoryx nghetinhensis)*. The saola, also known as the Vu Quong ox, is an endangered, nocturnal forest-dwelling ox weighing about 100 kilograms. Its habitat is

■ **Upper:** Siamese crocodile. **Lower:** The most elusive Saola.

the dense montane forests in the Annamite Mountains, which run through the Lao PDR and Viet Nam. It is thought to be restricted to a 4,000-square kilometer area along the border between Viet Nam and the Lao PDR. The saola is generally considered the greatest animal discovery of recent times. First documented in Viet Nam in 1992, it is so different from any other known species that a separate genus had to be created for it. The classification of the saola has generated some controversy; different physiological and genetic studies classify it with goats, antelope, or cattle. Only 11 saolas have ever been caught. Much of what is known about them comes from villagers' tales and unearthed skeletons. The saola seems to prefer the edges of wet lowland and montane evergreen forests. Villagers say that it eats the leaves of fig trees and other bushes along riverbanks. The saola stays at higher elevations during the wetter summer season, when streams at these altitudes have plenty of water, and moves down to the lowlands in winter, when the mountain streams dry up. They are said to travel in groups of two or three animals, rarely up to six or seven. The animal has been classified as endangered by IUCN. Hunting and the loss of forest habitat due to logging and conversion to farmland threaten its survival.

Siamese Crocodile *(Crocodylus siamensis)*. The Siamese crocodile, also known as the softbelly crocodile, is an endangered species found in Cambodia, the Lao PDR, Thailand, and Viet Nam. It prefers to move in groups in slow-moving areas of freshwater, feeding on fish, amphibians, reptiles, birds, small mammals, and carrion. It grows to about 3 meters. The Siamese crocodile is not considered dangerous to humans, although it has been mistaken for its far more threatening cousin, the saltwater crocodile, which is larger and has a narrower snout. The Siamese crocodile has all but disappeared from many countries in the subregion, although a new population has been discovered in the Cardamom Mountains. Expectations for its survival are poor because it is under significant threat from poaching and habitat destruction.

■ **Upper:** The giant Mekong catfish. **Lower:** The Irrawaddy dolphin in the Tbong Kla pool in the Mekong River.

Fish of the Major River Systems. There are more than one thousand freshwater species of fish recorded from the Mekong Rivers, as well as about 250 species of coastal or marine origin. The number is expected to increase as more field studies are done and the system of classification improves. For instance, among 1,500 new species discovered in the subregion since 1997, over 279 new fish species were identified. The discovery of new species is especially likely in the mountain tributaries of the Lao PDR and Yunnan, where little or no research has been done. Only the Amazon River system of South America has greater fish diversity—about 2,000 fish species are found in a river basin roughly nine times the size of the Mekong. Many fish species found in the Mekong are also found in other rivers of the subregion. The Ayeyarwady, Thanlwin, and Red rivers, however, have endemic fish species not found in the Mekong. In fact, the Ayeyarwady River is more like the Ganges River in its fish species composition. Yunnan, through which all four rivers run, probably has the highest fish diversity of any region in the PRC.

Several fish species in the subregion's rivers are already endangered and, if protective measures are not taken soon, many more could become endangered. Perhaps the most famous endangered fish are the giant Mekong catfish and the giant barb, both of which can grow up to 3 meters long. The giant Mekong catfish is an important species endemic to the Mekong River system. One of the largest freshwater fish in the world, it can weigh more than 300 kilograms. The catfish migrate along the rivers to spawn in tributaries. The species has recently gained recognition because of the increasing threat posed to it by humans. Although listed as endangered, the fish are still caught and sold for meat in Cambodia, the Lao PDR, and Thailand. Because of its size, it is increasingly sought after by sport fishers.

The giant catfish and barb qualify for protection under the Convention on Biological Diversity (CBD) and the Convention on the Conservation of Migratory Species of Wild Animals (CMS). While all six countries represented in the subregion have signed the CBD, Cambodia and the Lao PDR have yet to ratify it, and none of the six have signed the CMS.

Another famous endangered "fish" in the subregion is a mammal, the Irrawaddy or Mekong River dolphin, whose numbers have fallen drastically over the past 3 decades. The Irrawaddy dolphin prefers to live near the coast and at the mouth of rivers. It also lives upstream in some tropical rivers. In Myanmar, Irrawaddy dolphins have been reported at Bhamo, 2,300 kilometers upstream from the mouth of the Ayeyarwady River. Freshwater populations are also found in the Mekong and Se Kong. A few years ago, Irrawaddy dolphins were a relatively common sight in rivers and waterways of the Lower Mekong and in Tonle Sap. Little is known about the dolphins, which grow up to 2.8 meters long and can weigh as much as 150 kilograms. A recent survey discovered a small population of 80 dolphins living in the stretch of the Mekong River from Cambodia's northeastern Kratie Province to the far northern border with the Lao PDR. These dolphins and their prey are seriously threatened by entanglement in gill nets, blast fishing, and the potential barrier effects and habitat degradation from planned dams. Although fishing, hunting, and increased river traffic have wreaked havoc on the dolphin's habitat, in some areas dolphins are considered sacred. And they are said to have a special relationship with fishers on the Ayeyarwady and Mekong rivers, helping fishers drive fish into their nets.

Action is being taken in some areas to protect critical fish habitats and, thus, fish production in the Mekong and other rivers of the subregion.

Some Buddhist temples in Thailand and elsewhere provide protection to small stretches of river habitat or wetlands, to ensure that some fish will survive each dry season to spawn and repopulate the river. Over the past decade, several local communities in Champasak Province, Lao PDR, have also established fish protection areas in the Mekong River, typically around the deep pools where many fish species seek refuge during the dry season.

■ **Upper:** Prek Toal Sanctuary in Tonle Sap, Cambodia, is home to a rich variety of water birds. **Lower:** Giant barb, a freshwater fish in the Mekong and Chao Phraya rivers.

■ **Left:** Dugong. **Right:** Coral reef, Thailand.

Marine Biodiversity

The waters around the GMS—the Andaman Sea and South China Sea—are largely tropical; they support several kinds of marine mammals and turtles, hundreds of fish and coral species, dozens of species of macroalgae (seaweeds and seagrass) and innumerable invertebrates, particularly crustaceans like crabs and shrimps; mollusks like clams, oysters, and mussels; and echinoderms like sea cucumbers, sea urchins, and starfish.

Among the marine mammals, populations of dugongs occur in the Andaman Sea in Myanmar, especially in Rakhine State, and in Trang Province of Thailand, totaling about 200 individuals. There is also a population of about 50 dugongs in the Gulf of Thailand. Dugongs are hunted for meat or caught in trawl nets. Dugongs were formerly abundant in Cambodia and Viet Nam but nowadays are rarely sighted. Their survival in the subregion is threatened not only by hunting but also by disturbance or degeneration of beds of seagrass, their main food.

The subregion holds many kinds of cetaceans—whales and dolphins. Surveys have shown the presence of the short-finned pilot whale and a large rorqual whale, spotted dolphin, striped dolphin, spinner dolphin, Indo-Pacific humpback dolphin, bottlenose dolphin, finless porpoise, and Irrawaddy dolphin. Interestingly, 16 cetacean species are known from Viet Nam waters from their bones but few species are seen there now.

Five of the world's seven marine turtle species—hawksbill, green, loggerhead, olive Ridley, and leatherback—are found in the waters of maritime GMS countries. All five are known to feed and/or nest along the coastal regions of the Andaman Sea and most species nest on coastal beaches of Thailand, including the inner Gulf of Thailand, and Cambodia and Viet Nam. However, populations in most places have been decimated by hunting or habitat disturbance.

The total number of marine fish species in the subregion has not been assessed. Surveys at different times have recorded over 800 species in Myanmar, 520 in Cambodia, 880 in Thailand, and a remarkable 2,458 in Viet Nam. All are probably underestimates, given the paucity of surveys and cryptic behavior of many species, but the total is somewhat less than in the Coral Triangle in the southwestern Pacific Ocean, which contains the world's highest marine biodiversity, including some 3,000 fish species.

Elasmobranchs—sharks and rays—are far fewer in number, with 36 species known from Myanmar's waters and 41 in Cambodia, and similar numbers likely in Thailand and Viet Nam. Some 15 shark species are caught as by-catch in commercial and small-scale fishing activities around the GMS coastline. They are also targeted for their fins, which are used for making a specialty soup, with the result that some species are now endangered in the subregion.

Beds or meadows of 9–14 species of seagrass are scattered throughout the coastal zones of the five maritime GMS countries, ranging from 28 square kilometers in Cambodia to 40 hectares in Guangxi.

Coral reefs exist in all five countries. Thailand, for example lists around 420 coral reefs in its waters. Those in the Gulf of Thailand have 388 coral species while 645 species are recorded from the more remote Andaman Sea reefs.

Offshore reefs in Cambodia similarly have higher coral diversity than inshore reefs. Guangxi is at the northern end of coral distribution in the South China Sea and only 45 species of reef building corals are found on the few fringing reefs there. Offshore from Guangxi is Hainan Island, which holds 98% of all the coral reefs in the PRC. However, more than 90% of PRC coral reefs are said to have been totally or partly destroyed. The reefs of Guangxi, Thailand, and Viet Nam face the most severe threats from destructive fishing (dynamite and poisoning); overfishing; sedimentation from river outflows; pollution from land sources, including agriculture, industry, and domestic sources; and coral bleaching from high water temperatures, possibly associated with climate change. In Viet Nam, 85% of the coral reefs face such threats; reefs in Myanmar are healthier due to lower levels of both fishing and onshore activities.

Coral Bleaching in Thailand

Coral bleaching is a process during which coral is deprived of pigmentation within its tissues as a result of unusually high temperatures in the sea. This condition puts coral reefs in an unhealthy state due to insufficient nutrient uptake, which may ultimately lead to the death of corals unless they are able to tolerate the crisis. In recent years, coral bleaching has emerged at increasing scales covering national and regional territorial waters.

Thai seas experienced unusually high temperatures in 1991, 1995, 1998, 2003, and 2005. In 1991 and 1995, the coral reefs in the Andaman Sea were extensively affected, resulting in the death of up to 20% of corals. In 1998, the reefs in the Gulf of Thailand were more severely damaged than those in the Andaman Sea and Andaman Sea reefs experienced little bleaching during the last two bleaching events. The corals rapidly recovered to their previous state because the southwest monsoon waves helped to reduce regional water temperatures.

But in 2010, coral reefs both in the Andaman Sea and the Gulf of Thailand were more severely damaged than previously as sea temperatures reached 31-33°C during April to June. The impact varied widely from place to place, depending on the structure of coral communities. Areas dominated by sensitive species, especially staghorn and table corals, were most damaged. Between 30% and 95% of the corals were bleached. The damage caused by coral bleaching was exacerbated by waves, which shattered the reef structures. Most species were affected to some extent except for a few species, such as blue coral (*Heliopora coerulea*), flower coral (*Pavona decussata*), and double star coral (*Diploastrea heliopora*), which seemed resistant to the event. The impact was less on the west side of islands in the Andaman Sea as reefs with this aspect were more exposed to currents and did not experience consistently high temperatures.

Upper: Giant leatherback turtle. **Lower:** Coral bleaching.

■ **Upper:** ***Sapria,*** **a genus of parasitic flowering plants, Xishuangbanna, Yunnan, PRC. Lower: Red Canna Lily flower, Thailand.**

Flora

The subregion is home to an enormous number of plant species, at least 20,000 and possibly many more. Thailand has about 12,600, Viet Nam 10,500, and Myanmar 7,000 species of higher plants. About 20% of the plant species in Thailand and Viet Nam occur only in those countries. The flora of Yunnan is estimated to contain 14,000 species. There is undoubtedly great overlap between the countries and considerable overlap with the more temperate Yunnan. Numbers recorded depend not only on the actual numbers that occur, but also on the nature of the country, and efforts taken to survey and collect data. The more intensively an area is studied, the greater the number of plants and animals likely to be discovered.

The flora in the subregion includes many rare ornamental flowers and trees that beautify the entire region and support a thriving horticulture industry in most of the countries. The flora also includes highly valued hardwood tree species like teak and rosewoods that generate a major share of the forestry income and are currently the focus of major conservation efforts to stop illegal logging and cross-border trade.

Significant numbers of plant species are threatened with extinction within the subregion, nearly 400 species in Thailand and more than 300 in Viet Nam, although only a handful in Cambodia, the Lao PDR, and Myanmar. Around 300 species are threatened in the entire PRC; presumably those in Yunnan are far fewer.

The Three Parallel Rivers of Yunnan Protected Areas, a World Heritage Site, contains the richest diversity of higher plants in the PRC and a wide spectrum of fungi and lichens. The protected area is one of the world's least disturbed ecological areas. It has 22 vegetation subtypes and harbors 6,000 plant species. This represents more than 20% of the PRC's higher plants, 10% of which are endemic to the area.

Botanical explorations in the subregion continue to yield new plant species. WWF surveys brought to light 519 new plant species between 1997 and 2007 and a further 145, including five carnivorous plants, in 2010. In 1999, a new genus and species of conifer was discovered on steep limestone ridges in a mountainous area in northern Viet Nam. In 2002, a new genus and species of fern was found in a collection made by a National Geographic Society expedition.

Human activities such as deforestation, illegal trade of endangered species, and agricultural encroachment, however, threaten the richness of plant species in the subregion. Nevertheless, the flora continues to be a resource to be conserved and a beauty to be appreciated.

Flowers of Yunnan. Because of the unusual natural conditions in Yunnan—no extreme cold in winter and no intense heat in summer—the province is home to 2,500 kinds of ornamental rare flowers and uncommon trees. Yunnan is said to produce the best quality and cheapest flowers in the world. Flowers are grown on a vast scale and are produced with very minimal requirements.

The province has a long history of growing flowers. One thousand years ago, people from the area cultivated flowers to uplift their spirits, decorate their gardens, and enhance their environment. In Kunming, breeding of flowers began as early as in the Tang and Song dynasties. Camellias became popular and were widely grown during

the Yuan Dynasty. In the Ming Dynasty, there were about 70 famous types of ornamental flowers and the number grew to more than 180 during the Qing Dynasty and the rise of the Republic. The province presently identifies "eight famous flowers of Yunnan." They are camellia, rhododendron, indigo, primrose, lily, orchid, rough gentian, and meconopsis. Camellia was chosen as the city flower of Kunming.

In the late 1980s, Yunnan started to develop a flower industry and the Government of Yunnan decided to support this as a way to boost the local economy. By 1994, Yunnan had replaced Shanghai as the flower center of the PRC. The province now contributes more than 80% of the total sales volume of cut flowers in the PRC.

Aside from the domestic market, Yunnan also exports flowers to more than 40 countries, mainly Japan; Republic of Korea; Hong Kong, China; Thailand; and Singapore. Export earnings in 2010 amounted to $150 million compared to only $5 million a decade earlier. In 2010, the Yunnan flower industry produced a total of 6 billion fresh flowers valued at 23.2 billion yuan ($3.5 billion!) on an area of 42,000 hectares, mostly in Kunming, up from only 2,000 hectares in 2000.

The success of the flower industry in Yunnan can be attributed to the initiatives of farmers in the village of Dounan in the late 1980s.They used to grow vegetables for their living until a farmer in the village, during his trip to Guangzhou, found that there was a high demand for flowers in the cities. At the same time, there was a decrease in prices of vegetables because of oversupply. He planted some gladiolis in his land and other farmers in the village soon followed his example. The flower cultivation area expanded quickly and in less than half a decade, Dounan had become one of the major production and wholesale centers for cut flowers in the PRC.

Orchids of Thailand. Thailand is well known for its many beautiful orchids, locally known as "Gluay Mai." There are around 1,300 species of orchids in the country. They come in many gorgeous colors and shapes and vary from common to rare. Although they are most prolific in the north, orchids are found in all parts of Thailand, from the low plains of the central region to the highest mountains of the north, from the forests of the south to the dry northeastern plateau.

The most beautiful of Thailand's orchids are the white, the bright yellow oncidium, and the brick red orchids. The white orchid commands a high price because of its scarcity in the wild. Other orchid varieties are easy to grow and are abundant year round, such as the violet bloom, which is usually offered to visitors. There are many orchid farms in northern Thailand; Chiang Mai is considered the center for cultivation and exhibition of these exotic flowers.

■ A pony tail palm, (*Cordyline fruticosa*), Xishuangbanna, Yunnan, PRC.

Interest in orchid cultivation in Thailand can be traced back to 1913 when some exotic plants were brought to the attention of Prince Krompranakornsawanvorapinit. He became interested in growing orchids, both as a hobby and for commercial purposes. In 1957, the Orchid Society of Thailand was formed under royal patronage.

The most important orchid study center in the north of Thailand is found in Doi Inthanon National Park. This park is an abode to more than 25% of all the orchid species in Thailand. Orchids are found in the deciduous forests from the foothills to the forests at the top of the mountain within the park. The most common species is *Dendrobium infundibulum*. Also, many rare montane orchids can be found along the Keo Mae Pan Nature Trail near the summit of the park. Farmed on some 3,500 hectares, orchids are an important source of export earnings in Thailand. In 2009, the kingdom's exports of tropical orchids, comprising more than 24,000 tons of cut orchid flowers and more than 30,000 live orchid plants, were valued at more than US$80 million.

Vanishing Teak. Teak is a highly-valued wood because of its elegance, quality, and high resistance to weathering. Teak trees grow in groups among other tropical species and are oily to the touch. The oil makes the trees extremely durable against water, rust, and termites, and the wood can last for more than a thousand years. Teak plantations are abundant in the subregion, particularly in Myanmar and Thailand. Myanmar is now one of the world's biggest suppliers of teak. Teak production there is the biggest source of forestry sector earnings and provides significant foreign exchange to the country. In 1995, teak

■ Forest clearing, Champasak, Lao PDR.

exports reached 200,000 cubic meters, with a value of $200 million. If managed properly, teak production could become one of the pillars of Myanmar's economy in the future.

Before the Second World War, teak was the third most important export commodity of Myanmar. In the early 1970s, teak exports accounted for 25% of total export earnings. With the decline in rice exports, Myanmar identified the forestry sector as a primary source of foreign exchange to boost the economy. Increased investment led to an increase in annual teak production from 291,000 tons in 1971 to 440,000 tons in 1991. A major cause for the increase was the ban by Thailand in 1989 on cutting timber from its forests. To ensure supplies of wood, Thailand signed a series of logging contracts with Myanmar. The increased rate of timber extraction in Myanmar caused growing concern about Myanmar's forest resources. At 1990 felling rates, it was estimated that the teak stock would be depleted within 15 years.

Because of the unsustainable cutting of teak, Myanmar has now focused its forest management on the sustainable management of natural teak-bearing forests. The annual allowable felling of teak trees was lowered from 609,000 to 409,060 cubic meters. Myanmar has also programmed the planting of trees on 40,500 hectares per year, of which teak plantations cover 8,100 hectares, on a 40-year rotation. The country has also established two model forests in which natural teak forests are prominent, namely Oktwin and Pauk Khaung model forests in Bago Yoma region.

Ecosystem Fragmentation

The forest ecosystems of the GMS are a source of livelihood for local people, biodiversity richness, and ecosystem services. In spite of establishment of a large number of terrestrial protected areas or complexes by governments of the GMS countries, a glance at the map of the subregion shows ecosystem fragmentation across the landscapes. Between 2005 and 2010, development pressures and subsequent land-use change have contributed to an increase in ecosystem fragmentation in some landscapes; land-use planning and development need to take cognizance of the importance of maintaining forest connectivity.

Protected Areas

Protected areas are the primary means of protecting biodiversity. IUCN defines a protected area as an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means.

As defined by IUCN, protection must maintain biodiversity and natural resources. And it must have an explicit legal or social basis.

Sites that combine attraction, recreation, and nature conservation uses can also qualify if at least 75% of the area is managed primarily for conservation. Nonconsumptive and low-intensity uses are compatible with some categories within the IUCN scheme, but such sites as forest plantations managed primarily for timber production do not qualify.

IUCN categories

The IUCN system of classifying protected areas was designed to standardize and facilitate the collection and dissemination of data and to improve communication among countries. Standardization of parks and protected areas in differing ecosystems and in different political, legal, and cultural contexts is achieved by using management objectives as the basis for comparison. This provides enough flexibility to account for a range of possible combinations of management objectives, socioeconomic contexts, and ecosystems. Definitions of the categories, and examples of each, are provided in Guidelines for Protected Area Management Categories (IUCN 1994).

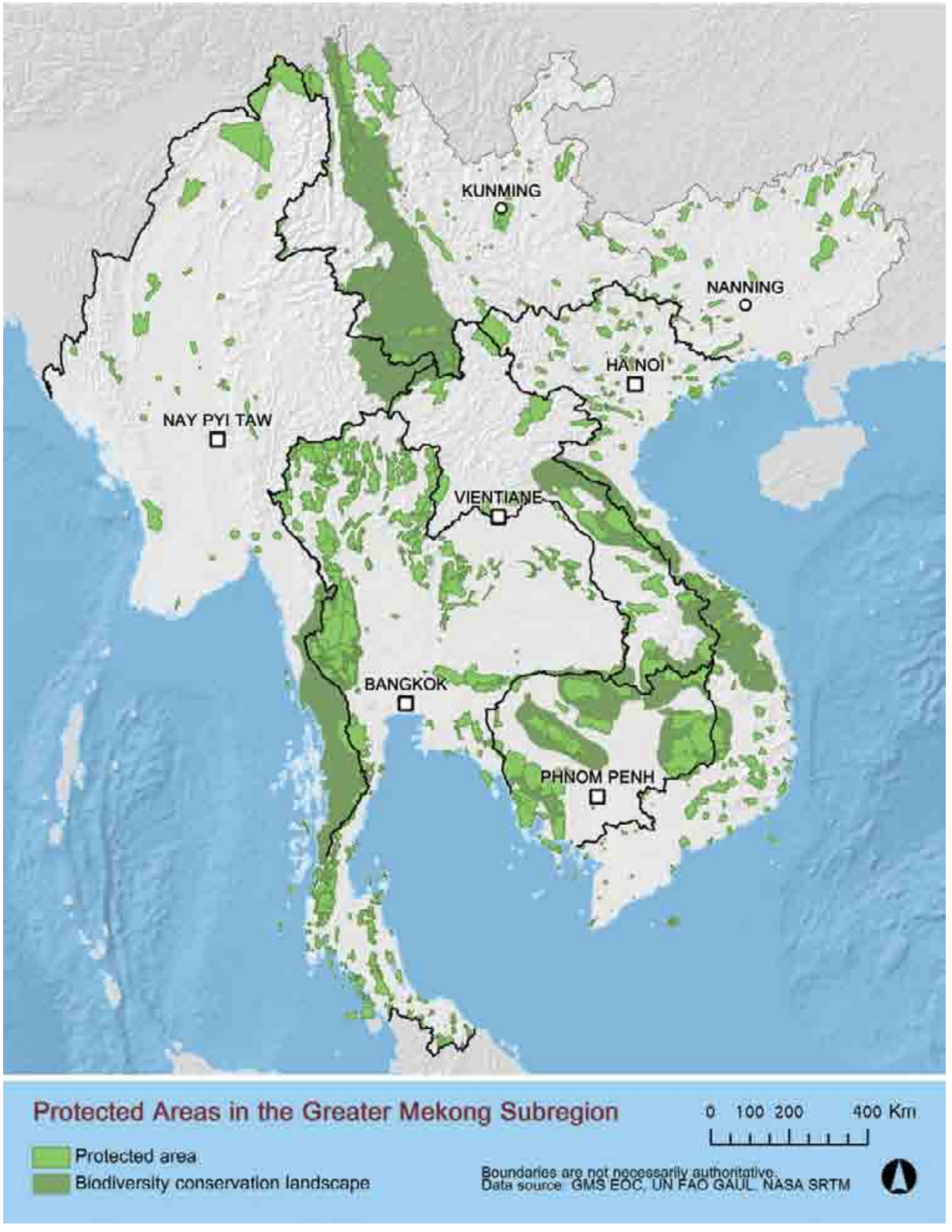
CATEGORY Ia.	Strict Nature Reserve: protected area managed mainly for science.
CATEGORY Ib.	Wilderness Area: protected area managed mainly for wilderness protection.
CATEGORY II.	National Park: protected area managed mainly for ecosystem protection and recreation.
CATEGORY III.	Natural Monument: protected area managed mainly for conservation of specific natural features.
CATEGORY IV.	Habitat/Species Management Area: protected area managed mainly for conservation through management intervention.
CATEGORY V.	Protected Landscape/ Seascape: protected area managed mainly for landscape/seascape conservation and recreation.

Three Parallel Rivers of Yunnan Protected Areas

This World Heritage Site consists of eight geographical clusters of protected areas within the boundaries of the Three Parallel Rivers National Park in the mountainous northwest of Yunnan. The 1.7-million hectare site features sections of the upper reaches of three of the great rivers of Asia: Thanlwin, Mekong, and Yangtze (Jinsha). These rivers run roughly parallel, north to south, through steep gorges that, in places, are 3,000 meters deep and are bordered by glaciated peaks more than 6,000 meters high. The site's special features are

- outstanding value for displaying the geological history of the last 50 million years associated with the collision of the Indian Plate with the Eurasian Plate, the closure of the ancient Tethys Sea, and the uplifting of the Himalaya Range and the Tibetan Plateau;
- dramatic expression of ecological processes—a mix of geological, climatic, and topographical effects;
- outstanding natural features—the deep, parallel gorges of the Jinsha, Lancang (Mekong), and Nu Jiang (Thanlwin) are the dominant scenic elements in the area, and high mountains are everywhere, with the glaciated peaks of the Meili, Baima, and Haba Snow Mountains providing a spectacular scenic skyline; and
- location in northwestern Yunnan, the area of richest biodiversity in the PRC and possibly the most biologically diverse temperate region on earth, encompassing most of the natural habitats in the Hengduan Mountains, one of the most important remaining areas for conservation of the earth's biodiversity.

Upper: One of the three parallel rivers is the Mekong, pictured here in Yunnan, PRC. **Lower:** A spruce forest (***Piicea likiangensis***), Yunnan, PRC.



■ **Upper Left:** Mangroves in Peam Krasaob, Koh Kong, Cambodia. **Lower Left:** Crested serpent eagle. **Upper Right:** Mountain stream, Bach Ma National Park, Viet Nam.

History of Protected Area Management

Cambodia was the first country in Southeast Asia to establish a national park: the 10,800-hectare forest around the Angkor Temple complex, in 1925. Twenty-nine IUCN categorized protected areas were designated in 2009, covering about 22% of the total land area and representing a diversity of habitats.

In Guangxi, there are four major categories of protected area: nature reserves,forest parks,scenic spots, and geological parks. Both Guangxi and Yunnan Provincial Forest Departments exercise overall authority for protected areas, which are managed at four levels: national, provincial, prefectural, and county. By the end of 2011, Guangxi had 78 protected areas with a total area of 14,510 square kilometers, accounting for about 6.1% of Guangxi's land area. In Yunnan, there are 162 protected areas (2010) that cover in total about 7.5% of the province.

The Lao PDR has one of the youngest and most comprehensive protected area systems in the world. Established in 1993, the system of national biodiversity conservation areas, now called national protected areas, was based on sound scientific principles and currently includes 24 sites covering 14.7% of the land area.

The Protection of Wildlife, Wild Plants and Natural Areas Law was promulgated in Myanmar in June l994 in order to carry out biodiversity and environmental conservation more effectively. Currently, protected areas cover about 4.7% of the land area of Myanmar, including 22 wildlife sanctuaries and 6 national parks, with plans to increase this eventually to l0% of the land area.

Protected areas in Thailand were given a legislative basis in the early 1960s with technical assistance from IUCN through promulgation of the Wildlife Act (1960) and National Park Act (1961). Khao Yai was the first National Park, established in 1961, followed by Salak Pra Wildlife Sanctuary in 1965. Currently, more than 21% of the country is covered by protected areas.

Viet Nam established an extensive national network of protected areas in the 1990s. This has succeeded in slowing the rate of destruction of the country's forests. The network is now being expanded to include wetlands and marine areas. Currently, only about 5% of the country is covered by protected areas.

Conservation Coverage

There are now 692 IUCN categorized protected areas in the subregion, of which 380 are judged to have biodiversity conservation as a major function. Their classification varies from country to country and there are 18 different classes of protected areas around the subregion. Not all classes appear to fulfill major roles in conserving biodiversity. For example, the forest parks of Thailand and Yunnan, Thailand's nonhunting areas, and the protected landscapes of Cambodia and Viet Nam may have limited value for biodiversity conservation.

Cambodia, the Lao PDR, and Thailand have relatively large protected area systems. Thailand's system is long established, although several areas have been added in recent years. Those in Cambodia and the Lao PDR are of recent origin, designed specifically with biodiversity conservation and representation in mind. In these larger systems, cover of biotic communities and their species is very good although there is a paucity of lowland dry evergreen forest. Forests of this type, where they occur inland, have been extensively destroyed throughout Southeast Asia.

In Cambodia, 16 out of 29 IUCN categorized protected areas are larger than 500 square kilometers, and comprise 94% of the total system. The figures for the Lao PDR (21 areas) are even higher. The average size of Thailand's protected areas is less than half those for Cambodia and the Lao PDR, only 73 out of 207 IUCN categorized areas being larger than 500 square kilometers, covering 71% of the total protected area. Guangxi's, Yunnan's, and Myanmar's protected area systems have the smallest average sizes in the subregion.

In Guangxi, the nature reserves have the potential to play a vital role in protecting endangered species, ecosystems, and natural resources. The Conservation Department is working with government agencies to train reserve managers to effectively manage, patrol, and monitor reserves, develop ecotourism and address the needs of people living in and around the reserves, which are off-limits to human activity.

In Yunnan, only 10 of the 162 protected areas exceed 500 square kilometers although, because 5 areas are larger than 1,000 square kilometers, they make up about two thirds of the total system by area.

The protected area system in Myanmar has scope for enlargement. The ultimate target of 10% cover, according to the Myanmar National Forest Policy of 1995, is believed to be a realistic target because large, well-forested, and sparsely populated tracts of country exist in the north. At present, Myanmar still has the lowest proportion of cover in the subregion (4.7%), and most of its protected areas cover an average of 840 square kilometers. Fifteen of its 38 IUCN categorized protected areas are larger than 500 square kilometers and 10 exceed 1,000 square kilometers.

Viet Nam's system has good biodiversity representation but individual protected areas are relatively small. Only 9 out of the 88 IUCN categorized protected areas are larger than 500 square kilometers—covering 47% of the total protected area.

Legal instruments for biodiversity conservation and protected area management vary from country to country. Thailand has the most sophisticated set of laws and regulations while the Lao PDR has the least

Upper: Kang Krachan National Park, Thailand. The terrain is mainly evergreen rainforest with some mixed deciduous forest. **Lower:** Barbados lily (*Hippeastrum vittatum*), Thailand.

Upper: Asiatic leopard with prey in Huai Kha Khaeng Wildlife Sanctuary, Thailand. **Lower:** Pagoda flower, *Clerodendrum*, Thailand.

developed. Viet Nam promulgated a Biodiversity Law in 2010, while Cambodia and the Lao PDR plan to undertake similar steps. In many cases, the broad umbrella of laws and policies is in place but the implementing regulations are still to come.

Thailand, Viet Nam, and Yunnan have already used up a large portion of their forests. The remaining forests are now mostly within protected areas. However, in many cases, this has not stopped the continuing unsustainable and illegal extraction of timber. To safeguard the biodiversity of the subregion for future generations, this issue must be tackled. In Cambodia, the Lao PDR, and Myanmar, governments at the highest levels must support the protected area system while committing the human resources necessary to ensure that the areas are managed appropriately. In the short run, the much needed support is likely to continue to come from international and nongovernment organizations.

Legally Designated Protected Areas, 2010 (square kilometer) (excluding non-categorized sites)

Protected Area Type	IUCN Category	Cambodia	PRC Guangxi	PRC Yunnan	Lao PDR	Myanmar	Thailand	Viet Nam
Bird sanctuary	III or IV	—	—	—	—	893.76	—	2.73
Cultural and historical site	II or V	—	—	—	—	—	—	1,127.22
Elephant range	III	—	—	—	—	1,755.71	—	—
Forest park	—	—	—	—	—	—	—	—
Mountain park	IV	—	—	—	—	128.54	—	—
Multiple use area	VI	4,111.54	—	—	—	—	—	—
Multiple use areas- core area	IV	422.57	—	—	—	—	—	—
National biodiversity conservation area	VI	—	—	—	34,868.75	—	—	—
National marine park	Ib or II	—	—	—	—	204.84	6,539.32	—
National park	II or III	5,674.64	—	—	—	10,498.38	64,556.60	4,725.99
Nature reserve	IV	—	—	29,556	—	—	—	10,213.18
Nonhunting area	III	—	—	—	—	—	2,030.90	—
Protected landscape	III or V	994.97	—	—	—	120.54	—	—
Protected forest	III or IV	9,760.53	134,270	181,773	—	—	—	—
Species/habitat reserve	—	—	—	—	—	—	—	—
Wetland sanctuary	III	—	—	—	—	—	—	—
Wildlife park	II	—	—	—	—	6.24	—	—
Wildlife sanctuary	III or IV	18,647.58	—	—	—	18,314.88	3,5935.41	—
Totals of all protected areas	—	39,611.83	—	—	34,868.75	31,922.89	109,062.23	16,069.12
Proportion of total land area (%)	—	21.9	—	—	14.7	4.7	21.3	4.9

- = not available, IUCN = World Conservation Union, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Source: Guangxi Bureau of Statistics. 2011. *Guangxi Statistical Yearbook 2011*. Beijing; Guangxi Forestry Department; IUCN and UNEP. 2010. *The World Database on Protected Areas*. Cambridge, UK: World Conservation Monitoring Centre. www.protectedplanet.net; Yunnan Bureau of Statistics. Yunnan Statistical Yearbooks 2001 and 2011. Beijing.

Agriculture, Fisheries, and Food Security

The contribution of agriculture to gross domestic product (GDP) of the countries in the Greater Mekong Subregion (GMS) except for Thailand has been declining over the past decade; however, the sector still plays a very important role in food security. In 2010, agriculture made up around one third of GDP in Cambodia, the Lao People's Democratic Republic (Lao PDR), and Myanmar, while in Guangxi Zhuang Autonomous Region and Yunnan Province of the People's Republic of China (PRC), Thailand, and Viet Nam, it was less than one fifth. Land area for agricultural use has remained fairly stable in Guangxi, Yunnan, and Thailand with increases in Cambodia, the Lao PDR, and Viet Nam.

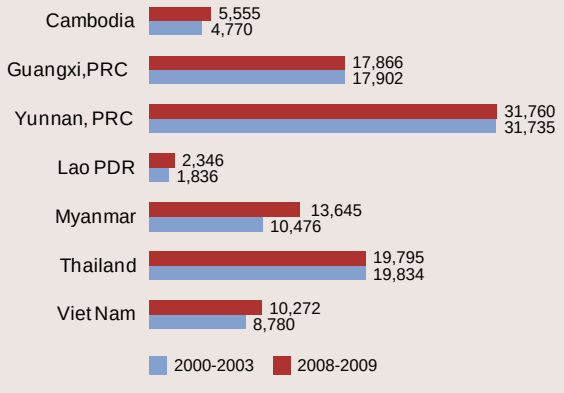
GDP Share of Agriculture and GDP per Capita in the GMS

	GDP share of Agriculture (%)		GDP per Capita ($/year)	
Country	**2000**	**2010**	**2000**	**2010**
Cambodia	37.90	36 .00	290.00	788.00
PRC				
Guangxi	26.80	17.50	561.84	2,986.56
Yunnan	20.70	12.81	560.00	2,327.00
Lao PDR	48.54	30.81	303.47	1,003.71
Myanmar	57.20	36.40	177.64	742.44
Thailand	9.02	12.42	1,983.32	4,992.43
Viet Nam	24.53	20.58	401.57	1,173.55

GDP = gross domestic product, GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Source: ADB. 2011. *Key Indicators for Asia and the Pacific 2011*. Manila; Council for the Development of Cambodia. 2011. *Why Invest in Cambodia?* Phnom Penh; Guangxi Bureau of Statistics. 2011. *Guangxi Statistical Yearbook 2011*. Beijing; International Monetary Fund. *World Economic Outlook Database, September 2011*. http://www.imf.org/external/pubs/ft/weo/2011/02/weodata/index.aspx; Government of Viet Nam, Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi; Yunnan Bureau of Statistics. Yunnan Statistical Yearbooks 2001 and 2010. Beijing.

Even with dynamic growth in manufacturing and services sectors in GMS countries, a large portion of the population still lives below the poverty line. Almost 70% of the poor were living in rural areas in 2009, mostly working in the agricultural sector. This underlines the importance of enhancing and stabilizing growth in agriculture and agriculture-related, value-added goods and services as a major key to reducing poverty.

Agricultural Land in the GMS (thousand hectare) in 2000-2003 and 2008-2009



GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Note: Guangxi, PRC data referred to 2003, 2008 and Yunnan, PRC data referred to 2003
Source: National Bureau of Statistics of China. China Statistical Yearbooks 2004 and 2009. Beijing; FAO. FAOSTAT; Government of Myanmar, Ministry of Agriculture and Irrigation. 2011. *Myanmar Agriculture in Brief 2011*. Nay Pyi Taw; World Data Bank. *World Development Indicators and Global Development Finance*. http://databank.worldbank.org/ddp/home.do?Step=1&id=4 (Accessed 26 December 2011).

Upper: Women tending rice fields in the Mekong Delta, Viet Nam. **Lower:** Rubber tapping in Yunnan, PRC; an increasingly important cash crop in parts of the subregion.

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Land Use in the Greater Mekong Subregion

- Intensive agriculture (irrigated)
- Intensive agriculture (rainfed)
- Extensive agriculture
- Small-scale farming, shifting agriculture, agroforestry
- Dense forest
- Water bodies
- National capital
- Provincial capital

0 125 250 500 Kilometers

Boundaries are not necessarily authoritative
Data source: GMS EOC (Class aggregation based on ESA GlobCover V2.3), UN FAO GAUL, NASA SRTM

Importance of Rice. The GMS is home to the "rice bowls" of the Ayeyarwady, Chao Phraya, Mekong, and Red River deltas. Most of the poor subsist on a diet of rice and fish. Myanmar, Thailand, and Viet Nam earn foreign exchange by exporting their surplus production. Rice production is crucial to the subregion's economies.

In Viet Nam, rice accounts for more than 85% of food grain output; the country became a net rice exporter in 1989 and produced about 40 million tons in 2010. In Thailand, in spite of a declining trend in domestic demand, rice production continued to grow, making it the second largest producer in the GMS. Thailand's rice exports have been growing steadily and stood at 9.1 million tons in 2010. Next to Thailand, Viet Nam exported 6.9.million tons of rice and is now the second largest rice exporter in the world. Much of the surplus production in Thailand is from the intensively cultivated central region, where the area planted with rice grew from 6.9 million hectares in 1968 to 10.9 million hectares in 2010 and has since been fluctuating between 9 million and 11 million hectares, depending on the relative price of rice in the world market.

GMS Rice Production, 2000 and 2010 (thousand ton)

Country	2000	2010
Cambodia	4,026.1	8,249.5
PRC		
Guangxi	13,607.7	11,212.5
Yunnan	5,362.9	6,165.7
Lao PDR	2,201.7	3,006.0
Myanmar	21,324.0	32,579.0
Thailand	25,844.0	31,597.2
Viet Nam	32,529.5	39,988.9
GMS	**104,895.9**	**132,798.8**

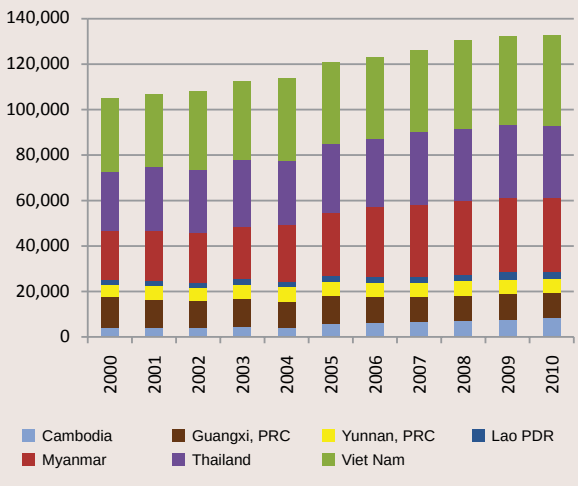
GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Source: Cambodia Ministry of Agriculture, Forestry and Fisheries. *Rice Production*. http://www.stats.maff.gov.kh/en/index.php?page=stat&mode=riceproduction&option=com_content&Itemid=47; FAO. FAOSTAT. http://faostat.fao.org/site/291/default.aspx (accessed 6 August 2012); Government of Myanmar, Ministry of Agriculture and Irrigation. 2011. *Myanmar Agriculture at a Glance 2011*. Nay Pyi Taw; Guangxi Bureau of Statistics. 2011. *Guangxi Statistical Yearbook 2011*. Beijing; Thailand Ministry of Agriculture and Cooperatives. 2011. *Indicators of Agricultural Economy of Thailand 2010*. Bangkok; Government of Viet Nam, Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi; Yunnan Bureau of Statistics. Yunnan Statistical Yearbooks 2001 and 2010. Beijing.

In Myanmar, rice is virtually the only food grain produced and employs nearly 40% of the labor force. In 2010, Myanmar produced 32.6 million tons of rice on 8 million hectares of land. In Cambodia, rice is the most important staple food, growing on about 2.7 million hectares and the country has ambitious plans for expansion and intensification. Cambodia was a net importer of rice until 1995; since then, the country has become self-sufficient in rice production and produced 8.2 million tons in 2010, exporting a small quantity. The Lao PDR produced 2.3 million tons of rice (2010) on an area of about 627,865 hectares.

Trends in Agricultural Production

Agriculture in the GMS is shifting from traditional subsistence farming to modern commercial farming practices. Although individual countries are progressing at different paces, in general, the countries are adopting intensification, specialization, increased agrochemical use, and mechanization. Trends observed in Thailand and the PRC are likely to emerge in other countries of the GMS in future. Production of such commodities as rice, oil crops (soybean, groundnut, sesame, and sunflower), and coarse grains (maize, millet, and sorghum) has more than doubled since 1990, outpacing the region's rapid population growth. Many farmers have switched from growing rice to producing commercial crops, such as fruits, vegetables, rubber, and pulpwood.

GMS Rice Production, 2000–2010 (thousand ton)



GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Source: See table on GMS Rice Production, 2000 and 2010.

Most of the rice crop in the subregion is still harvested manually. Upper: Threshing rice, and Lower: Sun drying rice, in Guangxi, PRC

Upper: Pig farming, Vientiane Province, Lao PDR. **Lower:** Vegetable growing, Cambodia.

Farmers in the GMS are increasingly opting for "green revolution" approaches and technologies rather than land expansion. These approaches include more effective irrigation, improved plant varieties, increased use of fertilizer, and better farming practices.

Crop Diversity. The wide variety of crops grown across the subregion reflects national preferences and the nature of available farmland. In Thailand, more than twice as much sugarcane—68.8 million tons (2010)—as rice is produced each year. Sugar is also important in Viet Nam, where it is about half the size of the rice crop, and in Myanmar. Other major crops are cassava and maize.

Thailand produces large amounts of oil palm fruit and is the subregion's leading rubber producer. Viet Nam produces most of the subregion's coffee beans, while Myanmar produces far more dry beans, groundnuts, and onions than the other countries and is the only one producing plantains.

Livestock. The main livestock raised in the subregion are pigs, chickens, and cattle, with buffalos and ducks being significant in some countries as well. Quantities produced in the different countries vary considerably, based to some extent on differences in cultural values. The main product in Cambodia, the Lao PDR, and Viet Nam is pig meat, while in Myanmar and Thailand it is chicken and hen eggs. Thailand's egg production was almost 1 million tons in 2010, three times that of Viet Nam, the second largest egg producer.

Land Degradation

The dramatic changes in land use and agricultural intensification have come at an environmental cost. According to the Greater Mekong Environment Outlook, land degradation affects between 10% and 40% of land in the GMS countries. Forest loss, agricultural intensification, and overgrazing are the main causes. Changes to natural landscapes associated with farming activities have disrupted vital ecological services by reducing the capacity of ecosystems to contain floods, control erosion, and limit damage from pests.

Fertilizer Consumption (kilogram per hectare of arable land)

Country	2002	2003	2004	2005	2006	2007	2008	2009
Cambodia	6	4	5	20	22	21	6	7
Myanmar	4	10	20	7	9	16	7	5
Thailand	111	149	132	113	117	137	131	125
Viet Nam	305	342	404	292	300	353	306	402

Source: http://www.worldbank.org/data?qterm=fertilizer consumption&language=EN

GMS Primary Crops Production, 2010 (thousand ton)

	Cambodia	PRC		Lao PDR	Myanmar	Thailand	Viet Nam
		Guangxi	Yunnan				
Rice	8,249	11,213	6,166	3,006	32,579	31,597	39,989
Maize	773	2,087	6,130	1,084	1,376	4,454	4,607
Pulses	39[a]	—	795	15	5,490[b]	51	145
Sugarcane	366	71,196	17,509	434	9,398	68,808	15,947
Soy Bean	157	167	271	16	259	177	297
Cassava	4,249	1,732	1,736	140	326	22,006	8,522
Rubber	42	0.4	331	—	128	3,252	755
Oil Palm	—	—	—	—	335	8,223	—

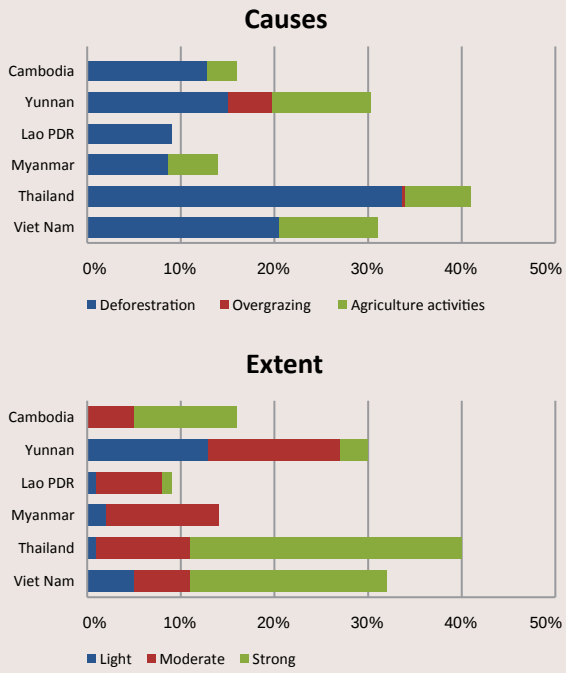
[a] = 2008 data, [b] = 2009 data, - = not available.
GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Source: See table on GMS Rice Production, 2000 and 2010.

GMS Primary Livestock Products, 2010

	Cambodia	PRC		Lao PDR	Myanmar	Thailand	Viet Nam
		Guangxi	Yunnan				
Pig (thousand head)	2,057	32,300	27,668	3,400	9,300	7,624	27,373
Chicken (thousand head)	17,448	—	—	23,000	125,000	231,918	196,140[d]
Cattle (thousand head)	3,485	3,199 [a]	4,971[b]	1,400	13,600	6,498	5,916
Duck (thousand head)	7,000[d]	—	—	3,200	14,000	29,233	84,060[d]
Buffalo (thousand head)	702	4,135[a]	2,647[b]	1,200	3,000	1,623	2,913
Eggs (thousand ton)	22	200	208	16	302	981	326
Milk (thousand ton)	27	82	504	7	1,603	851	341

[a] = 2004 data, [b] = 2006 data, [c] = 2008 data, [d] = 2009 data. - = not available, GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Sources: See table on GMS Rice Production, 2000 and 2010; Guangxi Bureau of Statistics. Guangxi Statistical Yearbooks 2005 and 2011. Beijing; Yunnan Bureau of Statistics. Yunnan Statistical Yearbooks 2008 and 2011. Beijing.

The Causes and Extent of Land Degradation in the GMS



GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic.
Source: Thailand Ministry of Natural Resources and Environment and UNEP Regional Resource Center for Asia and the Pacific. *Thailand National Environmental Performance Assessment (EPA) Report*. Bangkok. http://www.ekh.unep.org/files/SEF%20II%20Report%20-%20Thailand.pdf

Water Use for Agriculture

Agriculture is the largest user of water in all the GMS countries, consuming between 58% in Guangxi, PRC, and 95% of total withdrawals. By altering natural flow regimes, irrigation development has affected fish populations and wetland habitats. The resulting dry-season water shortages have increased competition for water, especially in intensively-irrigated areas, such as Viet Nam's Red River Delta and Thailand's Chao Phraya River Delta. Hydropower schemes planned for the Mekong, Thanlwin, and Ayeyarwady rivers will disrupt natural flows further, with implications for farming and fisheries. Blocking fish migration paths with dams, for example, prevents their reaching spawning and feeding areas.

Irrigation consumes an estimated 41.8 billion cubic meters of freshwater in the lower Mekong basin, which includes parts of Cambodia, Lao PDR, Thailand, and Viet Nam. More than half of the water is used in Viet Nam in the Mekong Delta (26.3 billion cubic meters), followed by Thailand (9.5 billion), the Lao PDR (3.0 billion), Cambodia (2.7 billion), and the highlands of Viet Nam (0.5 billion). Water-use strategies range from supplementary water during the wet season to fully irrigated multicropping strategies.

The area under irrigation has expanded gradually in all countries. Most of the installed irrigation infrastructure is found in northeastern Thailand and Viet Nam's Mekong Delta. A recent assessment of irrigation in the lower Mekong basin recorded almost 15,000 individual irrigation projects, varying from small to large scale, and from gravity-fed to pump-fed irrigation. The total area under irrigation in the lower Mekong basin is estimated at 4 million hectares, of which 3.5 million are irrigated in the wet season, 1.2 million in the dry season, and about 1.5 million hectares where a third crop is grown.

Area of Irrigated Rice and Other Crops in the Lower Mekong Basin, 2007 (hectare)

Country	Irrigable Area	Rice 1st Season	Rice 2nd Season	Rice 3rd Season	Non-rice Crop Area	Annual Irrigated Area
Cambodia	504,245	273,337	260,815	16,713	12,172	563,037
Lao PDR	166,476	166,476	97,224	—	6.977	270,677
Thailand	1,411,807	1,354,804	148,255	—	252,704	1,755,763
Viet Nam						
Total	1,919,623		739,594	1,478,740	329,740	4,217,983
Delta		1,528,225	663,410	1,478,740	294,899	3,965,274
		141,684	76,184		34,841	252,709
Highlands						
Total LMB	4,002,151	3,464,526	1,245,888	1,495,453	601,593	6,807,460

- = not available, GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic, LMB = lower Mekong basin.
Source: Mekong River Commission. 2010. *State of the Basin Report 2010*. Vientiane.

Upper: Cattle farming, Thailand.
Lower: Land cleared for shifting cultivation of rice or maize, central Annamites, Viet Nam.

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Rice Production in the Greater Mekong Subregion

Rice production by type
(1 point = 10,000 hectares)

- Irrigated dry season
- Irrigated wet season
- Irrigated first crop
- Irrigated second crop
- Shallow rainfed (0-30cm)
- Intermediate rainfed (30-100cm)
- Deepwater (>1m)
- Hybrid
- Dryland

- National capital
- Provincial capital

0 125 250 500 Kilometers

Boundaries are not necessarily authoritative
Data source: IRRI, GMS EOC, UN FAO GAUL, NASA SRTM

Agroecological Zones

The GMS comprises four agroecological zones that have common farming systems and are subject to similar geographic constraints and risks.

Deltas and the Tonle Sap Floodplain. The Tonle Sap floodplain and mega deltas of the Red, Mekong, Chao Phraya, and Ayeyarwady rivers represent around 8% of the total GMS land area but house over a third of the total population, some 86 million people. Rural population densities are high and each delta hosts a major city. The cities provide markets and fuel demand for staples, vegetables, poultry, and meat. The main delta "rice bowls" of the GMS vary from the Tonle Sap floodplain and the Ayeyarwady Delta, which still have limited irrigation and low populations, to the densely settled and intensively farmed Chao Phraya, Mekong, and Red River deltas; the latter produce two or three crops a year and have highly developed irrigation infrastructure (dykes, levees, and canals to divert and retain water). But they all suffer from water shortages in the dry season. In the Mekong Delta in Viet Nam, more than 80% of dry-season flows are diverted for irrigation, resulting in local water shortages and seawater intrusion.

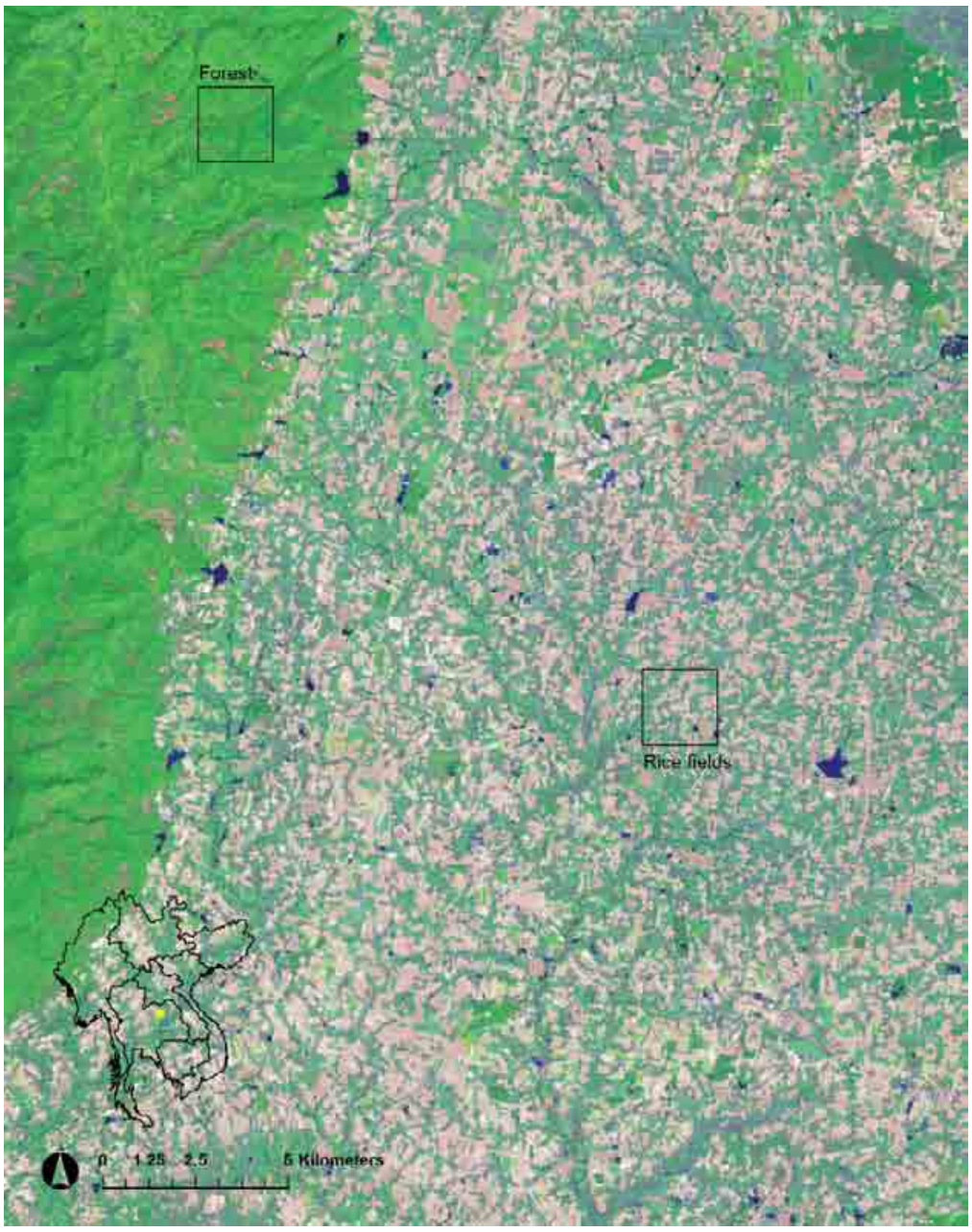
The deltas and the Tonle Sap floodplain support extensive capture fisheries, as well as rapidly expanding brackishwater and freshwater aquaculture. The Mekong Delta accounts for 70% of Viet Nam's aquaculture production and 63% of its marine capture fisheries. The Tonle Sap floodplain is particularly important because of its productivity and link to the inland fisheries of the lower Mekong basin, including Cambodia, Lao PDR, and Viet Nam. The Tonle Sap fishery alone accounts for almost two thirds of Cambodia's inland fishery catch and according to the *National Accounts of Cambodia* the fisheries sector made up 7.5% of GDP in 2010.

Lowland Plains and Plateaus. Lowland plains and plateaus—from forests growing in northern Cambodia to the partially irrigated, extensive agriculture of the Isan Plateau, to the highly irrigated Central Thailand plain—make up a quarter of the GMS and house 64 million people. Apart from sparsely populated northern Cambodia, population densities are moderate and poverty is widespread. Lowland plains have been largely cleared for agriculture in Thailand and Myanmar, with the remaining native vegetation limited to higher, steeper land. Significant stands of forest remain in northeastern Cambodia and the southern Lao PDR. Poor soils are widespread, access to water is limited, and the remaining forests have significant conservation value.

Agriculture is mostly rainfed, although annual rainfall is generally low. Lowland plains and plateaus produce a quarter of the GMS's rice, mostly in the wet season. In the dry season, farmers graze livestock on the rice stubble, planting a second crop of irrigated rice, or growing irrigated sugarcane, maize, legumes, pulses, or cassava. Large herds of cattle and buffalo graze in the plains and plateaus. Cattle are progressively replacing buffalo due to mechanization and dietary preferences for beef.

Large-scale plantations of oil palm, rubber, eucalyptus, sugarcane, cassava, and other industrial crops are increasing on the plains and plateaus. For example, by 2007, Lao PDR had granted

Upper: Manual tractor, Yunnan, PRC, called the "iron buffalo" in some lower Mekong countries. **Lower:** Carrying freshly harvested sugarcane, Guangxi, PRC. Women carry out vital farming tasks across the subregion.



Above left: Satellite image showing the extensive conversion of land in Isaan, the northeastern region of Thailand on the Khorat Plateau, to small-scale farming, mainly of rice.

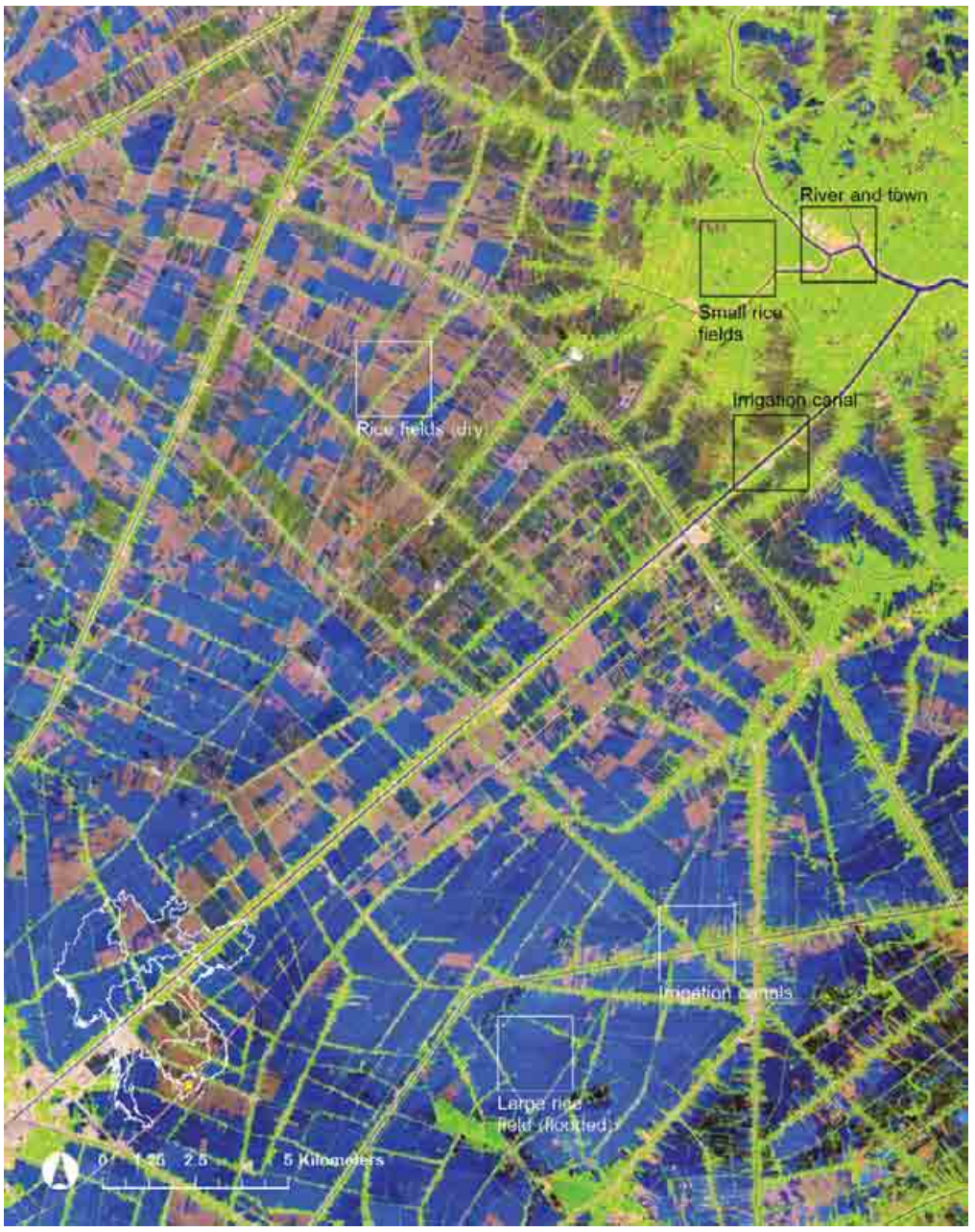
concessions to 123 large plantations covering 165,794 hectares. Sixty percent of these were located in the lowland plains of the central and southern Lao PDR. There is minimal infrastructure on the plains of northern and northeastern Cambodia but all other GMS countries have invested heavily in irrigation. Thailand's Chao Phraya River Basin is highly developed with two large water storages and thousands of small dams and reservoirs. Irrigation has expanded in Myanmar since the 1980s and now covers a quarter of the cropped area. In the Lao PDR, more than 4,000 small to medium-sized schemes pump water from rivers. This irrigation infrastructure covers 190,000 hectares during the wet season and 136,000 hectares in the dry season.

Coastal Plains. Narrow coastal plains rising rapidly to coastal ranges of 500 to 2,000 meters in height make up 10%–15% of Thailand, Myanmar, and Cambodia, and over a third of Viet Nam. Coastal rivers tend to be short and steep, with small watersheds. Coastal zones exhibit a range of agricultural systems, from paddy rice to rainfed field crops (legumes, cassava, sugarcane, and peanut), tree crops (fruit, nuts, eucalypt for paper pulp, jatropha, and rubber), and intensive cattle and pig farming. With farm sizes small and grazing areas limited, there has been a shift toward raising livestock intensively in combination with growing crops. Small-scale irrigation of rice and vegetables using rivers and groundwater takes place on the floodplains of coastal rivers. Plantations account for a quarter of the cropped area.

Significant areas of forest remain in coastal parts of Myanmar and Cambodia but rates of deforestation and mangrove clearance are high. Little natural forest cover remains in Thailand as a result of conversion to plantations since the early 1900s. Significant areas of forest remain in Viet Nam but logging and thinning have taken their toll.

Erosion in the coastal uplands is exacerbated by flash flooding along the short, steep coastal rivers. The sandy, low-fertility soils of the coastal strip make it hard for farmers to maintain productivity. Urban and agricultural pollutants reduce water quality in coastal environments close to densely populated parts of Viet Nam and Thailand. Pollution and the destruction of mangrove and coral habitats have affected fish stocks in the shallow waters fished by large numbers of small-scale fishers. Marine and brackishwater aquaculture is carried out extensively in the coastal zone, mainly in deltaic areas, and has been responsible for much of the loss of mangroves.

Intensively Farmed and Forested Uplands. Over half of the GMS consists of hills and mountains. These uplands support 85 million people, of



■ **Above left:** Weeding rice in the Mekong Delta, Viet Nam. **Above right:** Satellite image showing a typical section of the Mekong Delta, almost completely converted to rice fields. Increasing challenges are reduced freshwater flows during the dry season and seawater intrusion due to rising sea levels.

whom 46 million live in Yunnan Province, PRC. Two agricultural systems exist: intensive farming of highly productive, densely populated upland river valleys; and swidden agriculture and livestock grazing of sparsely populated forested terrains. This distinction is likely to remain, as large tracts of the forested uplands are steep, with poor, infertile soils. The boundaries between the two will shift as degraded soils return to forests and new lands come into production.

Intensive farming takes place on upland plains and in river valleys, which are often terraced for growing rice. The subtropical climate gives way to temperate conditions at altitude, enabling a wide range of plants to grow. Major food crops include rice, maize, vegetables, wheat, and cassava. Important cash crops are vegetables, flowers, tobacco, coffee, sugarcane, tea, rubber, pepper, tree fruits, cocoa, and mulberry. Farmers supplement irrigated wet-season rice with dry-season crops of faba bean, wheat, oil seed rape, or sugarcane. They also raise livestock semi-intensively. Partial irrigation supports some cash crops, including tobacco, vegetables, and coffee. Using groundwater to irrigate coffee plantations in Viet Nam's Central Highlands has depleted water supplies.

Traditionally, upland farmers derived their livelihoods from shifting or swidden cultivation (see next section), livestock farming, and by growing a limited number of cash crops. Upland fishing is insignificant economically but provides valuable protein to communities.

Concerns about sustainability, the desire to locate populations in areas where services exist, and various political and security issues have led all governments to introduce programs to resettle ethnic minorities and eradicate shifting cultivation. These policies have prompted the expansion of permanent upland agriculture, often in unsuitable areas. Commercial plantations of rubber, timber, and oil crops are also increasing, particularly in southern Yunnan, the northern Lao PDR, and parts of Myanmar. Wild-sourced timber remains an important economic sector in the uplands of Myanmar. A relatively high proportion of forest cover remains in the uplands, but it is shrinking. Rates of loss are high in Myanmar and the Lao PDR but have stabilized in Yunnan Province and Viet Nam, where replanting and restoration programs have increased tree cover.

Intensive upland farming causes catchment-wide soil erosion. This decreases soil fertility and overloads waterways with sediment. Inle Lake in Myanmar has shrunk in length from 56 to 15 kilometers during half a century. Plantations also cause high soil erosion rates unless the understory is maintained.

Plowing fields using draught animals—here water buffaloes near a Karen village, Thailand—is a common sight across the subregion.

■ **Upper:** Upland farming in the Song Bung area, Quang Nam Province, Viet Nam. **Lower:** Carrying harvested rice stalks home for drying, Luangprabang, Lao PDR.

Swidden Agriculture

Swidden cultivation, practiced for centuries in the highlands of the subregion, is the dominant farming system among traditional ethnic societies. Two forms of swidden cultivation can be distinguished: pioneering and established. Vietic groups, such as Arao, Maleng, and Malang in the Lao PDR, practice pioneering swidden cultivation, a simple slash-and-burn technique for monocropping mainly cereals and legumes. Other ethnic groups, such as the Brou of the Lao PDR, practice the more stable established form, in which trees, annual crops, short-term cereals, and legumes are grown together.

Swidden cultivation is understood differently by government, academe, and civil society groups. Some believe swidden cultivation causes deforestation and soil erosion. But, in reality it can contribute to biodiversity conservation and soil erosion control. Established rotational cultivation is an important way to conserve traditional plant genetic resources that are highly adapted to local conditions. Nevertheless, some swidden cultivation practices are destructive to the environment.

Viet Nam Central Highlands. In the Se San watershed of the Central Highlands of Viet Nam, the Gia Rai and Ba Na people plant upland rice in forest clearings. Most Gia Rai swiddens use few crop species, depending on the suitability of the soil. The common swidden cycle takes 5–7 years: 2 years of dry rice farming, followed by 3–5 years fallow. Some rice swiddens are almost pure monocultures. The average area cultivated for swidden rice is approximately 0.05 hectares per person, yielding an average harvest of 65 kilograms. Cassava swiddens are often planted in soils that are too sandy and infertile to support rice.

Chamkars of Cambodia. In Cambodia, a clearing for swidden or chamkar—a field or garden cut from the forest—is usually made in secondary forest or forest fallows. Chamkars are cultivated for 1–5 years, depending on soil quality, after which they are left fallow for 7–10 years, depending on the extent of tree regrowth, soil fertility, and the absence of weeds.

Rice is the central or staple crop and in each chamkar 3–7 different varieties of rice, usually upland rice, are grown. Many other crops are grown for food security, including vegetables (sesame and legumes), root crops, gourds, fruit (bananas), and nonfood crops of different heights. This method helps to maintain a complete cover of vegetation, which prevents soil erosion, retains moisture during dry periods, and discourages the growth of grasses.

The Hai System of the Lao PDR. In the Lao PDR, the swidden cultivation or hai system is relatively stable under low population density (less than 0.4 persons per hectare) and low to moderate cropping intensity. Hai fallows should be long, 10–15 years. When the fallow period is less than 6 years, the hai system becomes unsustainable, as indicated by such factors as poor fallow vegetation cover, rapid reduction of yield, high weeding requirements, acute rice deficit, and rapid depletion of forest resources and other communal resources.

Precarious Balance: Ecology and Development. Population pressure and lack of government support have generally undermined the productivity and sustainability of swidden cultivation. Government campaigns of fixed settlement and cultivation have limited the mobility of ethnic minority communities. In Viet Nam, households practicing swidden agriculture have been allocated a fixed area for cultivation, with leasehold ownership of 20–30 years. As a result, the living space of these households that were formerly dependent on swidden farming has now been limited to the few hectares of land allocated to them.

Agroecosystems

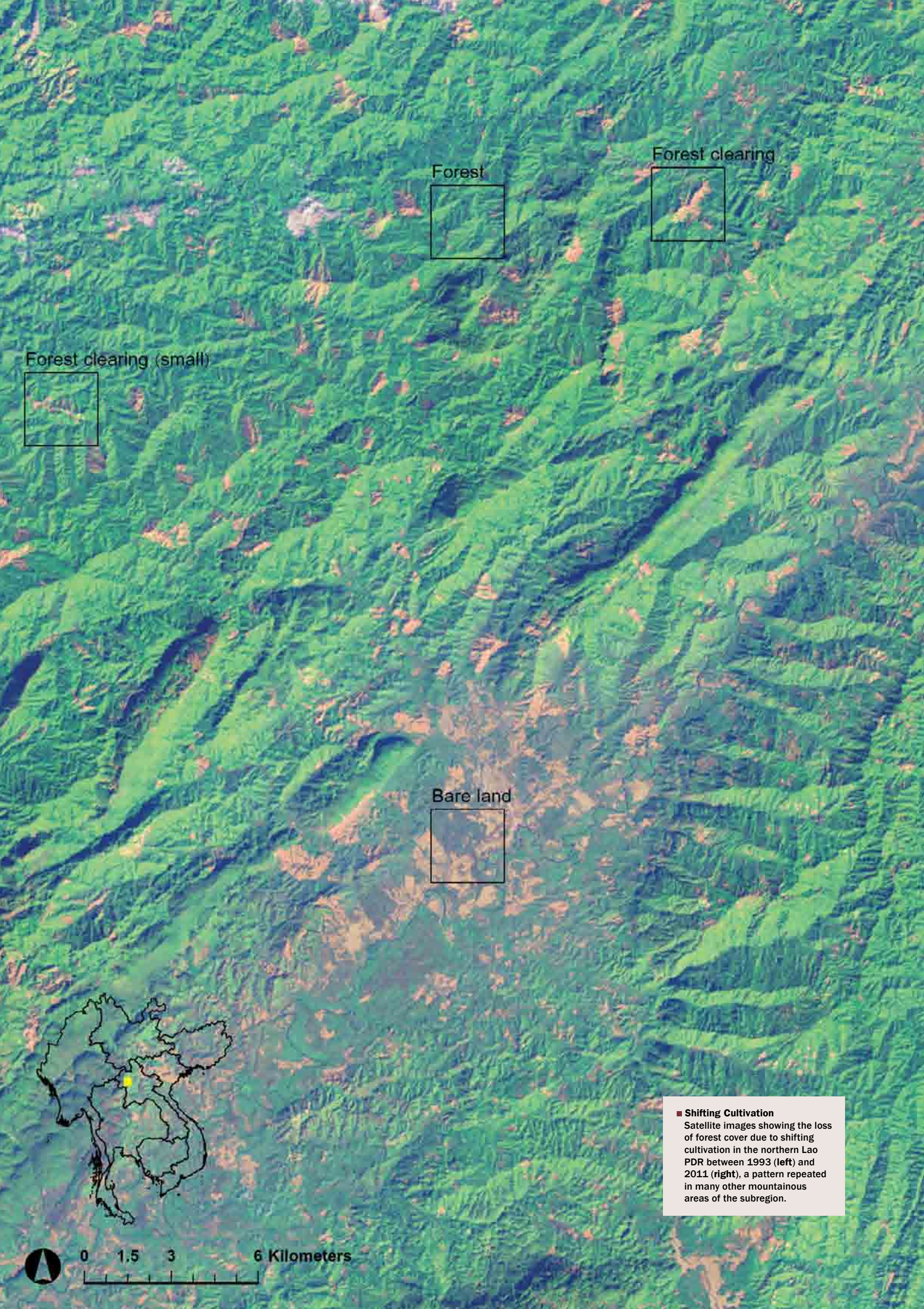
Livelihoods in each agroecological zone are quite diverse; farmers make use of a number of different land types in their livelihoods. These "agroecosystems," or ecological systems in agricultural lands, are essentially natural ecosystems modified by humans for farming and livelihood purposes. These livelihood systems fall within one of eight generic agroecosystem types.

The key services and functions, major problems, and opportunities for each of the eight types are described in the table below. Some, like flooded rice fields, have lasted hundreds of years. In recent decades, the ecosystem goods and services that the different agroecosystems provide have in some cases been altered and often threatened as agricultural technology development has accelerated.

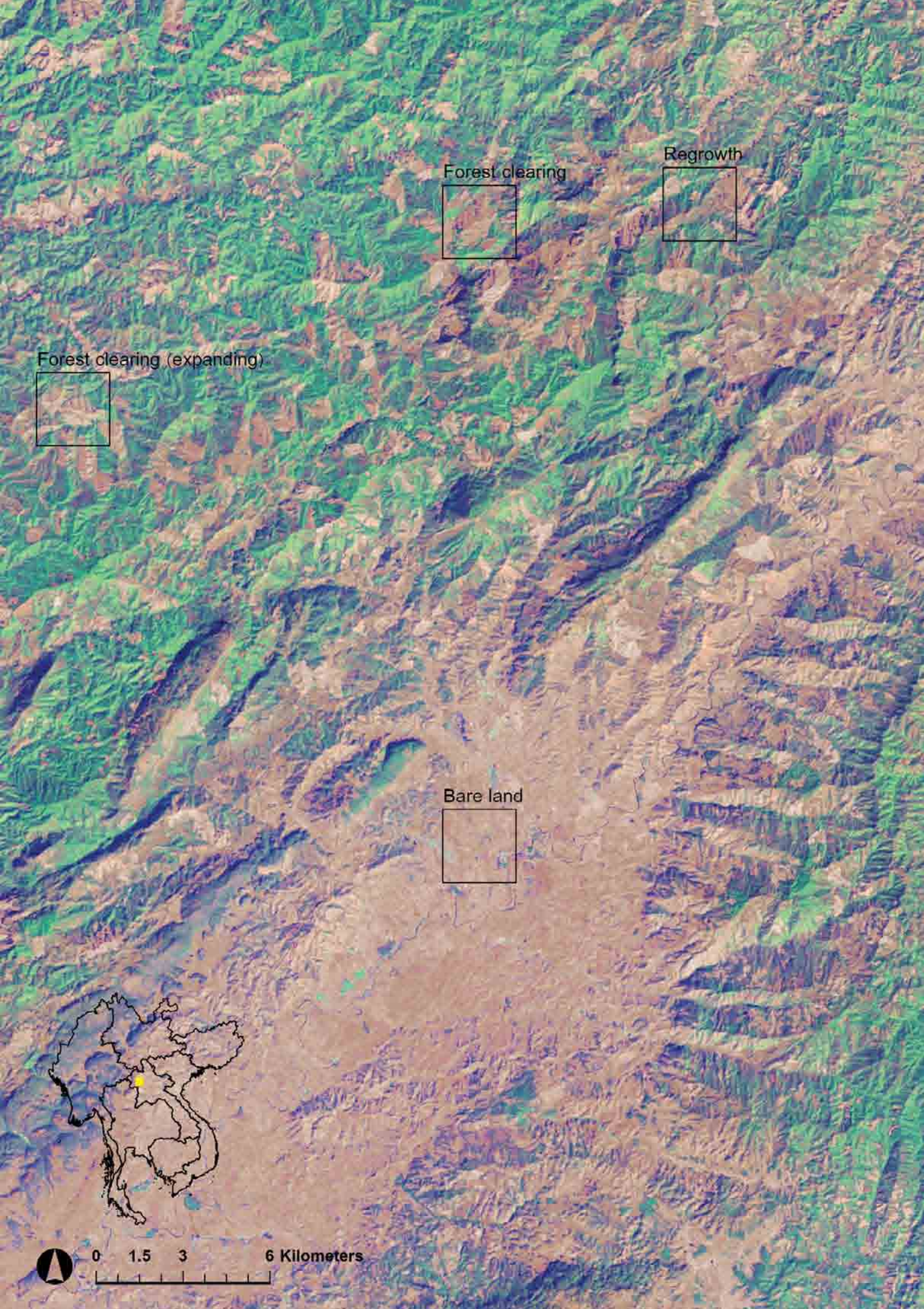
Agroecosystem	Ecosystem Services Provided	Major Problems	Key Opportunities
Forest	Hydrological and nutrient cycling Carbon sequestration Biodiversity conservation Crop pollination, Microclimate and pest regulation Provisioning (fish, etc.).	Forest conversion Forest degradation Loss of ecosystem services Wildlife poaching Overexploitation of non-timber forest products (NTFPs)	Strengthened protected area management systems Sustainable livelihood development in protected area buffer zones and corridors NTFP sustainable management NTFP domestication NTFP value-chain development Ecotourism
Wetland	Hydrological cycling Sediment sink Water purification Aquatic biodiversity conservation Provisioning (wood, NTFPs, etc.) Amenity (ecotourism, etc.)	Increased water demand Drying due to climate change Sedimentation Land filling Chemical run-off. Loss of riparian forest	Rehabilitation of riparian forest Check dams to rehabilitate aquatic biodiversity Community management of wetlands
Grassland	Grass cycle Pollination Provisioning (forage, NTFPs) Amenity (scenic values)	Overgrazing Soil erosion Land-grabbing	Enhanced land tenure systems Sustainable pasture management Fire control Improved cattle disease control
Seasonally flooded	Nutrient cycling Aquatic species conservation Provisioning (fish, NTFPs, etc.) Amenity (tourism transport, etc.)	Changed hydrology Land grabbing Increased use of agro-chemicals	Improved environmental safeguards Organic rice production Genetic improvement of floating rice varieties
Flooded rice field	Nutrient cycling Sediment capture Erosion and weed control Provisioning (rice, fish, etc.) Cultural (rice-growing cultures)	Increased input costs Extreme weather events Insufficient irrigation Increased pests/disease	Integrated fertility management Integrated pest management Irrigation expansion Improved on-farm water management
Upland	Swidden nutrient cycling Carbon sequestration Crop pollination (fallows) NTFPs (fallows) Provisioning (rice and other crops) Cultural (ethnic diversity and indigenous knowledge)	Reduced swidden cycle Insecure tenure Soil erosion/fertility loss Increased chemical use	Climate resilient technology development Agrobiodiversity conservation Soil improvement (bio-char, etc.) Integrated pest management NTFP domestication
Plantation	Carbon sequestration (tree crops) Provisioning (labor and income)	Land degradation Loss of community access Limited opportunities	Improved land management planning Strengthened agriculture sector Environmental safeguards Improved land-use planning Management information systems Community land titling
Home garden	Byproduct recycling Food-chains Provisioning (food and herbs) Cultural (traditional livelihoods, indigenous knowledge)	Limited area Animal diseases Lack of markets Limited value added	Product processing, value added Green value chain development Improved livestock management Animal health programs NTFP domestication

NTFP = non-timber forest product.

Upper: Preparing a Chamkar (cleared forest area) for crops, northern Cardamom Mountains, Cambodia. **Lower:** Draught power using bullocks, Myanmar.



■ **Shifting Cultivation**
Satellite images showing the loss of forest cover due to shifting cultivation in the northern Lao PDR between 1993 (**left**) and 2011 (**right**), a pattern repeated in many other mountainous areas of the subregion.

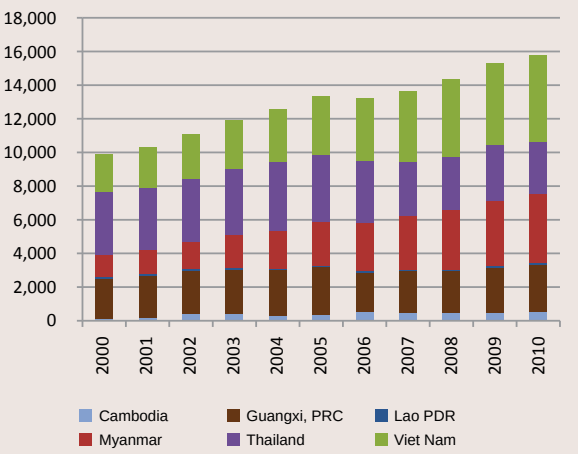

Forest clearing
Regrowth
Forest clearing (expanding)
Bare land
0 1.5 3 6 Kilometers

■ **Upper and Lower:** Early morning scenes at a bustling fishing port near Nha Trang, Viet Nam.

Fisheries

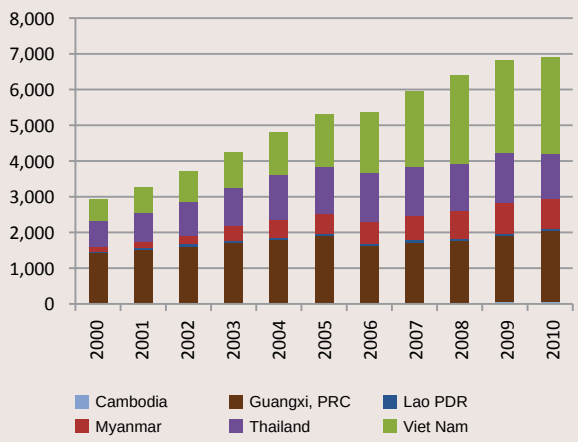
Fisheries Production. Total (marine and freshwater) annual fisheries production in the GMS (except Yunnan, PRC) in 2010 was in excess of 15 million tons, showing an increasing trend, except in Thailand. Aquaculture, or fish farming, production has risen more rapidly, doubling from 3 million tons to 6 million tons during 2000–2007, and to around 7 million tons in 2010, with Viet Nam showing the fastest growth. However, there has been clear underreporting, especially in the case of Cambodia, whose estimated annual production was raised significantly following recent improvements in data collection and reporting. The large number of widely dispersed small-scale and subsistence fisheries around the subregion hinders accurate measurement.

Annual Total Fisheries Production in the GMS, 2000–2010 (thousand ton)



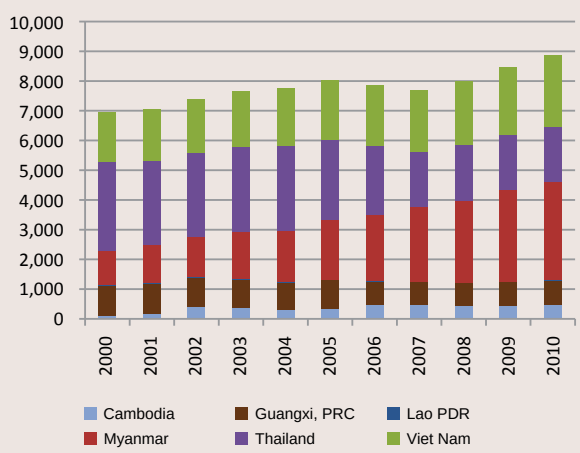
GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic.
Note: Yunnan data not available.
Source: FAO. FAOSTAT. http://faostat.fao.org/site/291/default.aspx (Accessed 7 August 2012); Government of Myanmar, Ministry of Agriculture and Irrigation, Department of Agricultural Planning. 2011. *Myanmar Agriculture at a Glance 2011*. Nay Pyi Taw; Kingdom of Thailand, Ministry of Agriculture and Cooperatives, Department of Fisheries. 2009. *Fisheries Statistics of Thailand 2008*. Bangkok; Guangxi Bureau of Aquatic Products and Animal Husbandry. Nanning; Royal Government of Cambodia, Ministry of Agriculture, Forestry and Fisheries for Food Security and Sustainable Development. http://www.stats.maff.gov.kh/en/index.php?option=com_content&view=article&id=20&Itemid=93 (Accessed 1 December 2011); Viet Nam Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi.

Annual Aquaculture Production in the GMS, 2000–2010 (thousand ton)



GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic.
Note: Yunnan data not available.
Source: See table on annual total fisheries production.

Annual Capture Fisheries Production in the GMS, 2000–2010 (thousand ton)



GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic.
Note: Yunnan data not available.
Source: See table on annual total fisheries production.

Freshwater capture fisheries and aquaculture from the lower Mekong basin are a major component of the total at more than 3.9 million tons in 2008, comprising 1.9 million tons from capture and 2 million tons from aquaculture. This basin and its freshwater fisheries are among the most productive in the world. The total economic value of the Mekong fisheries is estimated at US$3.9–7.0 billion per year. Hundreds of wild fish species are caught, as well as a wide range of other aquatic animals, including shrimps, crabs, molluscs, insects, snakes, and turtles.

Aquaculture operations include dozens of species. Cultured fish dominate sales in city markets in the Lao PDR and Thailand. Much of the increase is due to culture of tilapia, pangasiid catfish, and shrimp. Aquaculture exports amount to about one million tons per year.

Dependence on Fish. The importance of fish to the people of the subregion has often been underestimated. In Cambodia, fish and rice production is the basis for food security, and in other countries in the subregion, most poor people also rely heavily on fish for protein. Some fish are consumed fresh throughout the year, but preserved fish, fish paste, and fish sauce—which are made at the end of the wet season when fish are abundant and cheap—are equally important.

As well as the catching or growing of fish and other aquatic animals, fisheries involve processing, transporting, and marketing of fishery products and many other supporting industries. Fisheries in the lower Mekong basin occupy millions of people who work full- or part-time, as individuals or in small groups, or as part of large commercial operations.

Data from consumption surveys in the lower Mekong basin in 2000 indicate that about 2.6 million tons of freshwater fish and other aquatic animals were consumed by a population of 56

Upper: Family sorting their fish catch on Tonle Sap, Cambodia. Artisanal fisheries on the lake support many thousands of households. **Lower:** Artisanal fisher with traditional fishing net on Inle Lake, Myanmar.

■ **Upper:** Fish from the Mekong River for sale in a Luangprabang market, Lao PDR. **Lower:** Bargaining for fish at a fishing port near Nha Trang, Viet Nam.

million people, an average of nearly 34 kilograms per capita in that year, of which fish made up 80% and other aquatic animals the remainder. Viet Nam and Cambodia were the highest consumers. Freshwater production accounted for 47%–80% (country range) of animal protein in the diets of the population, a daily average intake of 18.3 grams per capita of a total animal protein intake of 32.5 grams. To these totals must be added the consumption of marine products in the four lower Mekong basin countries, although only significant in Thailand and Viet Nam as the table below shows.

Estimated Per Capita Consumption and Production of Fish and Other Aquatic Animals in the Lower Mekong Basin in 2000

	Cambodia	Lao PDR	Thailand	Viet Nam	Average/ Total
Per capita consumption (kilogram/year)					
Inland fish	32.3	24.5	24.9	34.5	29.3
Other aquatic animals	4.5	4.1	4.2	4.5	4.3
Total freshwater	36.8	28.6	29.0	39.0	33.7
Production (ton/year as fresh weight animal equivalent)					
Inland fish	481,537	167,922	720,501	692,118	2,062,077
Other aquatic animals	105,467	40,581	190,984	160,705	497,737
Total freshwater	587,004	208,503	911,485	852,823	2,559,814
Marine products	11,421	2,480	130,075	129,418	273, 394

Lao PDR = Lao People's Democratic Republic.
Source: Mekong River Commission. 2007. *Consumption and the Yield of Fish and Other Aquatic Animals from the Lower Mekong Basin*. Vientiane.

Scientists estimate a maximum sustainable annual freshwater catch in the lower Mekong basin in the range of 0.7–2.9 million tons. The catch in 2008 (1.9 million tons) suggests that the fishery still has potential to expand, but much depends on maintaining the ecosystems that support the aquatic fauna. Overall, the data reveal an enormous inland fishery that is vital in terms of nutrition, livelihoods, food security, and culture.

Most inland aquaculture is in northeastern Thailand on the Khorat Plateau and in the Mekong Delta in Viet Nam, and production has been steadily increasing. Traditionally, tiny fry or fingerlings are caught in rivers and lakes and raised in enclosures but in recent years, the artificial rearing of fry of some species is making their production more reliable. Given the problems facing the fisheries in the subregion, the aquaculture subsector will become more important in the future, but itself may be constrained by environmental problems, such as water shortages and pollution from agricultural run-off.

Fish Provide Much More than Protein

Virtually all farm families in the lower Mekong basin, and most other rural families as well, fish for subsistence and for extra cash income. Fish are eaten regularly by almost all people, providing not only a major source of protein but also essential elements (including calcium, iron, and zinc) and vitamins—particularly vitamin A. Smaller fish generally have higher mineral content than large fish, so they are particularly important to the rural poor who tend to eat small fish and sell larger fish.

Fish also compare very favorably in calcium content with other common foods; recent studies show that calcium absorption from small fish is similar to that from milk.

Protecting the exceptionally productive freshwater fisheries of the Mekong and other rivers should be a very high priority across the GMS. If the fisheries begin to fail and the rate of fish consumption falls, public health, especially among the poor, will be very seriously affected. Most poor people have no other sources of food. The loss of dietary calcium, for one, would be difficult to offset. Milk has been successfully introduced into the regular diet of many people in Thailand, but it is comparatively expensive and there is not enough of it to feed everyone in the subregion. Besides, lactose would be indigestible to many adults who rarely, if ever, drank milk in their childhood.

Potential Threats to Aquatic Fauna and Fisheries

The Mekong River system has two general classes of fish: white fish, which migrate seasonally up and down the river and its tributaries; and black fish, which live in lakes, ponds, and swamps. Both classes of fish disperse seasonally across 70,000 square kilometers of diverse habitats on the nutrient-rich floodplains to reproduce and grow. There are about 20,000 dams and weirs in the lower Mekong basin alone. These structures have affected the fish, which are also under threat from current and planned dam projects on the Mekong River main stem.

There are at least 1,200 species of fish, and possibly as many as 1,700, living in the Mekong River Basin. They have developed over many millennia in response to a flow regime that varies greatly from the wet to the dry season. The annual change includes not only a large seasonal floodplain, but also the important and unique reversing flow of the Tonle Sap River and the flood buffer system of Tonle Sap itself. Fish reproduction is keyed to this hydrological cycle, as evidenced by the close correlation between the annual maximum flood level and the fish catch of the *dai* (large bag net) fishery in the Tonle Sap River.

Threats arise from two sources: the impacts of fisheries activities themselves and impacts arising from outside the fisheries sector. The direct threats to biodiversity posed by the fisheries sector include the use of destructive fishing methods (explosives, poisons, and electrocution); exploitation of fish at vulnerable stages, such as at spawning times; and fishing in sensitive areas, such as spawning grounds.

The highly migratory fish stocks are more vulnerable to over-harvest. Large numbers of these fish migrate at

the same time, making them vulnerable to intensive fishing, and especially to large-scale commercial operations. Examples include the *dais* on the Tonle Sap River. Because licenses have a short duration, many fishers tend to over-exploit the fishery.

Outside the sector, the negative consequences of deforestation, inappropriate agriculture, road construction, hydropower, and other forms of development are already evident. A second major concern is the loss of riparian vegetation cover, and, in particular, the rapid loss of flooded forests, which provide crucial habitat for fishes.

Dams and Weirs. Each dam built for hydropower generation, irrigation, flood control, or water supply stores water in the wet season and releases water in the dry season, thus reducing the flow of the river in the wet season and increasing it in the dry season. These modifications in the flow regime alter the natural dynamics of the river and can also disrupt fish migration and spawning, thus reducing the yield of fisheries.

The rapid pace of tributary hydropower development highlights the importance of assessing the cumulative impacts of the tributary dams, including the impacts on tributary river flow regimes, fish passage, water quality, and sediment flow.

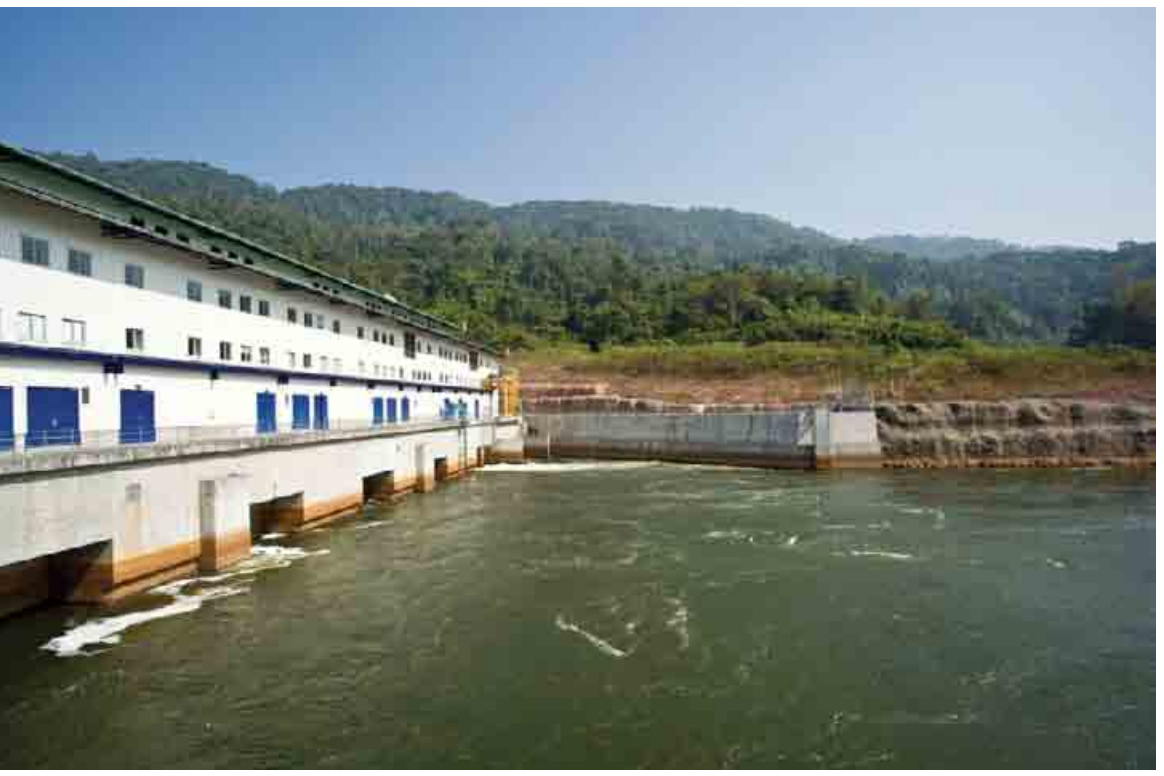
Two options have been identified for the proposed Sambor Dam on the main stem Mekong River in Cambodia. The high option, with an 800-square kilometer reservoir, would seriously obstruct fish migrations. The low option would be less of an obstacle, but would still present a significant danger to masses of planktonic fish eggs, larvae, and fry diverted through the power plant. A feasibility study for the low dam was done in 2000, but the proposal remains controversial, especially following the detrimental effects of the Pak Mun Dam on fisheries in that watershed.

Lancang Cascade. Of the planned cascade of eight dams, primarily for hydropower, in the Mekong main stem in Yunnan, two have been completed, and three more are under construction. The Lancang Cascade could have significant impact downstream on the river's hydrology, annual flood pattern, fisheries, and navigation. Most importantly, sedimentation in the reservoirs will make the released water deficient in sediments and thus clearer than normal; reservoir stratification could also make the water devoid of oxygen at times.

Navigational Improvements in the Upper Mekong River. In 1993, the governments of the Lao PDR, Myanmar, PRC, and Thailand began looking into how the Mekong River could be made more navigable for regional commerce. In its natural state, the river can be navigated year-round only

Upper: Scooping shrimp from a large shrimp pond in the Mekong Delta, Viet Nam. The pond is dotted with young, replanted mangroves, part of a Government coastal rehabilitation program. **Lower:** Family removing fish from a net, Tonle Sap, Cambodia.

Fishing boats anchored near Nha Trang, Viet Nam.



■ **Upper:** Using cast nets to catch fish in a flooded rice field, Cambodia. **Lower:** The Nam Theun 2 hydro dam in Lao PDR.

Removing Barriers to Fish Movement

The Pak Mun Dam, 5 kilometers from the confluence of the Mun and Mekong rivers, has blocked the migration of white fish between the two rivers, and decimated important fisheries upstream from the dam. The 120,000-square kilometer Mun-Chi River Basin is one of the largest sub-catchments of the Mekong River; however, the small, poorly designed fish pass at the dam is inadequate to accommodate either large individual fish or large numbers of fish (many tens of thousands of fish may need to pass at the height of the migrations). Social protests since the dam's completion in 1994 have occasionally forced authorities to keep its floodgates open to allow fish to pass through, and when that has happened, the fisheries have temporarily rebounded as a result.

by small vessels of less than 60 dead-weight tons because of reefs, shoals, and rapids between the Yunnan border of the PRC and Ban Houayxai in the Lao PDR, although some sections can be safely navigated by larger vessels in high water. In April 2000, the four countries agreed to make the river eventually navigable by barges of up to 500 dead-weight tons by removing the rapids, shoals, and reefs, and increasing the dry season flow by releasing water from the Lancang Cascade.

These rapids, shoals, and reefs regulate water flows and oxygenate the water. They are also important habitats and spawning grounds for fish. Among the fish most at risk from such development is the endangered giant Mekong River catfish.

River Pollution from Many Sources. Most arable land in the subregion is already cultivated. New technology and intensified farming to feed the growing population probably will mean increased fertilizer and pesticide use. Fertilizers speed up eutrophication (a process that reduces the amount of available oxygen) while pesticides can kill fish or affect their reproduction. Thus, fish production is reduced in rivers and lakes that receive agricultural runoff.

Industrial, municipal, and domestic wastes will increase as the population grows. Like agricultural chemicals, these wastes hasten eutrophication and increase the toxicity of receiving waters.

To protect both inland and coastal fish and fisheries in the GMS, better regulation of agricultural chemicals and their use, and more efficient facilities for treating industrial, municipal, and domestic wastes are essential.

Food Security

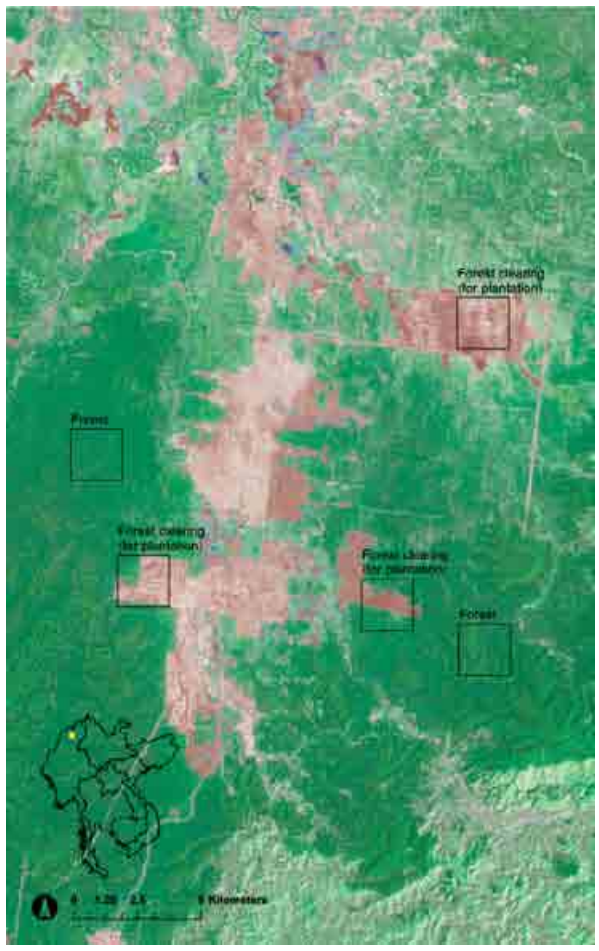
Although levels of nutrition have improved since 1990, undernourishment remains a problem in all countries of the GMS. The 2008 Global Hunger Index considers hunger levels to be "moderate" in Thailand, "serious" in Viet Nam and Myanmar, and "alarming" in the Lao PDR and Cambodia. Based solely on population growth, food demand will rise by at least 25% by 2050. The population of the GMS is forecast to exceed 340 million by 2030.

Food insecurity mostly affects remote mountain areas with low rice production. Local crop failures, lack of access to markets, poverty, floods, and droughts can all prevent people getting enough food. Food security is not only a local or national issue, as countries in the GMS are significant exporters. In 2006, Thailand and Viet Nam exported more than 12 million tons of rice, with much going to food-scarce African nations. Food exports to the PRC are rising; its population is expected to swell from the present 1.35 billion to 1.45 billion by 2025. A drop in food productivity in the GMS could, therefore, have serious consequences elsewhere.

Between 20% and 30% of the people of the GMS now live in cities and this proportion is expected to increase in the next 20 years. Cities provide alternative sources of income for farmers but conflicts over land can also arise as cities encroach on surrounding farmlands. To meet future needs, agriculture must be transformed to deliver food security, environmental services (such as clean water and carbon sequestration), and economic growth. Future agricultural systems will need to be flexible and diverse to withstand and respond to climate change and other factors.

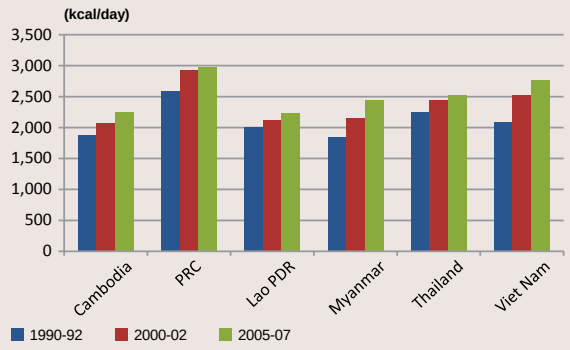
■ **Women vegetable traders in a market in Bagan, Myanmar.**

Above: Tea plantation, Quang Nam Province, central Viet Nam. **Right:** Satellite images showing the rapid development of commercial plantations in northern Myanmar from April 2010 (left) to April 2011 (right).



■ **Vegetable farm, Red River Delta, Viet Nam.**

Trends in the GMS Food Consumption per Person



GMS = Greater Mekong Subregion, kcal = kilocalories, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Source: FAO. FAOSTAT. http://faostat.fao.org/site/291/default.aspx.

International prices of the two key staple cereals produced and consumed in the GMS, rice and wheat, have spiked unexpectedly in the past. In 2007, world rice prices were roughly double the levels of 2002 and in the first quarter of 2008, the rate of increase of international rice prices sharply accelerated, fueling inflation and stoking fears of a 21st century food crisis in Asia. Wheat—the second most important item in the food consumption basket in Asia—has also had a spike in international prices although not as pronounced as in the case of rice.

A complex set of factors has caused a phenomenal increase in world food prices in recent years. These include declining stocks as a result of productivity growth failing to keep pace with consumption growth, the rising scarcity of oil, weather–related factors, and financial market behavior. Most importantly, the rapid increase in world population; competing use of food grains for non-human consumption, such as animal feed and biofuels; pricing policies; and underinvestment in agriculture in the past decade have discouraged farmers from increasing production. The rising cost of farm inputs due to high fuel prices, inadequate postharvest handling and distribution systems, and poor infrastructure have also served to dampen supply.

The surge in the prices of agricultural commodities has threatened economic stability and overall growth, especially for low-income net-importing countries. However, the impacts of high food prices on national income and the balance of payments can be relatively small, as distinct from impacts on poor households. The most visible impact of the price surge of agricultural commodities has been food price inflation.

In some GMS countries, where poor households spend about 70%–80% of their income on food, the impacts of rising food prices will

■ **Upper:** Busy floating market, Nga Nam, Viet Nam. **Lower:** Traditional food preparation, Champasak village, Lao PDR. Rice is almost always the main staple across the subregion.

be severe. With rapidly declining purchasing power, poor households face the risk of food insecurity and malnutrition as they compromise on more expensive sources of nutrient-rich foods, health care, education, and other non-food household expenditures. In the absence of social safety nets, this can pose serious risks to poor households, such as reduced food intake, or reduction in the intake of more nutritious foods, and a reduction in health and wellness. Coping mechanisms are likely to take the form of sale of household or farming assets, or taking out loans at exorbitant rates with the danger of default.

With over one third of the GMS population living under the poverty line, the consequences of rising food prices have already been severe for the poorer households and smallholder farmers, threatening to wipe out the gains from past poverty reduction efforts. A 10% increase in the price of rice will increase national poverty rates by 0.5%. Landless households, daily casual laborers, female-headed households, and the handicapped (those with chronic illnesses) are the most severely affected.

The urban poor are more likely to be affected by increasing fuel costs. Rising costs of inputs, such as imported feed ingredients, are raising prices of poultry and other meat products. This trend in rising food inflation is likely to erode food affordability of the poor. Urban households will experience greater losses in real income, owing to their larger proportion of food expenditure to total expenditure than that of rural households.

The increase in world food prices has coincided with not only the increase in fuel prices—which is a global phenomenon—but also with increases in the cost of land and housing, education, and social services.

Retail Price of Milled Rice (domestic currency per ton)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
PRC	1,323	1,422	1,580	1,637	2,362	2,225	2,174	2,430	2,400	3,930	4,600
Lao PDR	2,374,000	2,339,750	2,659,083	3,495,583	4,007,250	4,075,250	4,622,084	5,003,334	6,385,750	7,123,084	7,437,458
Myanmar	46,258	46,995	98,005	—	—	155,800	217,276	259,408	352,337	340,919	—
Thailand	7,332	7,040	7,681	7,636	8,968	10,847	10,885	10,500	18,951	16,964	13,927
Viet Nam	2,782,500	2,509,500	3,423,000	3,454,500	3,664,500	4,315,500	4,462,500	5,764,862	9,336,257	8,907,854	11,041,665

- = not available, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Note: For Thailand, data are wholesale prices.
Source: International Rice Research Institute. http://beta.irri.org/index.php/Online-Query.html.

Water Availability, Demand, and Use

The availability of surface water resources in terms of the amount internally renewable in a country on an annual basis varies widely in the Greater Mekong Subregion (GMS). In 2010, the Lao People's Republic (Lao PDR) had the largest per capita availability of water resources and Yunnan Province of the People's Republic of China (PRC) the smallest. Viet Nam had the highest per capita withdrawal rate of water resources followed by Thailand. Over 90% of total annual freshwater withdrawal in the GMS countries is allocated to the agricultural sector, except in Guangxi Zhuang Autonomous Region (58%) and Yunnan (64.6%). Water withdrawal for domestic use, as a percentage of freshwater availability, is highest in Guangxi (23.4%), closely followed by Yunnan (15.5%), with the lowest in Viet Nam (1.5%). These withdrawals will increase over the coming decades.

Although all countries in the GMS currently remain above the water stress limit (estimated at 1,700 cubic meters per capita), future challenges of population growth, increasing urbanization, impacts on water quality, and climate change need to be given due consideration. These challenges could exacerbate issues of food, water, and energy security, thus affecting the economic well-being in the GMS. Measures to mitigate and build resilience against these threats are needed to avoid future insecurity.

Freshwater Availability and Withdrawals in GMS Countries, 2005-2010

	Availability (2010)			Withdrawals (2005-2010)				
Country	Internal Flows (billion cubic meter)	Flows from Other Countries (billion cubic meter)	Annual Total Resources per capita (cubic meter)	Annual Withdrawals (billion cubic meter)	Total Water Withdrawal per capita (cubic meter)	Annual Withdrawals for Agriculture (%)	Annual Withdrawals for Industry (%)	Annual Withdrawals for Domestic Use (%)
Cambodia	120.6	355.5	33,675	2.2	159.8	94.0	1.5	4.5
PRC								
Guangxi	208.0	5.9	3,771	30.2	623.0	58.3	18.3	23.4
Yunnan	194.1	2.2	4,424	14.8	321.6	64.6	17.3	15.5
Lao PDR	190.4	143.1	53,782	4.3	718.3	93.0	4.0	3.1
Myanmar	1,576.6	165.0	30,838	47.1	926.0	90.9	3.1	6.0
Thailand	224.5	214.1	6,345	57.3	845.3	90.4	4.8	4.8
Viet Nam	359.4	524.7	10,064	82.0	965.0	94.8	3.7	1.5

GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic, PRC= People's Republic of China.
Source: National Bureau of Statistics of China. 2011. *China Statistical Yearbook 2011*. Beijing; FAO. AQUASTAT. http://www.fao.org/nr/water/aquastat/dbase/index.stm (Accessed on 10 August 2012); Guangxi Bureau of Statistics. 2011. *Guangxi Statistical Yearbook 2011*. Beijing; Guangxi Conservancy Department. 2011. *Statistical Communiqué on Water Conservancy of Guangxi*. Nanning; Guangxi Environmental Protection Department. 2010. *Report on State of Environment in Guangxi*. Nanning; Myanmar Ministry of Agriculture and Irrigation. 2009. *Water Resources Management in Myanmar*. Nay Pyi Taw; World Data Bank. *World Development Indicators and Global Development Finance*. http://databank.worldbank.org/ddp/home.do?Step=1&id=4 (Accessed 26 December 2011); Yunnan Bureau of Statistics. 2011. *Yunnan Statistical Yearbook 2011*. Beijing; Yunnan Water Resources Bureau. 2010. *Yunnan Water Resources Report 2010*. Kunming.

Upper: Transplanting young rice plants, Champasak, Lao PDR. Agriculture accounts for over 90% of water use in most GMS countries. **Lower:** Swimming in an irrigation canal, Champasak, Lao PDR.

■ **Upper left:** Ba Lai Irrigation Dam in the Mekong River Delta, Viet Nam. **Upper right:** Water treatment facility, Phnom Penh Water Supply Authority, award-winning water utility in Cambodia's capital. **Lower left:** Water for domestic use. A hand pump provides water to Champasak village, Lao PDR.

Water Resources and Withdrawals in GMS Countries

	Cambodia	PRC*	Lao PDR	Myanmar	Thailand	Viet Nam
Water Resources						
Long-term average annual precipitation						
Depth (= internal renewable water resources) (millimeter per year)	1,904	645	1,834	2,091	1,622	1,821
Volume (cubic kilometer per year)	345	6,192	434	1,415	832	603
Long-term average annual renewable water resources						
External renewable water resources (cubic kilometer per year)	355	27	143	165	214	525
Total renewable water resources (cubic kilometer per year)	476	2,840	334	1,168	439	884
Total dam capacity (cubic kilometer)	—	562	8	15	77	20
Pressure on Water Resources						
Total freshwater withdrawal as proportion of average renewable water resources (%)	0.5	19.5	1.3	2.9	13.1	9.3
Agriculture water withdrawal as proportion of average renewable water resources (%)	0.4	12.6	1.2	2.5	11.8	8.8
Area Equipped for Irrigation						
Total area equipped for irrigation ('000 hectare)	353	62,938	310	2,110	6,415	4,585
As proportion of cultivated area (%)	8.9	51.4	26.5	18.1	34.0	48.7
Actually irrigated ('000 hectare)	317	54,219	271	2,110	5,060	4,585

* Refers to the People's Republic of China as a whole.
- = not available, GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic, PRC= People's Republic of China.
Source: FAO AQUASTAT. http://www.fao.org/nr/water/aquastat/countries_regions/index.stm

There is increasing competition for water from agriculture, towns and cities, and industrial estates and growth centers. Urban centers and industries in the Mekong River Basin depend very much on the Mekong River and its tributaries for their water supply. Populations in some cities 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 demand projections to 2020 denote a dramatic rise.

Demand scenarios of the Lower Mekong River Basin studied by the Mekong River Commission in its second Basin Development Plan provide some guidance on growth patterns. In the agricultural sector, demand for water is set to nearly double across the GMS countries by 2030.

Total Water Demand Per Capita and Domestic-Industrial Demand in the Mekong River Basin, 1990 and Projected to 2020

	Total Demand Per Capita (cubic meter)	Domestic-Industrial Demand (million cubic meter)	
Country	**1990**	**1990**	**2020**
Cambodia	150	78	187
PRC, Yunnan	250	121	328
Lao PDR	280	70	168
Myanmar	—	—	—
Thailand	350	725	1,467
Viet Nam	550	899	1,994

- = not available, Lao PDR = Lao People's Democratic Republic, PRC= People's Republic of China.
Source: UNEP. 2006. Global International Waters Assessment. *Regional Assessment 55 Mekong River*. Nairobi. http://www.unep.org/dewa/giwa/publications/r55.asp

Annual Irrigation Demand, Lower Mekong River Basin, Projected to 2030 (million cubic meter)

Country	2000	2007	2030
Cambodia	2,917	2,775	4,120
Lao PDR	2,912	2,494	7,279
Thailand	9,863	11,241	21,296
Viet Nam	25,867	25,751	31,483
Basin Total	**41,558**	**42,261**	**64,178**

Lao PDR = Lao People's Democratic Republic.
Source: Mekong River Commission. 2010. *Basin Development Program II*. Vientiane.

Industrial Water Use and Trends in Lower Mekong Countries (million cubic meter)

	Annual Industrial Water Use			
Country	**2000**	**2007**	**2030**	**2060**
Cambodia	13	20	108	331
PRC				
Guangxi	—	4,780	—	—
Yunnan	1,831	1,880	—	—
Lao PDR	12	20	47	190
Myanmar	—	222 (2008)	—	—
Thailand	94	140	239	581
Viet Nam	44	122	149	837

- = not available, Lao PDR = Lao People's Democratic Republic, PRC= People's Republic of China.
Source. Mekong River Commission. 2010. *State of the Basin Report 2010*. Vientiane; Government of Myanmar, Ministry of Agriculture and Irrigation. 2009. *Water Resources Management in Myanmar*. Nay Pyi Taw; : National Bureau of Statistics of China. 2007. *China Statistical Yearbook 2007*. Beijing; Yunnan Water Resources Bureau. 2010. *Yunnan Water Resources Report 2010*. Kunming.

The distribution of annual freshwater withdrawals for the industrial sector refers to the allocation of water resources for direct industrial use, for example the cooling of thermoelectric plants, paper making, chemical manufacture, iron and steel production, oil refining, food processing, vegetable washing, drinks bottling, ice making, chemical products, etc. Industrial development is progressing at a steady pace in Guangxi and Yunnan in the PRC, Thailand, and Viet Nam, and at an early stage in Cambodia, Lao PDR, and Myanmar. However, rapid urbanization is expected to continue along with growth of the industrial sector. Northeastern Thailand and the Mekong Delta are the most advanced industrial areas in the region. Industrial development in Cambodia and the Lao PDR is occurring almost exclusively in their capital cities, Phnom Penh and Vientiane. Most private industries in the GMS use groundwater or surface water from rainfall and water withdrawals are generally not recorded.

Water Supply, Sanitation, and Wastewater Treatment. The countries in the GMS have poor water supply and sanitation services in most urban and peri-urban areas. Many secondary towns have no formalized water supply. Although water supply and sanitation programs are underway in each country within the context of reaching Millennium Development Goal targets, current levels of investment are grossly inadequate. Urbanization is occurring at a faster pace than the rate of implementation of water supply and sanitation facilities. Urban wastewater treatment is largely absent in some countries of the GMS, except for treatment of some sewerage. An expected doubling of the urban population by 2030 will greatly increase pollutant loads.

Water Quality and Pollution Levels. The Mekong River and its tributaries are still regarded as fairly unpolluted, although some areas near urban centers or with intensive agriculture and aquaculture experience elevated levels of nutrients and organic matter. Livestock farms in the Lower Mekong River Basin countries are known to cause pathogen contamination and high levels of biochemical oxygen demand

Upper: Wastewater discharging into a canal from Navana Korn Industrial Estate, Thailand. **Lower:** Young boy helping to sell bottled drinking water on the Mekong River, Can Tho, Viet Nam.

Upper left: Water for health. Family bathing in a river, Champasak, Lao PDR. **Lower left:** Pristine stream, Lao PDR. **Above right:** Water for transport. The Saigon River at Ho Chi Minh City, Viet Nam, an important waterway for vessels large and small.

(BOD); pollutants in wastewater from fish processing generate BOD, nitrogen, and suspended solids. Water pollution from industrial sources has been identified, especially in the capital cities of Vientiane and Phnom Penh, and more generally in northeastern Thailand and the Mekong Delta. Generally, treatment of industrial wastewater is limited and handling and disposal of industrial hazardous waste are insufficient. So far, industrial water pollution is mainly concentrated around factories and downstream of major urban areas. With increasing industrialization, more severe water discharge problems will occur and inter-sectoral conflicts over water quality demands may increase.

Industrial waste water management in Cambodia is poor, few factories have waste water treatment facilities, and control of industrial waste water discharge is not enforced. Of the factories in Phnom Penh, only eight have on-site primary treatment and their effluents generally exceed Cambodia's water quality standards. Another pollution problem relates to gemstone mining activities in the western part of the country.

Industrial activity in the Thai part of the Lower Mekong River Basin is dominated by manufacturing (including agro-industry, but also some textile production, light assembly, and rubber processing). Industrial wastes are expected to increase as the sector expands. Over the next 10 years, pollution loading is expected to increase by 87%. Industrial development is also increasing the amounts of hazardous wastes. In northeastern Thailand, the generation of hazardous wastes is expected to increase by about 72% over the next five years. All factories are required to have their own wastewater recycling system to allow contaminants to settle before water is released.

In Viet Nam, water pollution is serious, especially in rivers and canals near urban centers. Most industrial wastewater is discharged without proper treatment. Hazardous wastes are generated by the fastest growing sectors, such as steel, electronics, and chemicals. Overall, there are no systems in place for the handling, storage, or treatment of hazardous wastes. In the Mekong Delta, where development of industry has been relatively slow, existing industries have caused quite serious water pollution (e.g., organic contamination from breweries and canneries). Heavy industry is becoming significant with the initiation of a steel rolling mill in Can Tho with a capacity of 120,000 tons per year.

Transboundary Water Pollution. There is no strong evidence of transboundary pollution within the Lower Mekong River Basin, although elevated nitrogen levels in the upper basin indicate some transboundary transmission of pollutants from the upper to the lower basin. The rapid development and increasing pollution of the upper Mekong basin in the PRC raises some concerns about the future quality of incoming water from the upper basin. The Mekong River transports large amounts of sediment, much of which originates in the upper basin. This process helps to redistribute nutrients within the basin and is very important for areas of high productivity, such as Tonle Sap. In this sense, transboundary transportation of nutrients along the river has so far been regarded as a benefit rather than a cause of pollution.

Water Security Challenges. Over the next decade, the countries of the GMS face decisions about water resource development that will have far-reaching consequences. The relatively low level of water resource development in the region to date and high levels of dependence on natural aquatic ecosystems

as a major source of food, mean that there are both great opportunities and great risks. Increasing infrastructure and withdrawals will inevitably—and possibly irrevocably—change the way that river systems function.

Proposed hydropower development in the major river basins of the GMS will result in changes to river flows at a previously unprecedented scale and rate. The importance of freshwater fisheries to food security in the region underscores the importance of protecting the productive capacity of freshwater ecosystems from the impacts of these changes. This requires attention not only to environmental flows, but also to habitat coherence and connectivity at the landscape scale. Main stem dams are predicted to have substantial and prolonged consequences for Mekong River system water resources and security.

Projections indicate that the impacts of climate change on water resources in the GMS over the next 20–30 years are likely to be small compared to the impact of economic, demographic, and environmental changes. This "breathing space" provides an opportunity for countries and communities to reshape their water management systems and to deal with the more extreme changes expected after 2050. The most effective strategies for adaptation will be those that promote more productive water use, reduce water-related risk and vulnerability, and build the overall resilience of rural and urban communities.

In the water sector, the GMS countries need to move rapidly toward improving water use efficiency in the agriculture sector expanding and promoting traditional water conservation measures, improving irrigation efficiency, and improving water demand management. Elimination of demand side measures, such as the recent removal of irrigation fees in Viet Nam, will make it more difficult to implement reforms. The countries in the GMS, particularly Viet Nam, need to increasingly prepare for climate change adaptation. The focus needs to be two-fold: early warning and preparedness for extreme events, both floods and droughts; and investment in capacity, infrastructure, and research and development to cope with gradual, long-term changes in sea-level rise and hotter weather. Given that all countries in the GMS tend to be affected at the same time by droughts and floods, as the 2010 and 2011 events have shown, climate change has opened an opportunity for the GMS countries to work together to mitigate adverse and enhance positive impacts from a changing climate. Technology transfer and joint learning and capacity building events would be essential elements for such collaboration.

Among the potential opportunities for irrigation development in the Lower Mekong River Basin are changes in the wet and dry season flow regime, resulting from the large number of planned storage projects, which will shift the river discharge (both in the Mekong main stem and major tributaries) from the wet to the dry season. These proposed developments would reduce flood peaks and result in higher water availability in the dry season. At the same time, rising water levels would reduce the current pumping lifts, on which much of the dry season irrigated infrastructure relies.

As the urban cities and towns in the Mekong region have grown over the past decades, so has the level of pollution that these settlements discharge into the local waterways. Governments, both local and central, as well as service providers, have not been able to adequately manage wastewater discharge from urban centers,

Upper: Water for agriculture. Irrigation canal, Can Tho, Mekong Delta, Viet Nam. **Lower:** Water for cooling. Pha Lai thermal power plant near Ha Noi, Viet Nam.

Upper: Water for food and livelihood. Fishing scene on Inle Lake, Myanmar. **Lower:** Irrigation weir, Luangprabang Province, Lao PDR.

especially secondary towns. Low levels of revenue generation that barely support operation and maintenance undermine the institutional and human resource capacities necessary to sustain the delivery of services, while protecting local environments. Gross domestic product growth in the GMS is now heavily biased toward industry and services, reflecting the urbanization trend. Without adequate consideration of the potential adverse impacts of inadequate sanitation, local waterways may become unusable as raw water sources. In the face of growing populations, there will be an almost tripling increase in the demands for urban water supply and management because of increasing development and the push toward attainment of the Millennium Development Goals. This implies, at one extreme, a doubling of available water in Viet Nam just for urban uses, and at the other, only a 20% increase in Myanmar. For Viet Nam, it may be difficult to meet the needs of agriculture and other water users if it needs so much for urban uses. Based on the electricity available in 2008, the 2030 electricity demands just for urban water supply and wastewater could amount to as much as 12% for Cambodia and 5% for Viet Nam.

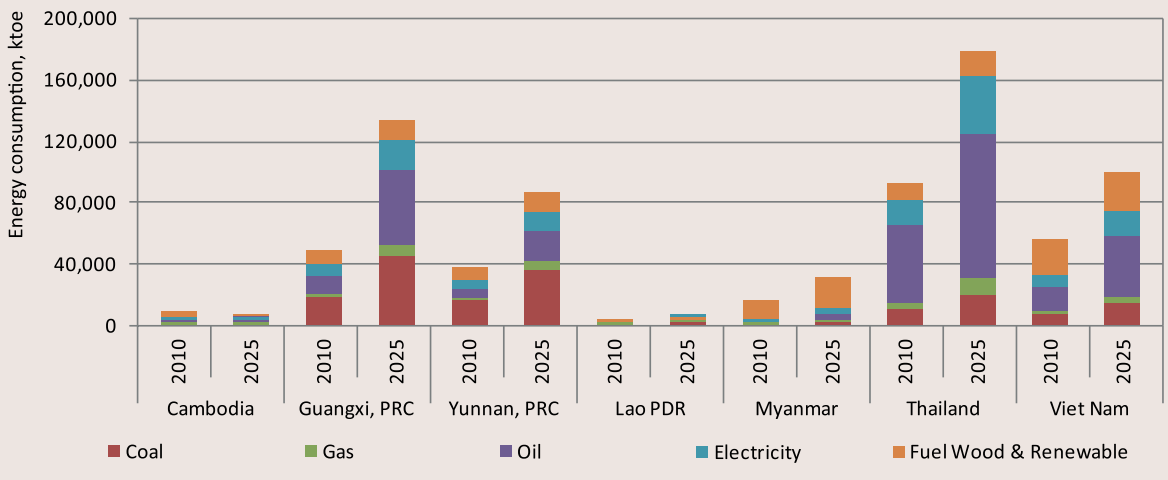
Maintaining water quality in the Mekong River is key to sustaining the health and productivity of the populations dependent on it. High salinity levels are prevalent in the delta, mostly during the dry months as diminished flows of the river are unable to push back against seawater incursions. Moreover, agricultural runoff, municipal wastewater, industrial effluent, and sulfate-rich soils have resulted in elevated levels of acidity and eutrophication of the lower Mekong River. Given the impacts of climate change and Increasing water pollution and scarcity, there is a need for bolder and comprehensive measures, such as strategic planning, both at national and subregional levels, increased investments, efficient water use, water management, and water sharing arrangements among the subsectors, and stronger monitoring and enforcement. Water availability and wise water use in the GMS will be the biggest challenges of the next decade and beyond.

Energy

Over the last two decades, rapid economic growth in the Greater Mekong Subregion (GMS) has been accompanied by a significant rise in energy consumption. Between 1999 and 2009, energy consumption grew annually by 5% on average, though growth has been uneven across the subregion. Highest growth in energy consumption was in Guangxi Zhuang Autonomous Region (11%) and Yunnan Province of the People's Republic of China (PRC) (14.4%). Energy consumption in the Lao People's Democratic Republic (Lao PDR), Myanmar, and Viet Nam grew at an average of 5%, while in Thailand and Cambodia, increase in energy consumption was slightly slower at 4% and 2%, respectively.

The GMS is likely to witness a continuation of strong energy demand growth. Total energy consumption is expected to double over the next 15 years, driven mainly by transportation and electricity. The demand for oil, largely to meet transport needs, will account for approximately 43% of the expected increase in energy consumption through 2025. Electricity will account for another 20%. These patterns of energy growth attest to the sharp increases in urbanization, industrialization, vehicle ownership, and transport

Total Final Energy Consumption in the GMS, 2010 and Projected in 2025



GMS = Greater Mekong Subregion, ktoe = thousand ton of oil equivalent, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Source: Gadde, B., K. Ganesan, and P.J. Tharakan. 2012. Status of Energy Use, Power Sector Expansion Plans and Related Policies in the GMS: Challenges and Opportunities. In H. Moinuddin and J. Maclean, eds. 2012. *International Conference on GMS 2020: Balancing Economic Growth and Environmental Sustainability. Focusing on Food - Water - Energy Nexus*. Manila: ADB.

Upper: Theun Hinboun hydropower dam expansion, Lao PDR. **Lower:** Lighting households using biogas, Cambodia.

KUNMING
NANNING
HA NOI
NAY PYI TAW
VIENTIANE
BANGKOK
PHNOM PENH

Dams, Present and Projected, in the Greater Mekong Subregion

Dams (status)

- Operating
- Under construction
- Planned or feasibility study
- Unknown

Major river

Major lake

0 125 250 500 Kilometers

Boundaries are not necessarily authoritative
Data source: EOC (compiled), UN FAO GAUL, NASA SRTM

requirements that marked the previous decades of economic growth. Such trends are likely to persist well into the future.

The development of physical infrastructure for that energy supply will have a significant local environmental impact, or footprint, in addition to increased greenhouse gas emissions from fossil fuel use. Renewable energy and energy efficiency are important means to moderate these impacts and form an important part of the energy mix portfolio. Nevertheless, the local footprint must also be well understood and managed.

Energy access remains uneven across the subregion, with a high dependence in some countries on traditional energy sources, such as firewood and agricultural residues. Rising energy demand without adequate access to commercial energy will add to already growing environmental pressures. The subregion depends heavily on oil imports and significant increases in demand will aggravate already existing energy concerns.

Ensuring Improved Access to Modern Energy

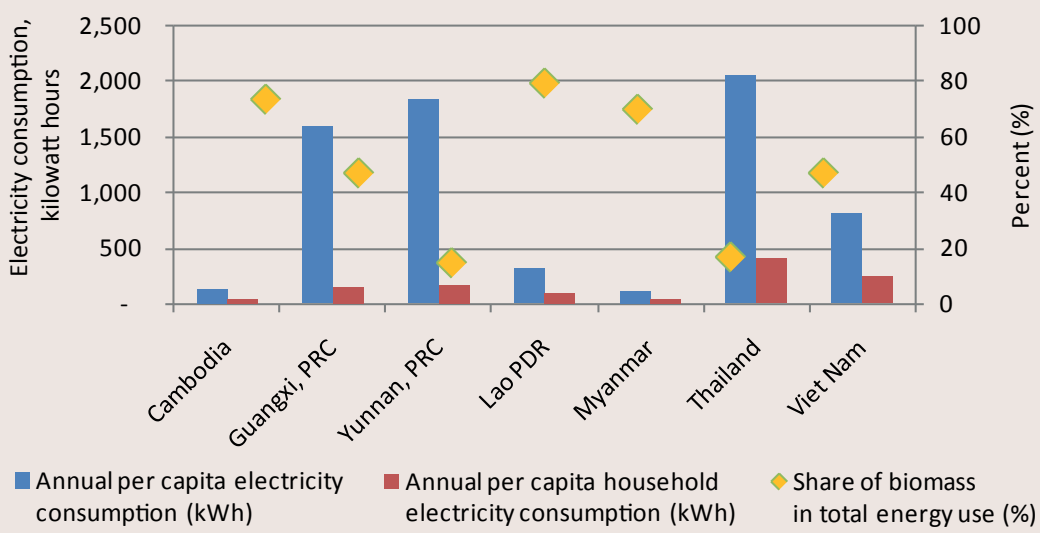
One of the key challenges in the GMS will be to ensure that quality modern energy reaches everyone. Electricity will be of particular importance. One quarter of the GMS population, some 74 million people, currently lacks access to electricity. The problem is particularly acute in Cambodia and Myanmar, where only about a quarter of the population have access to electricity. These countries, along with the Lao PDR and Viet Nam, are aiming to achieve 100% electrification by 2020.

Even in areas with access, electricity consumption is very low. In 2008, the average per capita electricity consumption for the subregion as a whole was 1,156 kilowatt hours, less than one sixth that in Organisation for Economic Co-operation and Development (OECD) countries. At the household level, Thailand has the highest annual per capita household electricity consumption in the subregion at only 409 kilowatt hours. Households in OECD countries in Europe consume three times as much, while households in the United States consume more than 10 times this amount.

Dependence on traditional energy is high, particularly in rural areas: 83% of households in Cambodia, 80% in the Lao PDR, and more than 50% in Viet Nam use firewood and other traditional energy sources for cooking. In addition to health problems from poor indoor air quality arising from the use of biomass, continued reliance on biomass will worsen existing local energy vulnerability.

Upper: Coal-fired (thermal) power plant in Xuanwei, Yunnan Province, PRC.
Lower: Hydropower dam construction, central Annamites, Viet Nam.

Per capita Electricity Consumption and Share of Biomass Use in Total Energy Use in the GMS



GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Note: Per capita electricity consumption is for 2008; share of biomass in total energy use is for 2006.
Source: ADB. 2009. *Building a Sustainable Energy Future: The Greater Mekong Subregion*. Manila; National Bureau of Statistics of China. 2010. *China Statistical Yearbook for Regional Economy 2010*. Beijing; Lao PDR Ministry of Energy and Mines; World Data Bank. *World Development Indicators and Global Development Finance*. http://databank.worldbank.org/ddp/home.do?Step=1&id=4

■ **Upper:** Nam Theun2 hydropower dam, Lao PDR. **Lower:** A child carrying firewood, Lao PDR.

There is growing realization that meeting goals for access to modern energy requires innovative solutions in the use of the growing subregional power grid, promoting off-grid renewable energy sources, encouraging private sector involvement, and offering subsidies.

Cambodia, for instance, has instituted a dedicated Rural Electrification Fund through which private rural energy supply companies can expect to receive a quarter of the investment requirement in addition to support in securing private sector financing. The Lao PDR is establishing a similar fund to support its off-grid household electrification program. Myanmar is promoting the use of liquefied petroleum gas (LPG) as household fuel, aiming to achieve a 46% decrease in firewood dependence over the next three decades.

Increased use of hydropower for cross-border electricity trade will also improve rural access. Cross-border energy flows require interconnections that pass through rural areas, providing an opportunity to improve electricity access in those areas, as is the case in rural electrification projects linked to the GMS Northern Power Transmission Project in the Lao PDR.

Exploiting Indigenous Energy Resources

The GMS has abundant conventional and renewable energy resources. Exploited appropriately, they could underpin much of the energy supply for the future. The available energy resources, however, are not evenly distributed across the subregion and require a framework of strong subregional collaboration for their use.

Coal. Over two thirds of the subregion's coal reserves are concentrated in Yunnan and Viet Nam. Yunnan still has remaining reserves of 6.2 billion tons. Viet Nam has an estimated resource base of 45 billion tons. Lesser deposits are scattered around the subregion. Coal deposits also offer significant opportunities for mine-mouth electricity generation and export across borders. The Hongsa lignite coal deposit in the Lao PDR, for instance, is being developed to fuel a 1,800 megawatt power plant designed for export of electricity to Thailand.

Oil. Approximately 80% of crude oil consumption in the GMS is met through imports. Marginal reserves are located in Cambodia, Myanmar, Thailand, and Yunnan, but many of them are yet to be developed. Cambodia and the Lao PDR are entirely reliant on imported petroleum products. Thailand meets 85% of the country's consumption through imports, the balance through domestic production. However, Thailand will have to import more in future as local production declines.

Gas. The GMS holds significant natural gas reserves, which could support large-scale expansion of gas-based power generation and help

Energy Resource Base in the GMS

Country	Coal	Gas	Crude Oil	Hydropower	Biomass	Other Renewable Energy
Cambodia	0.01 Bt	140 Bcm^3	400–500 Mbbl	15 GW	16 GW	2 GWh/year
PRC						
Guangxi	1 Bt	—	—	—	—	—
Yunnan	6.25 Bt	24.1 Bcm^3	0.122 Mt	103.6 GW	—	—
Lao PDR	0.60 Bt	102 Bcm^3	—	17 GW	33,000 Tj/year	40 GW
Myanmar	0.70 Bt	569 Bcm^3	—	99 GW	33 Tj/year	40 GW
Thailand	1.20 Bt	760 Bcm^3	0.2 Bbbl	7 GW	760 ktoe	56 GW
Viet Nam	45 Bt	256 Bcm^3	3.0 Bbbl	11 GW	240–400 MW	110 GW

- = not available, Bt = billion ton, Bcm3 = billion cubic meter, Bbbl = billion barrels, GMS = Greater Mekong Subregion, GW = gigawatt, GWh = gigawatt hour, ktoe = thousand ton of oil equivalent, Lao PDR = Lao People's Democratic Republic, Mbbl = million barrels, MW = megawatt, Mt = million ton, PRC = People's Republic of China, RE = renewable energy—excludes operational capacity, Tj = terajoule. Note: Hydropower excludes installed capacity.
Source: ADB. 2009. *Building a Sustainable Energy Future: The Greater Mekong Subregion*. Manila; National Bureau of Statistics of China. 2010. *China Statistical Yearbook for Regional Economy 2010*. Beijing; Lao PDR Ministry of Energy and Mines; World Data Bank. *World Development Indicators and Global Development Finance*. http://databank.worldbank.org/ddp/home.do?Step=1&id=4; Yunnan. 11th-Five Year Plan of Yunnan Water Resource Development.

meet transportation energy demand. The majority of the gas reserves are in Myanmar and Thailand, while Cambodia, Viet Nam, the Lao PDR, and Yunnan have smaller reserves.

Myanmar holds an estimated 560 billion cubic meters. The country's gas production increased more than 10-fold between 1991 and 2005 to 13 million cubic meters. Almost all of Myanmar's current gas production is exported to Thailand, making gas the largest export earner for the country. In Thailand, natural gas already accounts for 67% of the total energy supply and over 68% of total electricity generation capacity. Currently, approximately 70% of Thailand's gas consumption is sourced indigenously; the remainder is imported from Myanmar. Thailand has decided to import liquefied natural gas (LNG) to meet the country's growing demand for gas by the power and industry sectors. LNG terminal expansion at Map Ta Phut is under construction and will be operational by 2014.

Hydropower. With a total potential of 248,000 megawatts, the GMS is extremely rich in hydropower resources. Generation from hydropower plants is already an important energy source for the subregion. Approximately 20% (or 49,000 megawatts) of the total potential has been utilized and hydropower currently accounts for about 40% of the installed capacity. Hydropower forms 70% of Myanmar's generation capacity and 100% in the Lao PDR. Throughout the subregion, hydropower ranks as a key renewable energy source, perhaps second only to biomass.

Upper: Wang Noi gas power plant, Thailand. **Lower:** Many families in rural areas still gather firewood for cooking.

Emptying waste into a household biogas collector, also known as an anaerobic digester, Cambodia.

Total Potential and Installed Hydropower Capacity in the GMS (megawatt)

GMS Country	Installed Capacity	Potential
Cambodia	13	5,000–8,600
People's Republic of China		
Guangxi	25,100	78,800
Yunnan	11,980	90,000
Lao PDR	1,826	23,000
Myanmar	2,521	100,000
Thailand	3,424	10,000
Viet Nam	4,155	15,000
TOTAL	**49,019**	**248,000**

GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic.
Source: ADB. 2008. *Integrating Biofuel and Rural Renewable Energy Production in Agriculture for Poverty Reduction in the Greater Mekong Subregion: An overview and Strategic Framework for Biofuels Development*. Manila; ADB. 2008. *Energy Sector in the Greater Mekong Subregion*. Manila; Lao PDR. 2010. Briefing on Lao PDR Power Development Plan 2010 – 2020. Prepared for the GMS Ninth Meeting of the Regional Power Trade Coordination Committee, October 2010. Shenzhen, PRC; Myanmar. 2010. Myanmar Briefing. Prepared for the GMS Ninth Meeting of the Regional Power Trade Coordination Committee, October 2010. Shenzhen, PRC.

Two thirds of the hydropower potential in the GMS are in Myanmar and Yunnan, with smaller but still substantial resources across the subregion. Hydropower is currently the main source for cross-border electricity trading. The Lao PDR, for example, currently sells 1,881 megawatts of hydropower to Thailand. Future development of hydropower capacity will rely on significant expansion of cross-border electricity trading. Also, small, low-impact hydropower plants, which have the potential to be widely deployed throughout the GMS, could provide electricity access in rural areas.

The development of hydropower resources is not without costs. Large plants could reduce the availability of water resources, displace people from their land, and disturb ecosystems. There is also a strong perception that the planning process is skewed toward favoring the broader economic gains from hydropower plants over their environmental impact. An environmental assessment framework that is integrated into the planning process would provide a way to manage and mitigate the negative impacts of hydropower development.

Biomass and Biogas. Numerous renewable energy sources are available within the GMS. Biomass, especially in the form of fuelwood, remains the major source of energy for lighting and heating in most of the GMS (except Thailand), particularly in rural areas. In 2005, the share of biomass in the total primary energy supply was 26%, though down from 31% in 2000. Biomass is used by over 50% of the rural population in Viet Nam, 83% of households in Cambodia, 80% of households in the Lao PDR, and 93% of rural households in Myanmar. In Yunnan, almost 41% of rural households are totally dependent on firewood for cooking. In Thailand, 77% of the 2,120 megawatts of renewable energy capacity is fuelled by biomass, such as rice husks, bagasse, and wood and other agricultural residues.

The use of forest biomass resources has several implications for energy security and environmental sustainability in the subregion. Poor households often spend a significant amount of their income on fuelwood or charcoal. Forest resources are important for biodiversity and are also a source of livelihood for many people in rural areas. Forest resources have declined steadily over the last two decades, aggravating social and economic vulnerabilities of the rural population.

Biogas can provide rural households with modern lighting and heating. As a cheap, cleaner alternative to biomass, biogas could reduce pressure on forest resources. The PRC's biogas development initiative is the most extensive in the GMS: approximately 26.5 million rural households deploy biogas facilities that generate about one billion cubic meters of methane. The technology is being extended to other GMS countries through pilot projects supported by the Government of the Netherlands.

Biofuels. Spurred by strong national programs, biofuels are rapidly emerging as an important energy source for the GMS. The PRC (as a whole) ranks as the third largest producer of bioethanol in the world. Within the PRC, Guangxi produces ethanol from cassava at one of the PRC's five main bioethanol plants; Yunnan is a demonstration province for biodiesel from jatropha. Thailand ranks as the eighth largest producer of biofuels.

Between 2000 and 2009, transport energy demand in the GMS (excluding PRC) increased 50%. The high dependence on oil imports is likely to remain as demand continues to outpace domestic production. Future demand for oil accounts for approximately 40% of the increase in total energy consumption through 2025. Biofuels provide an alternative to oil products, reducing import vulnerabilities and offering an environmentally benign energy option for the fast growing transportation sector.

Biofuels also offer a strong development dividend. They provide new markets for existing agricultural products and could enhance economic opportunities in the agricultural sector, which sustains the majority of the subregion's population. Biofuel produced from conversion of 10% of the available land and wasted grain could displace up to 34% of the conventional transport fuel energy demand with biodiesel and even more with bioethanol.

Despite the potential, biofuel development is not without challenges. Experience suggests that if deployed unsustainably, biofuels can be associated with numerous risks. Increased demand for biofuel feedstock like maize and cassava leads to competition with the food industry, thus raising food prices and endangering food security. Biofuel development could threaten rural livelihoods by favoring large-scale plantation systems, reducing biodiversity, and affecting soil and water quality. Several best practices to mitigate these risks, such as use of surplus land, small holder-based production, use of nonfood crops and second

generation biofuels, have begun to emerge within the GMS and could provide the lessons and basis for sustainable development of biofuels.

Summary of Biofuel Policies and Targets in the GMS

Country	Policies / Incentives	Policy Targets (million liters per year)
Cambodia	No policies	
Lao PDR	E10 by 2015 E20 by 2020	Insufficient information
Myanmar	E5 and E15 B5 to B20	Insufficient information
PRC[a]	E10 Subsidies for producers	12 million tons of ethanol per year by 2020 6 million tons of biodiesel per year by 2020
Thailand	E10 and E20 B5 Tax incentives	Bioethanol: 3,285 by 2021 Biodiesel: 2,179.05 by 2021
Viet Nam	1% of total fuel demand in the transportation sector in 2015 and 5% by 2025 E5	Bioethanol: 684 by 2020 Biodiesel: 128 by 2020

GMS = Greater Mekong Subregion, PDR = People's Democratic Republic, PRC = People's Republic of China.
Note: Ethanol and biodiesel density assumed to be 789 tons/million liter and 845 tons/million liter, respectively; B5, B20 refer to percentage of biodiesel in diesel fuel; E5, E10 refer to percentage of bioethanol in gasoline.
[a] these policies cover the whole PRC.
Source: Tharakan, P., N. Chrishna, R. Jane, and M. David. 2012. Biofuels in the Greater Mekong Subregion: Energy Sufficiency, Food Security, and Environmental Management. *Southeast Asia Working Paper Series*. No. 8. Manila: ADB; Thailand Department of Alternative Energy Development and Efficiency. 2012.

Solar, Wind, and Geothermal Resources. Solar energy is an abundantly available clean energy source that can be deployed widely in rural areas. The estimated potential for solar energy in most GMS countries is high. Myanmar has potential solar energy of 51,974 terawatt hours per year. Thailand has a potential for 50,000 megawatts of solar-photovoltaic power and has targeted 2,000 megawatts for development. Despite some preliminary subregional level assessments, there has been little work done to develop robust estimates of wind potential across most of the GMS. Potential wind resources in Thailand and Viet Nam alone are each more than 100,000 megawatts. Geothermal resources appear to be limited in the GMS. Viet Nam has the most potential at 200–400 megawatts.

Development of these renewable resources, particularly wind and geothermal, will require the expansion of the electricity grid to remote areas where the plants are likely to be based.

■ Solar panel array of the Lop Buri solar energy project, Thailand.

Meeting Electricity Demand Growth

Electricity demand in the GMS is expected to experience a three-fold increase over the next 15 years, reaching 241,000 megawatts by 2025. Robust demand growth will occur across all countries in the GMS, with annual average growth of 6%–12%. About 218 gigawatts of new power capacity will be needed. Meeting this demand growth represents a serious, shared development challenge. It also opens up new opportunities for developing robust transmission networks, broadening electricity trade across countries, and better utilizing indigenous energy resources, as well as integrating energy efficiency, renewable energy, and clean technologies into the supply mix.

Coal fired power generation is likely to be a key part of the growth, meeting approximately 30% of the required new capacity over the next 15 years. Even under a low-carbon scenario, 37 gigawatts of new coal capacity could still be added between 2005 and 2025. The unbridled expansion of coal capacity would place increased pressure on the

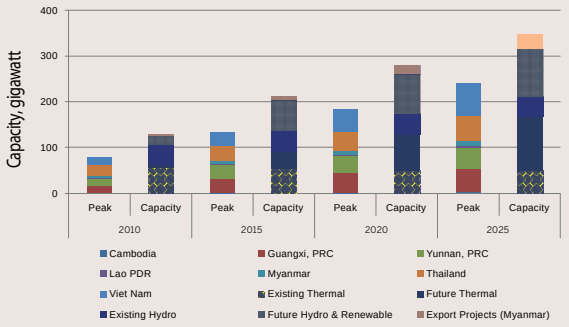
Potential Biofuel Production and Demand in the GMS

	Transport Demand (million liter)				Share of Transport Demand Met through Biofuels (%)			
	Gasoline		Diesel		Bioethanol[a]		Biodiesel[b]	
Country	2009	2020	2009	2020	2009	2020	2009	2020
Cambodia	903	1,729	2,235	4,396	44	23	8	4
PRC, Guangxi and Yunnan	2,978	5,404	4,970	8,518	73	40	4	3
Lao PDR	208	540	323	839	104	40	27	10
Myanmar	590	1,656	702	856	269	96	34	28
Thailand	7,524	9,209	18,465	25,267	6	36	3	9
Viet Nam	5,095	10,132	8,533	14,667	20	10	0	0

GMS = Greater Mekong Subregion, PDR = People's Democratic Republic, PRC = People's Republic of China.
[a] Includes bioethanol produced from converting 10% of available land and from wasted grain/crops. [b] Includes biodiesel produced from converting 10% of available land.
Source: Tharakan, P., N. Chrishna, R. Jane, and M. David. 2012. Biofuels in the Greater Mekong Subregion: Energy Sufficiency, Food Security, and Environmental Management. *Southeast Asia Working Paper Series*. No. 8. Manila: ADB; Thailand Department of Alternative Energy Development and Efficiency. 2012.

■ Nam Ngum 1 hydropower dam, north of Vientiane, on the Nam Ngum, a tributary of the Mekong River in Lao PDR.

Peak Demand and Projected Power Capacity by Type in the GMS



GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Source: ADB. 2010. *Facilitating Regional Power Trading and Environmentally Sustainable Development of Electricity Infrastructure in the Greater Mekong Subregion, Component 1, Module 1, Update of the GMS Regional Master Plan*. Manila; Myanmar. 2010. Myanmar Briefing. Prepared for the GMS Ninth Meeting of the Regional Power Trade Coordination Committee, October 2010. Shenzhen, PRC.

Natural gas-based power capacity could account for approximately 20% of projected capacity, or 22% under a low-carbon scenario. New gas capacity will largely be combined-cycle plants that are more efficient, but expansion of gas capacity will need more gas production and infrastructure facilities.

Hydropower is likely to grow significantly over the next 15 years, accounting for approximately half of capacity increases. Much will be intended for cross-border electricity trade, particularly from Myanmar into the PRC and Thailand, and from the Lao PDR and Cambodia into Viet Nam and Thailand. Hydropower development will depend on expansion of the transmission system.

environment, including air quality and water resources, and could be balanced with the adoption of clean coal technologies through incentives, with options for carbon capture and storage. Preliminary assessment in the GMS suggests moderate to high carbon dioxide storage potential in depleting oil and gas fields and deep saline aquifers, though the uncertainty of this assessment is very high and few studies have been conducted.

Across the GMS, renewable energy has been positioned as a key part of the future energy mix. Availability of renewable energy resources, along with supporting policies, will be a key driver of its growth. Wider deployment of renewable energy is being favored for its ability to simultaneously deliver on the goals of clean energy and access to modern

Renewable Energy Targets and Policies in the GMS

		Policies Supporting Renewable Energy						
Country	Renewable Energy Target	FIT	RPS	TWC/ TGC	Tax Credits	Fiscal Incentives	Loans/ credits	Net M
Cambodia	Over the next five years, 5% of all new installed capacity to be renewable energy based					✓	✓	
PRC Guangxi and Yunnan	Renewable energy to meet 15% of total energy needs by 2020	✓		✓ Voluntary	✓ Partly	✓	✓	✓
Lao PDR	Renewable energy to reach 30% of total energy by 2025							
Myanmar								
Thailand	Renewable energy to comprise 20.3% of total energy by 2022	✓	✓	✗	✓	✓	✓	✓
Viet Nam	Renewable energy to reach 5% of total energy by 2020	✓		✓ Voluntary	✓	✓	✓	

GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic, FIT = feed-in tariff, Net M = net metering, PRC = People's Republic of China, RPS = renewable portfolio standard, TGC = tradable green certificate, TWC = tradable white certificate.
Note: Fiscal incentives include fixed government investment subsidy/grant. Loan/credit includes low-interest loans and credit. Blank indicates information was not available.
Source: ADB. 2009. *Building a Sustainable Energy Future: The Greater Mekong Subregion*. Manila; Gadde, B., K. Ganesan, and P.J. Tharakan. 2012. Status of Energy Use, Power Sector Expansion Plans and Related Policies in the GMS: Challenges and Opportunities. In H. Moinuddin and J. Maclean, eds. 2012. *International Conference on GMS 2020: Balancing Economic Growth and Environmental Sustainability. Focusing on Food - Water - Energy Nexus*. Manila: ADB.

energy. Use of renewable energy expands the available resource base and reduces the vulnerability associated with dependence on fossil fuels. The potential that renewable energy offers for off-grid applications makes it especially suited to delivering the benefits of modern energy to rural populations not adequately served by the grid. Solar, wind and geothermal, however, remain relatively expensive supply options and their expansion will depend on continued policy support over the near to mid-term.

The promotion of clean technologies, hydropower, and other renewable energy sources also reflects efforts to minimize the increase in greenhouse gas emissions from the power sector. A low-carbon future, where the environmental and social costs of energy choices are internalized in decision making, could result in savings of 392 million–1,030 million tons of emissions from the power sector between 2005 and 2025.

Growth in Cross-Border Power Trading

Tighter integration of energy markets across the GMS will be a key component of its energy future and could save the subregion almost $190 billion, or approximately 20% of the discounted total cost through 2025, in addition to lowering energy dependence on the rest of the world by as much as 5.5% of total energy consumption.

The ability to meet future electricity demand hinges critically on the expansion of cross-border power trade. Power trading in the GMS began in 1971 with the Lao PDR's power export to Thailand from the Xeset Hydropower project. Several bilateral trade arrangements during the 1990s led to further expansion. Today there are cross-border links connecting all neighboring countries. The network, however, is still limited, consisting predominantly of medium-voltage transmission lines except for the two 500 kilovolt transmission lines connecting the Nam Theun 2 and Nam Ngum 2 hydropower plants in the Lao PDR to Thailand.

The current plan envisions an interconnected subregional grid by 2025 with an electricity trading market involving a number of buyers and sellers. This requires more than just new transmission lines; it also requires greater harmonization of power sector policies. The transition to such a grid from a pattern of one-way, dedicated cross-border power flows can only occur when GMS countries allow such a regulatory framework in their own sector policies.

At present, the GMS Regional Power Trade Coordination Committee coordinates subregional power trade and represents the countries. Efforts are underway to establish a permanent GMS Power Trade Coordination and Information Center, which would coordinate day-to-day operations, develop common operational norms, and monitor developments of the GMS power grid. A subregional master plan with short- and medium-term action plans has been developed.

■ Control room of the Nam Ngum 1 hydropower plant, Lao PDR.

Energy Security Challenges

The sharp rise in energy consumption coupled with dominance of fossil fuel use has created several environmental challenges. Over the last few years, particulate emissions in urban areas of the GMS have consistently exceeded ambient air quality guidelines of the World Health Organization (WHO). Increased use of gasoline and diesel to meet the burgeoning need for transport fuel could significantly worsen the health impacts of poor air quality.

Apart from emission problems, coal- and gas-based power plants often involve loss of forest or other natural habitats from the power plant and mining, production, and transportation of fuels. Thermal plants often affect water resources and aquatic ecosystems through the use of large quantities of cooling water. The release of cooling water can damage riverine and marine ecosystems through changes in temperature and oxygen levels, and pollution. These plants also generate solid and toxic waste. Fly ash, for instance, can be a particularly severe problem with coal-based power plants. The transport of fuel by rail, road, or pipeline can also have local impacts along the way, in addition to significant impacts at the site of exploration, mining, or fuel extraction.

Although the GMS has a relatively small carbon footprint, growing awareness about greenhouse gas emissions has helped frame climate-friendly energy

■ **The Nam Theun 2 hydropower complex, Lao PDR. Upper left:** Interior of the power plant. **Lower left:** Aerial view of the hydropower dam on the Nam Theun River. **Upper right:** a substation down river from the Nam Theun dam.

strategies. Between 2005 and 2025, emissions could grow by 1.2 to 1.8 billion tons; a strategy less reliant on carbon-based fuels (a low-carbon energy strategy) could lessen this to about 0.8 billion tons. Total discounted environmental costs from greenhouse gas emissions could vary between $320 billion and $358 billion, while a low-carbon energy strategy could lower those costs to $292 billion.

Hydropower will be a large part of the energy supply solution but has the potential to cause a wide range of adverse social and environmental impacts. The construction of hydropower facilities can lead to the loss of land, disruption of sensitive ecosystems—causing significant disruption of fisheries—displacement of communities upstream and downstream, increased vulnerability to environmental degradation in the plant's vicinity, and disruption of hydrological regimes and the associated aquatic and littoral ecosystems. Hydropower plants can also offer several benefits in watershed management, such as improvement in seasonal water flows that can enhance local agricultural and livelihood opportunities. These benefits and risks co-exist in complex patterns. They have to be well understood and managed in a manner that maximizes the benefits and mitigates the risks.

The increased use and expected growth of biofuels as a substitute for fossil oil in transport have spotlighted a new set of risks as agricultural lands are converted for energy production. Soaring food prices in early 2011 brought into sharp focus the need for countries to increase the security and sustainability of their food supply. Rising food prices, particularly for commodities like sugarcane and corn, have been partly attributed to biofuel expansion. Increasing biofuel exports could also have an indirect impact by increasing the prices of feedstock for other food commodities. The increased cultivation of energy crops would pose a risk as they compete with other agricultural products for land and water, and use agrochemicals with attendant risks to biodiversity.

Across the subregion, there is growing awareness that emission impacts and environmental costs must influence the future energy mix. Rather than being limiting, these environmental challenges provide an opportunity for the integration of biofuels, renewable energy, energy efficiency, and clean technologies into the evolving energy supply mix.

To make this integration happen, policies and institutions are needed that emphasize the use of robust and comprehensive social and environmental impact assessment that engages all stakeholders from the beginning of the energy planning process. For energy production and use to be truly sustainable, such social and environmental impact assessments must become important reference points in decision making on energy choices and planning.

Expanded Regional Energy Cooperation

GMS countries have recognized that a stronger integrated approach to energy planning and management can offer sustainable, secure, and competitive energy. The GMS road map for expanded energy cooperation takes into account the GMS Strategic Framework 2012–2022 and the needs for improved energy security, better utilization of energy resources, and mutually beneficial energy trade to meet national and regional energy needs in a sustainable manner.

The goals and objectives for expanded energy cooperation in the GMS are to improve access to energy of all sectors and communities, particularly the poor, by promoting best energy practices; developing and using more efficient indigenous low-carbon and renewable resources, while reducing dependence on imported fossil fuels; improving energy supply security through cross-border trade, while optimizing use of subregional energy resources; and promoting public-private

■ Power transmission lines, Thailand.

Proposed GMS Cross-Border Electricity Transmission Network by 2025

■ Satellite image, showing the Srinakarin hydropower dam, Kanchanaburi, Thailand, built in 1980 with a capacity of 720 megawatts and surrounded by a protected area. The reservoir has become a major attraction for domestic tourism.

Forest

Deforestation (bare slopes)

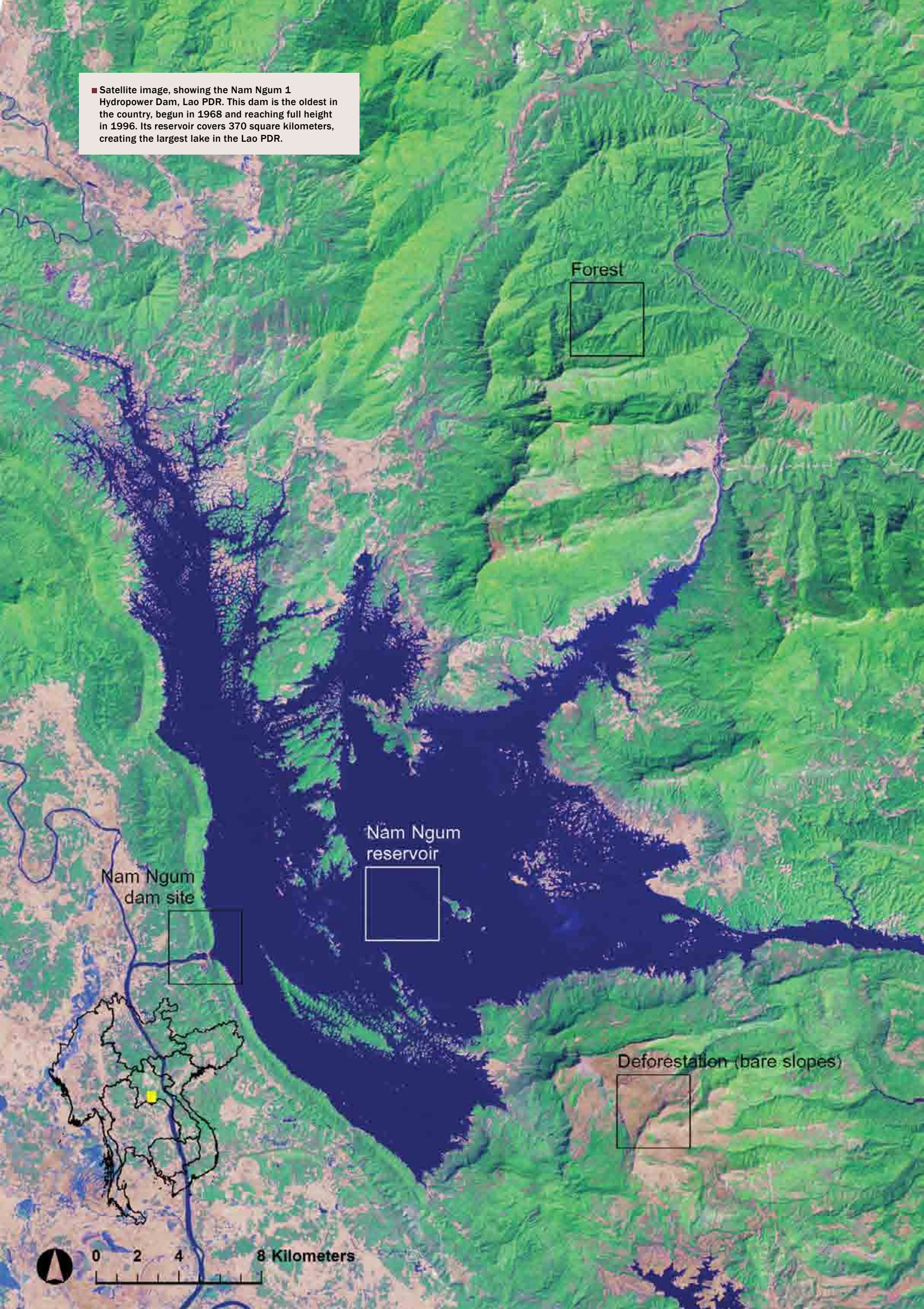
Srinakarin reservoir

Mixed agriculture

Srinakarin dam site

0 2 4 8 Kilometers

■ Satellite image, showing the Nam Ngum 1 Hydropower Dam, Lao PDR. This dam is the oldest in the country, begun in 1968 and reaching full height in 1996. Its reservoir covers 370 square kilometers, creating the largest lake in the Lao PDR.



■ **Upper** and **Lower:** Construction of the Lop Buri solar power project, Thailand.

partnership and private sector participation, particularly through small and medium-sized enterprises.

The road map for expanded subregional energy cooperation has a policy framework that includes ways to achieve the goals and objectives and concrete, practical activities for the short to medium term, such as promoting the use of new and renewable energy sources, energy efficiency and conservation, regional energy planning, policy and program coordination, and other initiatives specific to the power, oil-gas, and coal sectors. The institutional framework for the road map is based on a "lead" implementing member country and a subregional energy forum to monitor and manage progress.

Improving Energy Efficiency

At present, energy efficiency is low in the GMS but is widely regarded as a key part of the broader energy strategy. Many of the key barriers to improving efficiency, such as fossil fuel subsidies, lack of awareness, and absence of incentives, are common to most GMS countries. This offers considerable scope for subregional collaboration and sharing of experiences.

Policies designed to promote efficiency are highly uneven across the countries. Policy measures being adopted in GMS countries include energy conservation programs, standards and labeling, building energy standards, energy audit, financial incentives, and private sector participation. The PRC and Thailand already have well-tailored energy efficiency programs in place. Guangxi and Yunnan implement the national programs of the PRC that include targets to reduce energy intensity along with monitoring and reporting requirements at several levels. Thailand has a number of best-practice policies that could be replicated across other countries in the GMS. Viet Nam is targeting annual energy savings of 5%–8% of total energy consumed during 2011–2016 through its programs as part of the Energy Conservation law. The other GMS countries are drafting energy efficiency programs also.

Energy Efficiency Policies in the GMS

Policy measure	Cambodia	PRC (Guangxi and Yunnan)	Lao PDR	Myanmar	Thailand	Viet Nam
Energy Conservation Programs	A few	Yes	A few	Yes	Yes	Yes
Standards and Labeling	Planned	Yes	-	Planned	Partly mandatory	Planned
Building Energy Standards	Voluntary	Mandatory	Voluntary	Voluntary	Partly mandatory	Mandatory for industries
Energy Audit	Voluntary	Mandatory for certain categories	Voluntary	Voluntary	Partly mandatory	Mandatory for industries
Financial incentives	-	Available	-	-	Dedicated fund	Available
Private Sector Participation	Yes	Yes	Yes	Yes	Yes	Yes

- = not available, GMS = Greater Mekong Subregion, PDR = People's Democratic Republic, PRC = People's Republic of China.
Source: Gadde, B., K. Ganesan, and P.J. Tharakan. 2012. Status of Energy Use, Power Sector Expansion Plans and Related Policies in the GMS: Challenges and Opportunities. In H. Moinuddin and J. Maclean, eds. 2012. *International Conference on GMS 2020: Balancing Economic Growth and Environmental Sustainability. Focusing on Food - Water - Energy Nexus*. Manila: ADB.

Urbanization

Cities are important for the development of Asia. They have become the focal points of economic activity and the engines for economic growth, substantially contributing to national economic productivity. Most of the subregion's new economic growth will be generated in its urban economies. They provide the bulk of jobs and employment opportunities and serve as centers of excellence for education, health care, innovation, entrepreneurship, business, commerce, industry, culture, and social services. The cities also act as the markets for all types of products, goods, and services and they connect with the wider world through all types of transportation and communication systems.

Urban areas are growing at annual rates of 3.9% in Cambodia, 5.0% in the Lao People's Democratic Republic (Lao PDR) and 2.5% in Viet Nam. These rates are around 2.5 times the national population growth averages. Although urbanization drives economic growth, it brings with it serious challenges. The vast majority of the new urban citizens are poor people from rural areas. They pay higher prices for their water and at times use unsafe water and endure unsanitary conditions.

Poverty makes access to basic services, such as water supply and sanitation, difficult, particularly in urban areas. The poor not only have low incomes, but they have little or no access to safe water and basic sanitation, which adversely affects their health and productivity, and perpetuates poverty. A combination of speculation, market forces, urban beautification, and large-scale infrastructure projects has made land a valuable and hotly contested commodity in urban areas, particularly in cities where urbanization is most intense. Those living in informal slum settlements, especially the poorest, are least able to participate in the competition for land. Without policy and institutional reform, there is a real risk of urban services becoming unsustainable, leading to environmental degradation and serious health problems. These outcomes ultimately undermine the competitiveness of towns and cities, making them less livable.

Upper: Nanning, capital city of Guangxi, PRC, a modern 'green' city. **Lower:** Vientiane, Lao PDR, a 'serene oasis' among Southeast Asian capitals.

■ **Previous page:** View of densely populated area of Ho chi Minh City. **Upper left:** Evening view of Guilin, Guangxi, PRC, at night. Street scenes in Phnom Penh **(upper)** and Yangon **(lower)**.

Cambodia is currently at a relatively early phase of redevelopment of its urban areas. The present urbanization rate is around 15%, largely a result of rural-urban migration, and is leading to growing incidences of urban deficiencies and problems. An exception is the city's water supply, which provides water to almost all the city's residents as a result of being refurbished with world class management that won for the Phnom Penh Water Supply Authority the Stockholm Industry Water Award in 2010.

In the People's Republic of China (PRC), urbanization is a key policy of the Government, aiming to increase economic productivity and reduce the rural-urban income gap. Rapid growth of cities and towns has placed stress on both the environment and the planning and management of public services. Surplus labor arising from rural reform is the main source of migration from farms to towns. Large-scale rural-to-urban migration challenges the absorption capacity of nonagricultural sectors. An official report on the PRC's floating (temporary) population shows that there were 211 million migrants in 2009, and this is expected to rise to 350 million in 2050. Between 1979 and 2008 the level of urbanization in the PRC grew from 19% to 46%.

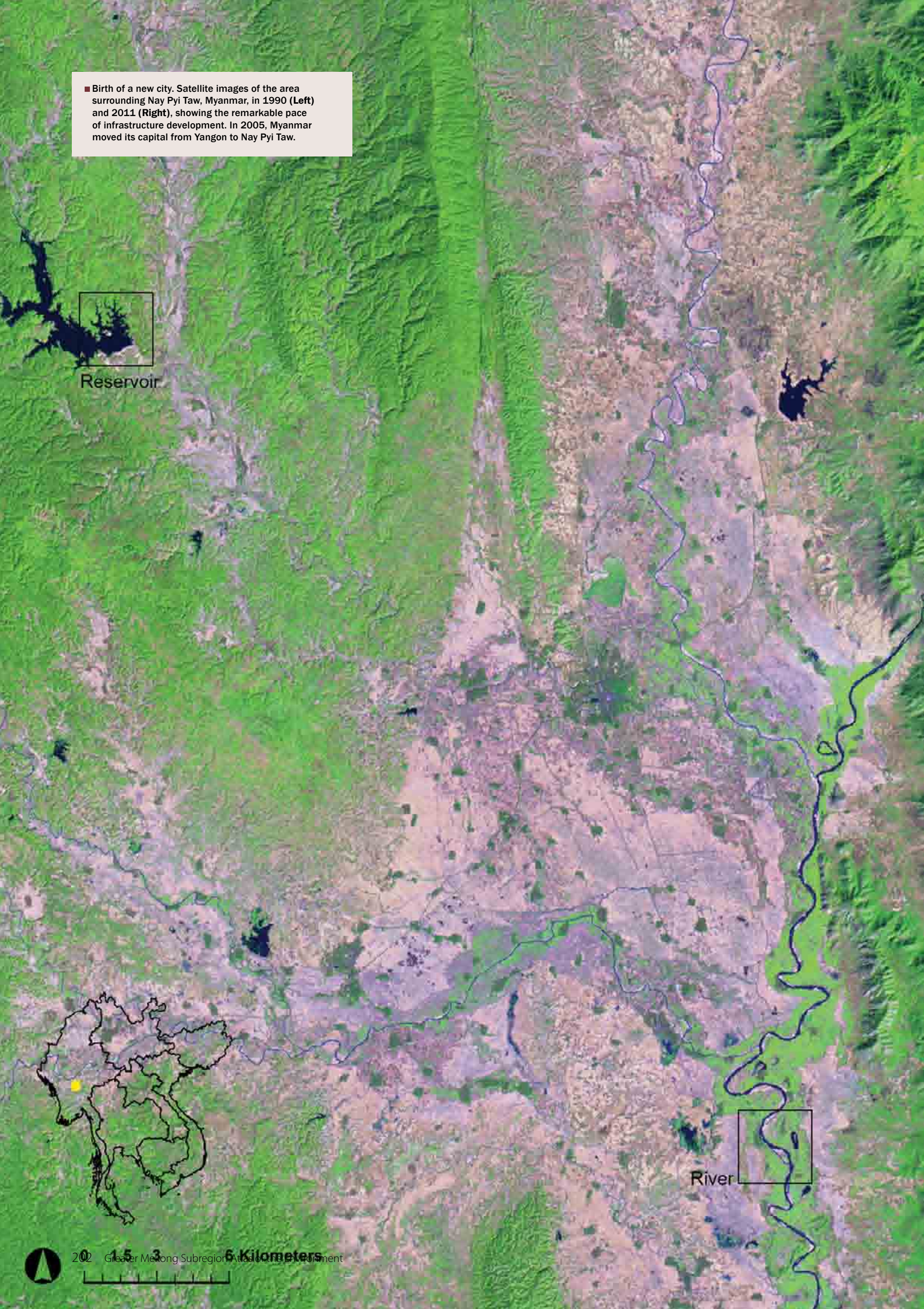
In Guangxi Zhuang Autonomous Region in the PRC, the present urbanization rate is 40%, below the national average. However, the Guangxi Government has formally promulgated a decision to speed up development of the Beibu (Tonkin) Gulf economic zone in the context of the PRC-Association of Southeast Asian Nations (ASEAN) free trade cooperation. The urbanization rate of Guangxi is estimated to rise to 50% by 2015. At present, Yunnan Province in the PRC is undergoing a period of accelerated urbanization, upgrading urban systems, and optimizing layout structures in urban areas. However, the urbanization level is still only around 16.59% (2010).

In the Lao PDR, urbanization is currently at 22%. Urban development is influenced by the Government's decentralization policy and growth in services, such as tourism, market access, and transit growth centers emerging from the GMS economic corridors initiative. The urban population of the Lao PDR is expected to increase from 1.28 million in 2005 to about 3.5 million or 38% of the total population by 2030.

In 2011, 31% of the total population in Myanmar was classified as urban following an upward trend in recent years; Yangon (the former capital Rangoon) contained one third of the total urban population. The Myanmar Government relocated the capital to Nay Pyi Taw in March 2006, but Yangon's population continues to increase, estimated at 6.7 million in 2011, including the suburban areas. The pull of the city and the perceived attraction in terms of opportunities offered by Yangon have not gone away. From the late 1800s to 1941, Indian immigration played a significant role in Yangon's growth. From 1941 to 1965, rural-urban migration, as a result of insecurity in the countryside, was a major factor. From1973 to the 1990s, natural increase and boundary expansion were the most important factors in growth of the city's population. The recent extension of city limits has not been accompanied by a proportionate increase in population size because the newly developed areas are settled by squatters relocated from various parts of Yangon, fire victims, and public servants and their families.

Thailand's urbanization level is forecast to reach 50% by 2015 from the current 43%. The 1997 financial crisis slowed down urbanization and

■ Birth of a new city. Satellite images of the area surrounding Nay Pyi Taw, Myanmar, in 1990 **(Left)** and 2011 **(Right)**, showing the remarkable pace of infrastructure development. In 2005, Myanmar moved its capital from Yangon to Nay Pyi Taw.



Urban area
Reservoir
Reservoir
Road
Urban area
Rice fields
Airport
River
0 1.5 3 6 Kilometers

■ **Upper:** Bangkok's mass transit system, the Skytrain, provides efficient transport for the city's growing numbers of commuters. **Lower:** Motor cycles fill the streets of cities and towns in Viet Nam.

widened the rural-urban poverty gap. Since 1997, urbanization has largely taken place in peri-urban areas that extend up to 75 kilometers around the large cities because of the improved transport and communication network. The 1999 Decentralization Law addresses the extensive centralization of the administration and increases the number of municipalities from 149 to 1,129—creating a shortage of qualified skilled persons in the National Civil Service. The Bangkok Metropolitan Region covers an area of 7,762 square kilometers and had an estimated population of 12 million in 2008, with a population density of 1,301 per square kilometer.

Due to the success of the service and tourism industries in Bangkok, the city has gained in popularity for work not only among provincial Thais from the rural areas but also with people from other countries in the subregion and beyond. Many workers reside outside the metropolitan area and travel into the city for day jobs. The population swells to 15–20 million in the city during the day. Peri-urban areas accommodated almost 90% of the recent population growth, indicating the importance of these areas.

Bangkok Metropolitan Region – Population Growth and Density

Administrative Area	Area (km^2)	Population (2000)	Population (2010)	Population Density (persons/km^2)
Bangkok Municipality	1,568.74	6,355,144	8,249,117	5,258.6
Nonthaburi	622.30	816,614	1,333,623	2,143.1
Samut Prakan	1,004.50	1,028,401	1,828,044	1,820.6
Pathum Thani	1,525.90	677,649	1,326,617	869.4
Samut Sakhon	872.30	466,281	885,559	1015.2
Nakhon Pathom	2,168.30	815,122	942,560	434.7
Greater Bangkok	7,762.00	10,159,211	14,565,520	1,876.6

Source: Census data, 2010. http://www.citypopulation.de/php/thailand-admin.php

Viet Nam's rapid urbanization is due to the transformation of an agriculture-based economy into an industrialized economy, which has put enormous pressure on the Government to invest in urban infrastructure. The degradation of environmental quality and sanitary hygiene associated with dense living has become acute as more people migrate to the cities, prompting the Government to embark on environmental improvement programs. Viet Nam's urban areas contribute 70% of the country's economic growth. The urban share of the population is not uniform across regions, being significantly higher (57%) in the southeast than in other regions, due to the presence of Ho Chi Minh City. Second in density (29%) is the Red River Delta, due to the presence of Ha Noi and Hai Phong.

Urban Share of Population by Region in Viet Nam, 2009 (%)

Region	Excluding 5 Central City-Provinces*	Including 5 Central City-Provinces
Northern Midlands and Mountains	16.0	16.0
Red River Delta	19.9	29.2
North and South Central Coast	20.9	24.1
Central Highlands	27.8	27.8
Southeast	30.1	57.1
Mekong River Delta	19.6	22.8
5 Central City-Provinces	62.7	62.7

* Central city-provinces are 5 municipalities that are administratively equivalent to provinces and directly under the central government; they are Ha Noi, Ho Chi Minh City, Hai Phong, Da Nang, and Can Tho.
Source: Ministry of Planning and Investment, General Statistics Office. 2011. *Viet Nam Population and Housing Census 2009. Migration and Urbanization in Viet Nam: Patterns, Trends and Differentials*. Ha Noi. http://unfpa.org/webdav/site/vietnam/shared/Census%20publications/7_Monograph-Migration-Urbanization.pdf

In Viet Nam, cites are administrative units that include territory outside the city center, i.e., rural areas. In 1989, three quarters of Ho Chi Minh City was urban, while only a third of Ha Noi and Hai

Phong was urban. By 1999, Ha Noi had become a city with urban population accounting for about 60% of the total because the overall area of the city had decreased and the inner city area had expanded. By 2009, the urban proportion of the population in Ha Noi decreased again due to the expanded geographic area when former Ha Tay Province was incorporated into Ha Noi.

As urban cities and towns in the GMS have grown over the past decades, so has the level of pollution that these settlements discharge into the local waterways. Governments, both local and central, as well as service providers have not been able to adequately manage wastewater discharge from urban centers, especially secondary towns. Low levels of revenue generation that barely support operation and maintenance undermine the institutional and human resource capacities necessary to sustain the delivery of services, while protecting the local environment.

One of the most adverse side-effects of economic growth, industrialization, and urbanization in the GMS is the increasing rate of solid waste generation in urban areas. Among the capitals, it is highest in Bangkok, followed by Kunming and Vientiane. In many countries that are experiencing rapid economic development, the problems associated with solid waste production and management are not addressed until they are already posing a serious threat to advancement. The PRC may have surpassed the United States as the world's largest generator of municipal solid waste; urban residents produce two to three times more waste than their rural counterparts. As per capita incomes of urban dwellers in the GMS have increased, vehicle ownership likewise has been increasing and generally following a similar path to that in developed countries. Much of this growth is occurring in the cities and towns where the bulk of economic activities are located. The overall number of vehicles remains currently very modest; for example, about 40 vehicles per 1,000 persons in the PRC versus 350 per 1,000 persons in Japan. However, the sheer size and dynamic growth patterns in countries like the PRC can lead in a relatively short period of time to an exponential increase in vehicle numbers, comparable to those in Europe and the United States.

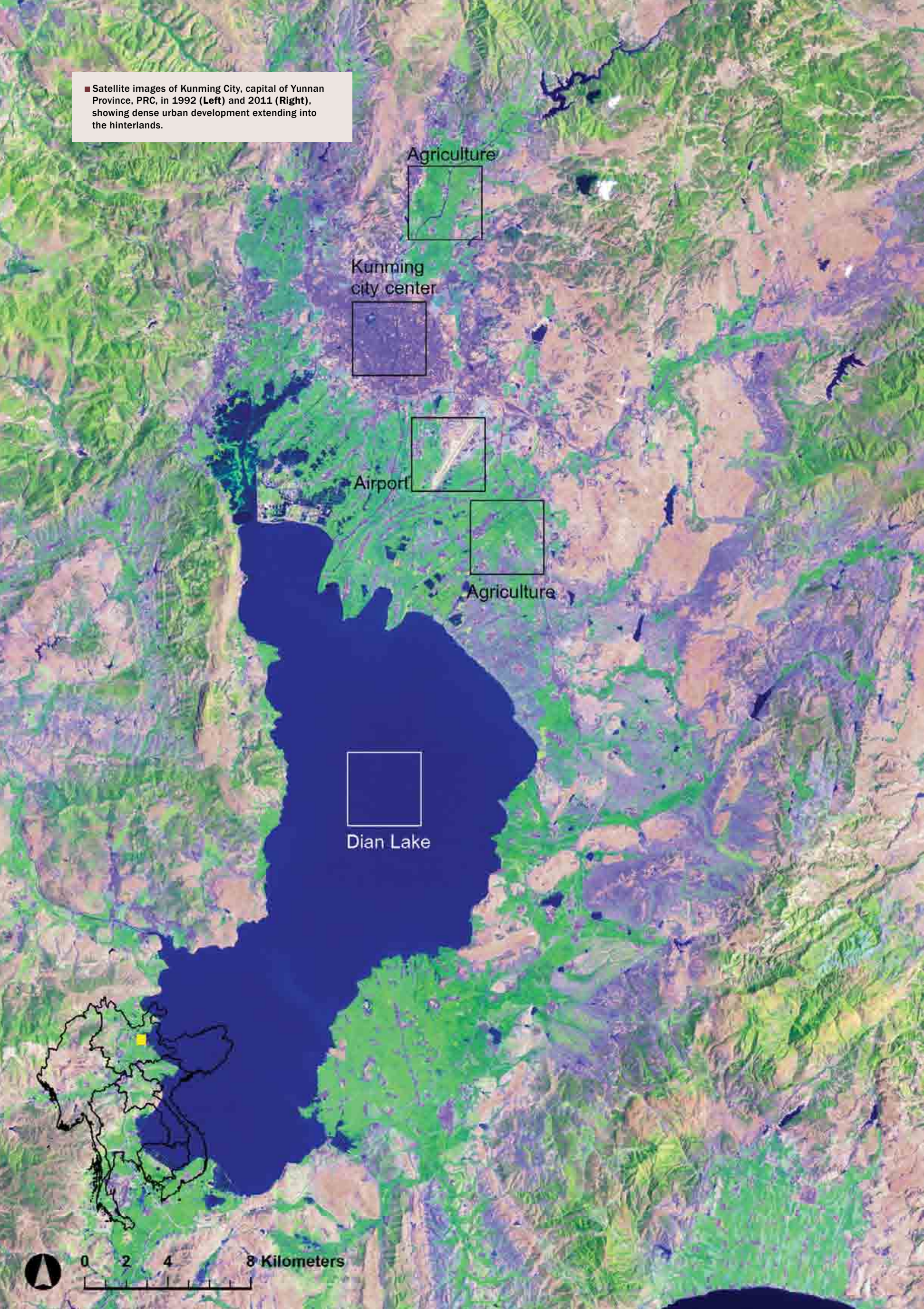
■ **Garbage collection in Ho Chi Minh City, Viet Nam. Garbage disposal has become a perennial problem in the subregion's cities and towns.**

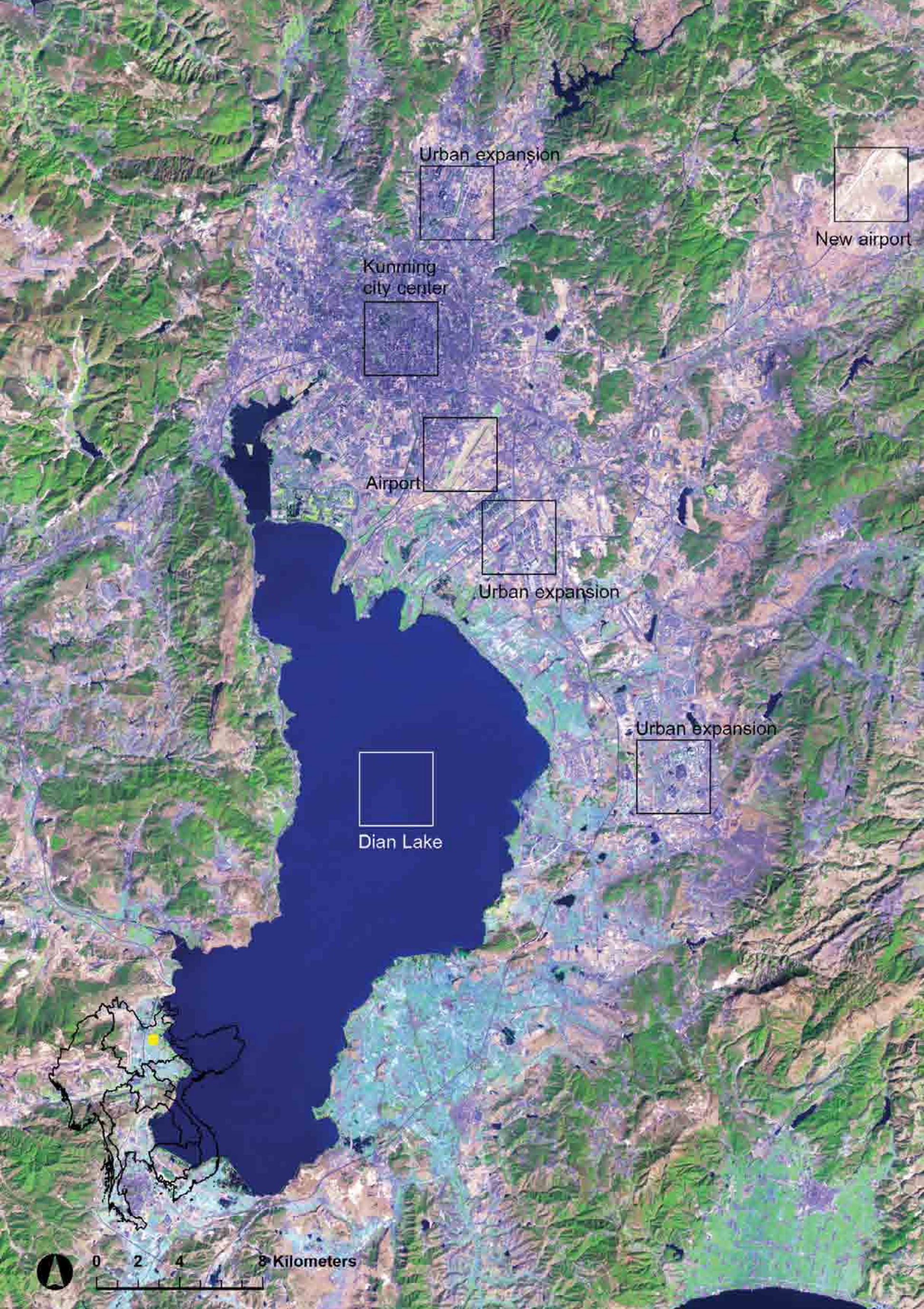
Population Growth Rate, Urban Population, Access to Improved Sanitation, and Solid Waste Generation in GMS Countries

Country	Capital /Major city	Capital/City Population Growth Rate (%)	Urban Population Share of Total Population (%)	Population in the Largest City, % of Urban Population (%)	Population with Access to Improved Sanitation, % of Urban Population	Population with Access to Improved Water Source, % of Urban Population[a]	Solid Waste Generation in Capital/Major City (kilogram/ capita/day)
Cambodia	Phnom Penh	2.8 (2010)	19.5 (2010)	48.5 (2010)	73 (2010)	87 (2010)	0.74 (2008)
PRC							
Guangxi	Nanning	0.90	40 (2010)	37 (2010)	80 (2010)	77 (2010)	0.78 (2010)
Yunnan	Kunming	1.07	35 (2010)	40 (2010)	—	—	0.25 (2010)
Lao PDR	Vientiane	2.0 (2010)[a]	33 (2010)	40 (2010)	89 (2010)	77 (2010)	0.64 (2008)
Myanmar	Yangon	1.4 (2009)[b]	30.7 (2010)	27 (2010)	84 (2010)	81.4 (2010)	0.26 (2010)
Thailand	Bangkok	0.03	34 (2010)	30 (2010)	95 (2010)	97 (2010)	1.54 (2009)
Viet Nam	Ha Noi	12.7 (2010)	30 (2010)	25 (2010)[c]	94 (2010)	99 (2010)	1.45 (2008)

- = not available, GMS=Greater Mekong Region, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
[a]Calculated from data of statistical yearbook 2010, [b]Yangon region, [c]Ho Chi Minh City.
Source: ADB. 2011. *Key Indicators for Asia and Pacific 2011*. Manila; AIT/UNEP RRC.AP. 2010. Municipal Waste Management Report; Cambodia National Committee for Sub-National Democratic Development. Commune Database Online; Guangxi Bureau of Statistics; Myanmar Ministry of Agriculture and Irrigation, Department of Agricultural Planning; Thailand National Statistical Office; UNDP. 2011. *Human Development Report 2011*. New York; Viet Nam Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi; World Bank indicators. http://data.worldbank.org/indicator/SH.STA.ACSN.UR; Yangon City Development Committee; Yunnan Provincial Environmental Protection Department. 2011. *2010 Report of Environment State of Yunnan Province*. http://en.7c.gov.cn/uploads/2010EnvrionmentState-final.pdf; Report of Environment State of Kunming 2010; Yunnan Bureau of Statistics. 2011. *Yunnan Statistical Yearbook 2011*. Beijing.

■ Satellite images of Kunming City, capital of Yunnan Province, PRC, in 1992 **(Left)** and 2011 **(Right)**, showing dense urban development extending into the hinterlands.




Urban expansion
New airport
Kunming
city center
Airport
Urban expansion
Urban expansion
Dian Lake
0 2 4 8 Kilometers

■ **Upper:** Bangkok on the Chao Phraya River. **Lower:** Commuter buses and vendors in Yangon, Myanmar.

Number of Vehicles per 1,000 Persons in GMS Countries

Region	Vehicles per 1,000 Persons
Cambodia	21 (2005)
PRC	
Guangxi	21 (2009)
Yunnan	21 (2010)
Lao, PDR	20 (2007)
Myanmar	7 (2009)
Thailand	134 (2006)
Viet Nam	15 (2010)

GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Source: Guangxi Bureau of Statistics. 2011. *Guangxi Statistical Yearbook 2011*. Beijing; Viet Viet Nam Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi; World Bank.. http://data.worldbank.org/indicator; Yunnan Bureau of Statistics. 2011. *Yunnan Statistical Yearbook 2011*. Beijing.

The types of vehicles plying the roads influence the nature of air pollutants. Diesel vehicles are associated with particulate emissions and gasoline vehicles, including two- and three-wheeler vehicles, with nitrogen oxides and hydrocarbon emissions.

Increasing traffic congestion in many of the cities in the subregion has exacerbated the problem.

Large cities in GMS countries are increasingly facing problems with urban ambient air quality. In most cases, the transport sector is the largest contributor to air pollution. Pollutants of main concern are particulate matter (PM), especially very small particles (known as PM_{10} and $PM_{2.5}$), nitrogen oxides, and hydrocarbons. Increasing nitrogen oxide levels contribute to an increase in ozone levels. On average, there has been a moderate to slight decrease in pollution levels of sulfur dioxide, which are now below the guideline values set by the World Health Organization (WHO)—proving that air quality management policies and measures can work in Asia. However, total suspended particulate matter and PM_{10} remain at levels harmful to human health, while ambient concentrations of nitrogen oxides are gradually increasing, currently just above the WHO guidelines.

Pollution Concentrations in Urban Ambient Air in GMS Countries and Cities

Country	Carbon Monoxide (parts per million)	Sulfur Dioxide (microgram per cubic meter)	Lead (microgram per cubic meter)	Suspended Particulate Matter (microgram per cubic meter)	Small particulate matter (PM_{10}), country level (microgram per cubic meter)
Cambodia, Phnom Penh	9.11 (2009)	—	—	—	37.00 (2009)
PRC					
Guangxi	—	0.031(2010)	—	—	—
Yunnan	—	—	—	—	59.00 (2010)
Lao, PDR	—	—	—	—	45.00 (2009)
Myanmar	—	—	—	—	41.00 (2009)
Yangon	—	0.745 (2008)	—	150.19 (2008)	—
Mandalay	—	1.100 (2008)	—	353.17 (2008)	—
Thailand, Bangkok	1.5 (2009)	5 (2009)	0.03 (2009)	82.50 (2009)	53.00 (2009)
Viet Nam	—	—	—	—	50.00 (2009)

- = not available, GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Source: Cambodia Ministry of Environment. 2009. *Annual Report*. Phnom Penh; Guangxi Environmental Protection Department. 2011. *Report on the State of Environmental Protection in Guangxi 2010*. Nanning; Myanmar National Commission for Environmental Affairs; Thailand Ministry of Science; World Bank. http://data.worldbank.org/indicator; Yunnan Provincial Environmental Protection Department. 2011. *2010 Report of Environment State of Yunnan Province.* http://en.7c.gov.cn/uploads/2010EnvrionmentState-final.pdf

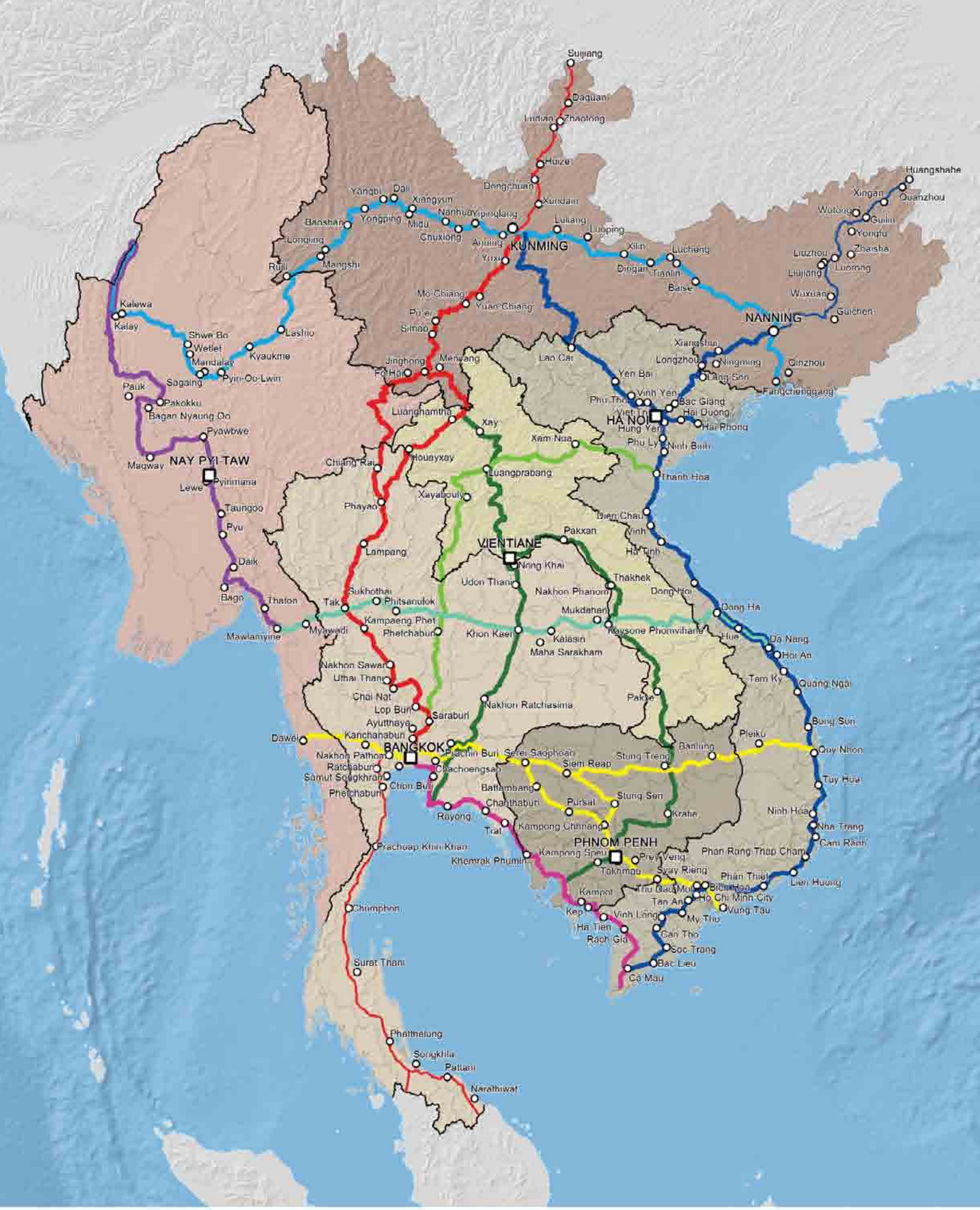
Transport

Over the past 15 years, transport infrastructure in the countries of the Greater Mekong Subregion (GMS) has improved connections between them, strengthened their ability to compete in the face of globalization, and promoted a sense of community among them. Borders were opened to increase trade among the countries and this has spurred their development, providing employment opportunities and, hence, contributing to reduction of poverty. Investments in priority infrastructure sectors, such as transport, energy, telecommunications, and tourism, focus on the same geographic space to maximize development impact and minimize costs. For this reason, economic corridors were developed in selected transport routes in the subregion.

■ **Upper:** Busy road to Kunming Railway Station, Yunnan, PRC. **Lower:** Transporting baskets to market, Nga Nam, Viet Nam.

Economic Corridors

An economic corridor is a geographically defined area in which infrastructure development, such as subregional roads, is linked directly to production, trade, and investment potential of the area. The aim is to start and accelerate economic activities throughout the corridor and its surrounding areas. Among the key elements of an economic corridor are the links, the transport corridors; the "nodes" or economic growth areas along the corridor route; "software," such as policies, programs, institutional arrangements, and multicountry agreements; and regionally integrated commercial infrastructure. In 1998, three main corridors were identified: North–South, East–West, and Southern. These corridors have now been extended to nine. They will play a major role in integrating the subregion.



Transport Corridors of the Greater Mekong Subregion

Economic Corridor Roads

- Central Corridor
- East-West Corridor
- Eastern Corridor
- Eastern Corridor Extension
- North-South Corridor
- North-South Corridor Extension
- Northeastern Corridor
- Northern Corridor
- Southern Coastal Corridor
- Southern Corridor
- Western Corridor

- National capital
- Administrative center
- Corridor town

0 100 200 400 Kilometers

Boundaries are not necessarily authoritative
Data source: ADB, GMS EOC, UN FAO GAUL, NASA SRTM

The main achievements in the sector have been the emergence of transport corridors linking the subregion from north to south and from east to west. Notable roads and highways projects include the Phnom Penh–Ho Chi Minh City Highway, the East–West Corridor Project, the Northern Economic Corridor (Boten–Houayxay), the Yunnan Expressway (Chuxiong–Dai) and Southern and Western Yunnan Roads Development, the Guangxi Roads Development Project, the Siem Reap airport, and the Dali–Lijiang railway project in Yunnan. In addition to Siem Reap, airports have been upgraded at Mandalay, Vientiane, Ha Noi, and Phnom Penh. These improved airports, air safety, and more open skies have stimulated business and tourism travel, encouraged investment, and generated new employment opportunities, even in remote areas of the subregion.

Waterways, which include large marine shipping ports in some countries as well as extensive inland rivers and canals, remain important in the subregion. Recent transport projects include upgrading inland water navigation systems and seaports.

Also, there have been many in-country transport initiatives that bear importantly on linking the subregion. This combination of transport initiatives has cut transport costs, reduced travel times, and created an effective and efficient trade link in Southeast Asia.

In 2003, the six GMS countries signed the GMS Cross-Border Transport Agreement (CBTA). The CBTA provides a basic framework, such as customs inspection, traffic rights, and infrastructure standards, for improving cross-border movement of goods and people.

Moving People and Goods

In terms of passengers carried, the road networks across the GMS countries are by far the most important mode of transport. The subregion's extensive inland waterways are next overall, but mostly due to ferry boat operations across rivers in Viet Nam. Railways are a close third and important in five of the seven economies. The picture is a little different in terms of freight. Roads again carry the major share of goods around the subregion, but inland waterways are also seen to be very important, while railways have a very minor share and aircraft, understandably, have a negligible role in freight transport.

In the following section are outlines of the four transport modes in the GMS countries. Further details are contained in the Information Resources section.

■ **Upper:** Bus plying highway Route 48, Cardamom Mountains, Koh Kong, Cambodia. **Lower:** Constructing highway tunnels to avoid destruction of forest in Xishuangbanna, Yunnan, PRC.

■ **Upper:** Savannakhet - Mukdahan border crossing between Thailand and the Lao PDR. **Lower:** Lao Bao border crossing between Lao PDR and Viet Nam.

GMS Passenger Transport (million passengers)

Item	Cambodia	Guangxi, PRC	Yunnan, PRC	Lao PDR	Myanmar	Thailand	Viet Nam
Road	—	722 (2010)	362 (2010)	45 (2010)	38 (2009)	427 (2009)	2,011 (2010)
Railways	<0.1 (2008)	31.6 (2010)	27.1 (2010)	—	71.6 (2009)	47.9 (2009)	11.6 (2010)
Inland Waterways	—	3.9 (2010)	7.3 (2010)	1.8 (2009)	27.1 (2009)	—	157.5 (2010)
Air Transport	0.3 (2010)	12.0 (2010)	7.5 (2010)	0.6 (2010)	0.4 (2010)	20.3 (2010)	14.1 (2010)

- =not available, GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Source: Guangxi Bureau of Statistics. 2011. *Guangxi Statistical Yearbook 2011*. Beijing; Lao PDR National Statistics Center; Myanmar Central Statistical Organization (CSO). 2011. *Selected Monthly Economic Indicators*. Nay Pyi Taw; and CSO. 2010. *Statistical Yearbook 2009*. Nay Pyi Taw; Thailand Ministry of Transport; Viet Nam Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi; Yunnan Bureau of Statistics. 2011. *Yunnan Statistical Yearbook 2011*. Beijing.

GMS Freight Transport (thousand ton)

Item	Cambodia	Guangxi, PRC	Yunnan, PRC	Lao PDR	Myanmar	Thailand	Viet Nam
Road	—	935,520 (2010)	456,650 (2010)	4,730 (2010)	2,411 (2009)	423,677 (2009)	585,024 (2010)
Railways	151 (2009)	70,520 (2010)	62,680 (2010)	—	3,327 (2009)	11,517 (2009)	7,980 (2010)
Inland Waterways	1,198 (2009)	128,320 (2010)	4,020 (2010)	961 (2009)	4,685 (2009)	—	144,325 (2010)
Air Transport	—	94.9 (2010)	87.4 (2010)	—	0.5 (2009)	—	139 (2009)

- =not available, GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Source: Guangxi Bureau of Statistics. 2011. *Guangxi Statistical Yearbook 2011*. Beijing; Lao PDR National Statistics Center; Myanmar Central Statistical Organization (CSO). 2011. *Selected Monthly Economic Indicators*. Nay Pyi Taw; and CSO. 2010. *Statistical Yearbook 2009*. Nay Pyi Taw; Thailand Ministry of Transport; Viet Nam Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi; Yunnan Bureau of Statistics. 2011. *Yunnan Statistical Yearbook 2011*. Beijing.

■ **Left:** Road traffic in Bangkok, Thailand. **Upper right:** Trucks are the main form of long-distance transport of goods in Viet Nam. **Lower right:** Low-cost motorcycles are a popular form of transport in Mandalay, Myanmar.

Roads

Road transport infrastructure in the GMS is in various stages of development. While standard indicators, such as road density and proportion of paved roads, are good measures of the maturity of a country's road network, they are also largely a function of the geography and demography of a country. Thailand's proportion of paved roads is much higher than elsewhere in the subregion, thus putting the country ahead in terms of road development. The Lao PDR has fewer paved roads, but this is principally due to its sparsely populated land.

The total road network in Cambodia, 44,919 kilometers, consists mainly of rural roads (33,005 kilometers), as well as 5,487 kilometers of national roads and 6,427 kilometers of provincial roads. Almost all national roads are now surfaced and about 10% of all roads are paved. However, the extensive rural road network continues to deteriorate because of the steady growth in traffic, inadequate maintenance funding, lack of capacity of maintenance institutions and private contractors, and design and construction deficiencies.

Rush hour traffic in Ho Chi Minh City, Viet Nam.

84-H1
3448
79-U2
6094

■ Traffic congestion in Bangkok, Thailand.

Road Accidents become Cambodia's No.1 Killer

Cambodia has one of the highest incidences of road accidents in the world. In 2010, 1,816 people were killed on Cambodia's roads, and 70% of the deaths were caused by motorcycle accidents.

Deteriorating road safety is a major concern, especially with the rise in traffic. Most accidents occur due to speeding, traffic violations, and driving under the influence of alcohol. Increased traffic speeds, resulting from improved paved road surfaces, poses tremendous safety risks.

Guangxi Zhuang Autonomous Region serves as an important passage linking southwestern People's Republic of China (PRC) with Association of Southeast Asian Nations (ASEAN) countries. The road network is about 101,782 kilometers long, including 2,574 kilometers of expressways. The network has been growing at more than 7% annually over the past decade and all prefectures in Guangxi are accessible by second grade roads or higher. Yunnan Province has some 209,231 kilometers of roads (2010), with an annual growth rate of 9.66% from 2000 to 2010. Major road infrastructure projects are underway in Yunnan to facilitate trade with its GMS neighbors and ASEAN, including a highway linking Kunming with Singapore. The highway network also connects with the network of neighboring provinces.

The Lao PDR depends heavily on road transport for trade links both externally and internally. The road network grew from 25,090 kilometers in 2000 to 39,585 kilometers in 2011. Due to its relatively sparse population, the road network density is low. Most roads remain in very poor condition and are often impassable during the wet season. Less than 15% of the total road network is paved. Meanwhile, demand has been increasing over the years at an annual

■ **Motorcycles are a favorite transportation mode for all kinds of goods, Ha Noi, Viet Nam.**

rate of 5%–8% for goods and 8%–10% for passengers, in line with rising economic growth.

In Myanmar, most roads have been constructed north to south along the geographic orientation of the mountain ranges and rivers. The network includes 11 roads totaling 3,946 kilometers designed as the Union Highway. Currently, east to west highways are being added to the existing north to south vertical highways. In all, 35 east-west highways totaling 15,208 kilometers and 45 north-south highways of 9,160 kilometers are designated under a Union Highways proclamation. Included are highways under regional cooperation agreements—ASEAN Highways, Asian Highways, GMS economic corridor highways, and an India-Myanmar-Thailand Trilateral Highway.

Thailand has the most developed transport network, with 108,004 kilometers (2009) of national roads, of which 92% were paved. All of the country's provinces are interlinked with a good interregional and interprovincial transport network, and services are mostly available even for isolated and remote rural areas. The direction, composition, and volume of traffic flows reflect the geographical distribution of economic activities. Freight traffic is concentrated mostly in the corridor along an axis radiating from Bangkok to the south and northeast.

The total length of the road system in Viet Nam is about 287,698 kilometers, of which 15,065 kilometers are national roads; 36,225 kilometers are provincial roads; and the remainder are district, commune, and village roads. About half the total length is paved. The transport sector has contributed to the rapid economic growth of Viet Nam over the past decade. It has helped reduce poverty through improved links to markets, education, and health facilities, and indirectly through its contribution to growth.

Most GMS countries appear to have focused on new road construction, without full funding for subsequent maintenance requirements.

■ Rehabilitated passenger train, Cambodia.

Railways

The railways in the GMS countries have developed independently over the course of a century. Each national railway has developed into a unique system with its own standards, line widths, and procedures. Some national railways are undergoing modernization with a view to subregional institutional and operational integration; many of the transboundary agreements that are required are common for all transport modes and have already been established under the GMS Cross-Border Transport Agreement. Adapting these agreements to railway traffic will give impetus to integrating railway traffic in the GMS. The national railways of the PRC, Thailand, and Viet Nam already operate international connections, which provide a useful starting point for establishing international connections within the GMS.

In addition, the GMS railways will need to be systematically designed by incorporating other supporting modes of transport, such as roads and waterways together with main gateways for each route. This would enable multimodal transport management to be put into practice, creating the most efficient and seamless connections. Major centers in the GMS are well connected by road and air, and some by inland waterways, but to date, only the PRC and Viet Nam are connected by rail.

In 2010, all six of the GMS countries had approved plans to establish a transnational rail link to improve transportation networks between neighboring nations. At present, the most viable route of four routes being considered to connect most of the countries would see a rail line stretch from Bangkok to Phnom Penh, then on to Ho Chi Minh City and Ha Noi, extending up to Nanning and Kunming in the PRC. The link would use existing tracks where possible as well as several lines currently under construction. Preliminary expectations are that the completed route will be open by 2020 and carry an estimated 3.2 million passengers and 23 million tons of freight by 2025.

Railway Network, Present and Projected, of the Greater Mekong Subregion

Cambodia's rail network is currently being reconstructed after decades of neglect and damage from war, as part of the Trans-Asian Railway project with modern trains replacing the current open-access system of "bamboo trains"—homemade bamboo mats powered by go-kart or water pump engines. Cambodia privatized its railways in 2009. Two rail lines exist, both originating in Phnom Penh and totaling about 650 kilometers. The railway rehabilitation project is a vital component of the GMS's Southern Economic Corridor that links Thailand, Cambodia, and Viet Nam. It is also a key component of ASEAN's Singapore to Kunming Rail Link Project, of which the line from Cambodia to Viet Nam represents the largest missing link.

The PRC has started an $11.8 billion program to expand railway connections between Kunming and Nanning, and new lines, including one to the Viet Nam border and another to the Myanmar border, are under way. A line to connect to the Lao PDR is under consideration. The railway network in Guangxi is now 3,205 kilometers long, connecting three major coastal harbors as well as neighboring provinces, including Guangdong, Hunan, Guizhou, and Yunnan, and linking to the Viet Nam railway network and the ASEAN project. Several trunk lines meet in Nanning and join the line to Viet Nam—Yue Gui railway (Guangdong to Guangxi), Xiang Gui (Hunan to Guangxi), Zhi Liu railway (Henan to Guangxi), Qian Gui railway (Guizhou to Guangxi) and Nan Kun railway (Nanning to Kunming).

Yunnan has a rail network of 2,155 kilometers (2010). Links are under construction to neighboring countries in Southeast Asia. From Yuxi, the Yuxi-Mengzi railway link, under construction since 2005, and the Mengzi-Hekou railway link, under construction since 2008, will form a standard gauge railway connection with Viet Nam. The Dali-Ruili railway link, under construction since May 2011, will bring rail service to the border with Myanmar. Also under planning is a rail line from Yuxi to Mohan, transversing Xishuangbanna Prefecture, on the border with

Upper: Skytrain, the mass transit system in Bangkok, Thailand. **Lower:** New and rehabilitated cargo wagons, Cambodia.

Lao PDR. This line will be extended further south to Thailand, Malaysia, and Singapore.

Other than a 3.5 kilometer rail link across the Mekong River between Thanaleng in Lao PDR and Nongkhai in Thailand, the railway subsector in the Lao PDR has not been developed, restricting the transport of bulk and heavy freight. This has contributed to slow growth of large industries in rural areas.

Myanmar Railways steadily increased the reach of its network in the last two decades, from nearly 3,200 kilometers in 1988 to 5,211 kilometers in 2008. Most lines run north-south with branch lines to the east and west. The condition of the network is generally poor. Most lines are not passable during the monsoon season. The speeds of freight trains are heavily restricted on all existing links as a consequence of poor track and bridge conditions. Myanmar Railways is currently undertaking an ambitious expansion program that will add another 3,645 kilometers to its network, including extensions to Myeik in the south, Kyaingtong in the east, and Sittwe in the west.

The State Railway of Thailand rail network is 4,429 kilometers long. Recently, 1,539 kilometers have been upgraded, allowing increased axle loads and speed. Plans are being considered for extending the length of double tracking, developing high-speed train lines, and constructing new lines, some of which could link to the Lao PDR and onward to Viet Nam. The Government also plans to implement policy measures aimed at encouraging a shift from road to rail.

The Viet Nam railway network is 2,600 kilometers long and was mainly constructed in the early part of the 20th century. It links the main population, cultural, agricultural, and industrial centers in Viet Nam and connects with Guangxi's railway network at Lang Son in northeastern Viet Nam and with Yunnan at Lao Cai in the northwest. The railway in Viet Nam is a strategic link in the GMS Transport Sector Strategy to connect Cambodia, Thailand, and Viet Nam with the southern PRC. As mentioned, it is part of the ASEAN Singapore to Kunming rail project.

Waterways

River basins are the backbones of social and economic development. Inland waterway transport contributes to sustainable development because it is safe, efficient, reliable, and environmentally friendly. The region's inland waterways play a special role in the economic development of remote rural areas and in the welfare of their inhabitants, who are usually among the lowest of low-income groups in the region. In the absence of inland waterway transport, many remote underprivileged communities would be inaccessible or too costly to service.

Growing freight demand points to the need to increase the capacity and quality of inland waterway transport. Cooperation between river basins and exchange of experiences create mutual benefit and there is scope for both public and private parties to increase cooperation and further develop the inland navigation system.

Deep Sea Ports

Ports for international trade are particularly important in several GMS countries. Cambodia has two major ports, Phnom Penh Port and Sihanoukville Port, also known as Kampong Som, and five minor ones. Guangxi has three harbors, in Fangcheng, Qinzhou, and Beihai, respectively, that have an annual throughput capacity of more than 20 million tons.

Myanmar, with its extensive coastline of 2,832 kilometers, has nine ports connecting the Bay of Bengal. Of these, four ports—Yangon, Sittwe, Pathein, and Mawlamyine—are suitable for international maritime transport. Yangon Port is the premier port and handles about 90% of the country's exports and virtually all imports. The Government has started to construct the Kyaukphyu deep sea port and Dawei-Nyaw Byin international deep sea port, which will give access to huge volumes of cargo handling toward various destinations in Europe, ASEAN, and South Asian countries.

Thailand's largest and one of Asia's leading deep sea ports is located at Laem Chabang, on the east side of the Gulf of Thailand. Second in importance is Bangkok and there are minor ports along the southwestern isthmus, both in the gulf and facing the Andaman Sea.

■ **Upper:** Saigon River Port, Ho Chi Minh City, Viet Nam. **Lower:** Loading Chinese boats at Chiang Saen, Thailand.

■ **Upper left:** Yangon River port, Myamnmar. **Lower left:** Boat transportation, Tonle Sap, Cambodia. **Right:** Chao Phraya River transport, Bangkok, Thailand.

Inland waterways

Cambodia has extensive inland waterways totaling 3,700 kilometers in length, including the Mekong and Sab rivers, and Tonle Sap, that are important for domestic trade as well as transporting passengers. They are linked via the Mekong River to the major port at Phnom Penh. In 2009, Cambodia and Viet Nam signed an agreement that will allow freedom of navigation on Mekong waterways between the two countries and increase access to the river system for foreign vessels.

Guangxi has nearly 6,000 kilometers of inland waterways, including the Xijiang or "golden" waterway complex that connects GuiGang, Nanning, Baise City, Guangdong Province, and Hong Kong, China. At present, Yunnan has six major water systems consisting of the Jinsha (Golden Sand), Lancang (Mekong), Yuan, Nanpang, Nu, and Ayeyarwady rivers, as well as some 30 lakes of various sizes. A total of 8,000 kilometers of waterways can be used for river transport. Along the Jinsha River and the Lancang River, the length of intra-province waterways is about 1,500 kilometers. Major ports include Shuifu, Suijiang, Jinghong, Simao, and Dali. However, the PRC is constructing a series of dams on the Mekong River that will reduce the length of continuous navigable waterways considerably.

Over 2,000 kilometers of the Mekong River and its tributaries are located in the Lao PDR. During the dry season, the navigable length is reduced to 1,300 kilometers. The river forms

■ **Satellite image showing Mekong River rapids at Si Phan Don, Lao PDR. Despite the difficulties, making the Mekong RIver navigable will be a millennium project for the GMS countries.**

the border with Myanmar and with Thailand. Twenty-one river port facilities, constructed by the Government, have typically been employed for domestic trade only. However, trade on the river has been increasing in recent years, especially cross-border trade with the PRC, Myanmar, and Thailand.

Myanmar is well endowed with natural river resources, including about 12,800 kilometers of navigable waterways, a quarter of which are commercially navigable, mainly along the Ayeyarwady, Chindwin, Thanlwin, and Sittaung rivers. There are two ports for international traffic on the Mekong—Wan Seng and Wan Pong.

Thailand has 6,000 kilometers of waterways but only 30% are commercially navigable and this is reduced by a further 12% in the dry season. Most activity is in four river systems: Chao Phraya, Pasak, Tha Chin, and Mae Klong, which provide transport routes between the agriculturally rich regions and Bangkok. Important ports for cross-border trade are Chiang Saen for trade with the southern PRC and Chiang Khong for the Lao PDR.

Viet Nam has over 2,360 rivers (longer than 10 kilometers) and channels with total length of 40,116 kilometers, including lakes and reservoirs, creating an inland waterway system. There are nine main river systems in the country—four in the north (Bang Giang-Ky Cung, Red River, Thai Binh, and Ma rivers), three in the Central Region (Lam, Thu Bon, and Ba rivers), and two in the south (Dong Nai and Mekong rivers, which are linked through channels and ditches creating a waterway transport network).

Major Airports and Routes in the Greater Mekong Subregion

Airports

- International
- Domestic

Regional and domestic routes

Passenger transport by air

(2009, million persons)

- 16 - 25
- 6 - 15
- 0 - 5

0 125 250 500 Kilometers

Boundaries are not necessarily authoritative

Data source: GMS EOC, OpenFlights, UN FAO GAUL, NASA SRTM

■ Ho Chi Minh City airport, Viet Nam.

Air Transport

Cambodia has 10 airports, the main ones being Phnom Penh International Airport (Pochentong Airport) and Siem Reap Airport, the gateway to Angkor Wat, which also serves international flights.

There are six civilian airports in Guangxi, namely Nanning, Guilin, Beihai, Liuzhou, Wuzhou, and Baise. Guilin, the largest, and Nanning Wuxu International Airport are international airports. In 2010, 5.63 million passengers used the Nanning airport alone. In Yunnan, there are 18 airports. Among them, Kunming Wujiaba International airport had been a major gateway to the PRC for many Southeast Asian countries. In 2010, the airport handled 20 million passengers, making it the 6th busiest airport in mainland PRC. Also, several provincial and 2 international routes originate from Xishuangbanna International Airport, 4 kilometers from Jinghong City. The Kunming Changshui International Airport replaced Wujiaba airport in June 2012, becoming the fourth largest in the PRC and fifth in the world in terms of area. The new airport is expected to handle 38 million passengers annually.

Wattay Airport at Vientiane and two regional airports at Luangprabang and Pakse, respectively, cover international traffic and associated services in the Lao PDR. Wattay is capable of assisting the largest jets, and Luangprabang and

■ **Suvarnabhumi airport terminal, Bangkok,the main gateway to the Greater Mekong Subregion.**

Pakse can handle regional jets and turbo prop aircraft. Another significant provincial airport is Savannakhet. There are also 10 minor airports in provincial capitals and 39 other airstrips.

Myanmar has 70 airports but only 12 have runways suitable for commercial aircraft. The latest and largest is at the new national capital, Nay Pyi Taw, opened in December 2011. Two other airports, Yangon International and Mandalay International, are the major airports at present. Yangon airport can handle 2.7 million passengers per year.

Thailand has six main international airports: Suvarnabhumi, Don Muang, Chiang Mai, Mae Fah Luang, Hat Yai, and Phuket, and more than 100 airports serving domestic flights. Suvarnabhumi Airport also known as Bangkok International Airport, serves as the regional gateway and connecting point for various foreign carriers. It is the sixth busiest airport in Asia and the busiest in the country, handling 47.9 million passengers in 2011, and is also a major air cargo hub with a total of 96 airlines.

In view of Viet Nam's geography, air transport growth is considered to be a prerequisite of national economic growth. In recent years, the sector has grown rapidly with 21 million inbound passengers and 10.7 million outbound in 2010. Viet Nam currently has 21 commercial airports, including nine international airports (Can Tho, Da Nang, Noi bai, Tan Son Nhat, Cam Ranh, Phu Quoc, Lien Khuong, Chu Lai, and Phu Bai) and 12 local airports. Of these, only Noi Bai (Ha Noi) and Tan Son Nhat (Ho Chi Minh City) operate frequent international flights.

Tourism

The Greater Mekong Subregion (GMS) is characterized by an abundance of natural and cultural tourism assets, with the iconic Mekong River at its core. Its mountains, valleys, and coastal regions contain lush tropical monsoon forests, pristine sea beaches, globally important wildlife, and some of the earliest known human settlements in Southeast Asia. Ancient and diverse cultural heritage, including Buddhist traditions, religious and vernacular architecture, music, literature, and indigenous knowledge, enriches the subregion and adds to the appeal of its striking rural landscapes and vibrant urban centers.

Tourism can contribute greatly to inclusive economic growth and sustainable development and has been promoted in the GMS Economic Cooperation Program since it was founded in 1992. The GMS Tourism Sector Strategy includes ways to help achieve the Millennium Development Goals on poverty alleviation, gender equality and empowerment of women, and environmental sustainability. Priority programs during 2011 to 2015 aim to train more people to participate in and manage tourism-related activities, improve tourism access infrastructure and services that benefit the poor, safeguard the environment, and boost subregional marketing and product development.

The GMS saw international tourist arrivals more than double from 17.9 million in 2002 to nearly 38 million in 2011, placing it among the world's fastest growing tourist destinations. This impressive growth is underpinned by a highly competitive cost structure, diverse mix of attractions, rapidly improving subregional connectivity, liberalization of immigration policies, and increasing affluence among the GMS population of more than 330 million people. Although Thailand's share of total arrivals declined from 61% in 2004 to about 50% in 2011, it receives more international tourists than any destination in the GMS.

Tourism is among the most labor intensive of the non-agricultural sectors, and one of the few pathways that unskilled and semi-skilled workers

Upper: Hạ Long Bay, the UNESCO World Heritage Site and a major tourist attraction in Viet Nam. **Lower:** Asian Elephants. Ecotourism is growing in popularity in the subregion.

Meili Snow Mountain
Three Parallel Rivers
White Water Terraces
Lugu Hu
Jade Dragon Snow Mountain
Black Dragon Pool
Erhai Lake
Cangshan Mountain
Qiongzhu
Kunming
Longmen Dragon Gate
Stone Forest
Sanjiang
Longji Dragon's Backbone
Elephant Trunk Hill
Yanshuo
Huangyao
Bama
Yuanyang
Tongling Grand Canyon
Detian
Nanning
Mandalay
Pyin Oo Lwin (Maymyo)
Xishuangbanna
Sapa
Sanniang Bay
Silver Beach
Bagan
Kyaing Tong
Mount Popa
Pindaya
Kalaw
Inle Lake
Nam Ha
Golden Triangle
Bokeo
Mekong River
Imperial Citadel of Thang Long
Halong Bay
Mai Chau
Ha Noi
Weizhoudao
Viang Xay
Citadel of the Ho Dynasty
Luangprabang
Hongsa
Phonsavan
Pai
Chiang Mai
Nan
Vang Vieng
Phou Khao Khouay
Ngapali
Vientiane
Tham Kong Lo
Ban Chiang
Dong Phong Nha
Phong Nha-Ke Bang
Bago
Kyaiktiyo
Yangon
Sukhothai
Mawlamyine
Savannakhet
Hue
Da Nang
Cua Dai
My Son
Hoi An
Thungyai Huai Kha Khaeng
Lop Buri
Sangkhlaburi
Kanchanaburi
Bolaven Plateau
Nam Tok Katamtok
Dong Phayayen-Khao Yai
Preah Vihear
Ayutthaya
Koh Ker
Si Phan Don
Ratanakiri
Quy Nhon
Bangkok
Samut Prakan
Siem Reap
Damnoen Saduak
Battambang
Kratie
Mondulkiri
Pattaya
Hua Hin
Koh Samet
Nha Trang
Ko Chang
Kompong Cham
Da Lat
Koh Kong
Phnom Penh
Can Tien
Ca Na
Ho Chi Minh City
Mui Ne
Phnum Bokor
Sihanoukville
Kampot
Mekong Delta
Phu Quoc
Koh Tao
Koh Samui
Khao Sok
Phuket
Krabi
Hat Yai
Major Tourism Sites of the Greater Mekong Subregion
Major tourism sites
History & Culture
Leisure
Nature
Urban
UNESCO World Heritage Site
Tourism arrivals
(International, 2010)
> 5 million
1 - 5 million
< 1 million
0
120
240
480 Kilometers
Boundaries are not necessarily authoritative
Data source: GMS EOC, UNESCO World Heritage Center, UN FAO GAUL, NASA SRTM

GMS International Tourist Arrivals 2002 – 2011

Country	2002	2004	2006	2008	2010	2011	AAGR (%) 2002-2011
Cambodia	786,524	987,359	1,591,350	2,001,434	2,508,289	2,881,862	13.9
PRC							
Guangxi	1,363,400	1,175,800	1,707,729	1,620,466	1,996,452	3,027,900	8.3
Yunnan[a]	1,303,550	1,100,994	1,810,017	2,502,170	3,291,532	3,953,800	11.7
Lao PDR	735,662	894,806	1,215,106	1,736,787	2,513,028	2,723,564	14.0
Myanmar	217,212	241,938	263,514	193,319	310,688	816,369[b]	14.2
Thailand	10,872,976	11,737,413	13,838,488	14,584,220	15,936,400	19,098,323	5.8
Viet Nam	2,627,988	2,927,876	3,583,486	4,207,895	5,049,855	6,014,032	8.6
Total	**17,907,312**	**19,066,186**	**24,009,690**	**26,846,291**	**31,606,244**	**38,515,850**	**8.0**

AAGR = average annual growth rate, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
[a] = Figures include visitors from Macau and Hong Kong, China. [b] = Including day-trips.
Source: GMS national tourism organizations; Mekong Tourism Coordinating Office estimates; Pacific Asia Travel Association; Yunnan Bureau of Statistics. Yunnan Statistical Yearbooks 2003, 2005, 2007, 2009, and 2011 and Yunnan Provincial Tourism Administration. 2011. *Yunnan Tourism Statistical Report of 2011*. Kunming.

GMS Tourism – Key Indicators

	Cambodia	Lao PDR	Myanmar	Thailand	Viet Nam
2009 Receipts (million $)	1561.0	267.7	196.0	15,358.0	4,227.00
Change in international arrivals 2010/2011 (%)	14.8	8.3	162.7	19.8	19.0
Travel and tourism economy as share of GDP [a]	18.3	11.4	5.6	13.8	12.3
Share of GDP forecasted in 2020 (%) [a]	15.3	10.4	6.1	17.7	13.0
Employment (2009)[b]	302,578	51,754	37,992	2,976,934	819,345
Women's share of tourism employment (%) [c]	54	50	—	65	70
Share of total GMS international arrivals (%) [d]	7.5	7.1	2.1	50.3	15.8

GDP = gross domestic product, GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic, - = not available.
Source: GMS national tourism organizations; [a]World Tourism and Travel Council; [b]Greater Mekong Subregion Tourism Sector Strategy Draft Final Report, 2005, suggests one job per $5,159 expenditure in 2009 dollars. [c]ADB. (2009), *Gender Related Impacts of the Global Economic Slowdown in the Greater Mekong Subregion: Emerging Trends and Issues.* Manila.
[d] Including Guangxi and Yunnan, PRC, which accounted for 8.8% and 6.3% of 2009 arrivals, respectively.

Upper: Li River cruise against the scenic backdrop of karst landscape, Guangxi, PRC. **Lower:** Part of the Grand Palace, Bangkok, Thailand.

Above left: Ko Phi Phi island, a major island beach attraction of southern Thailand. **Above right:** Some of the 4,400 temples of Bagan, Myanmar. Built in the 11th to 13th centuries, they rival the temples of Angkor, Cambodia, in splendor.

can follow to enter the service economy. Its ability to create employment in the informal sector has long been recognized as a key opportunity for job creation and poverty reduction in developing countries.

According to the World Travel and Tourism Council (WTTC), in 2010 the Mekong countries of Cambodia, the Lao People's Democratic Republic (Lao PDR), Myanmar, Thailand, and Viet Nam generated $22.1 billion in economic output from travel and tour operations, shopping, entertainment, transportation, and various other tourism-related service occupations and productive sectors. The WTTC forecasts that the combined tourism economy of these countries will be worth $56.95 billion in 2020 and represent a significant proportion of each country's GDP.

Domestic tourism is also an important contributor to the more developed GMS economies. An estimated 87 million domestic tourists spent $12.3 billion in Thailand during 2009, and Yunnan Province of the People's Republic of China (PRC) counted 120 million domestic visitors the same year. Thailand and the PRC minimize tourism-related imports to less than 4% of gross receipts due to strong linkages between the tourism sector and other productive sectors, such as manufacturing and agriculture. In contrast, such imports in the Lao PDR, Cambodia, and Myanmar amount to 20%–40% of tourism receipts.

Women represent at least half of the subregion's tourism industry workers and hold 65% or more of tourism-related jobs in Thailand and Viet Nam. Most women are employed in lower-skilled jobs paying lower wages. Men tend to secure a higher proportion of managerial positions in government and private sector tourism enterprises. In Thailand, 66% of hotel and restaurant workers are women; virtually all housekeepers in the Lao PDR's accommodation subsector are women. Notwithstanding lower wages and gender-biased pay rates that favor males, remittances from low and semi-skilled tourism workers are an important source of supplementary income for rural households. For example, remittences from hotel workers in Siem Reap and Phnom Penh, Cambodia amount to over $1.2 million per month.

About 65% of GMS international arrivals originate in Asia, led by Thailand, Malaysia, Republic of Korea, Japan, and the PRC. Long-haul source markets from Europe account for 21% of international visitors, followed by the Americas and Oceania at 6% and 5%, respectively. Average length of stay for long-haul visitors is 8 days and average spending varies widely by country, ranging from $60 to $170 per day. Intraregional tourists tend to vacation for shorter periods and spend less per trip than long-haul visitors.

Must-See Tourist Attractions

Each GMS country has several must-see attractions that draw millions of visitors each year. Topping most travelers' list in Cambodia is Angkor, epicenter of the Khmer Empire from the 9th to 13th centuries. This ancient landscape is exceptional for its cultural, historic and archaeological values. For nature lovers, Cambodia's Peam Krasaob Wildlife Sanctuary offers the subregion's largest intact mangrove forest.

The Old Town of Lijiang in Yunnan is set in a dramatic landscape where different cultural traditions have evolved harmoniously. Parts of the southern PRC, particularly Guilin in Guangxi and Yunnan's Shilin Stone Forest, are unrivalled for their karst features. Hạ Long Bay, situated in northeastern Viet Nam, is also a stunning karst landscape, comprising more than 1,600 islands and islets that harbor diverse marine life. For caves, Phong Nha Khe Bang National Park in Viet Nam has some of the largest, formation-rich, and most easily accessible caverns in the world.

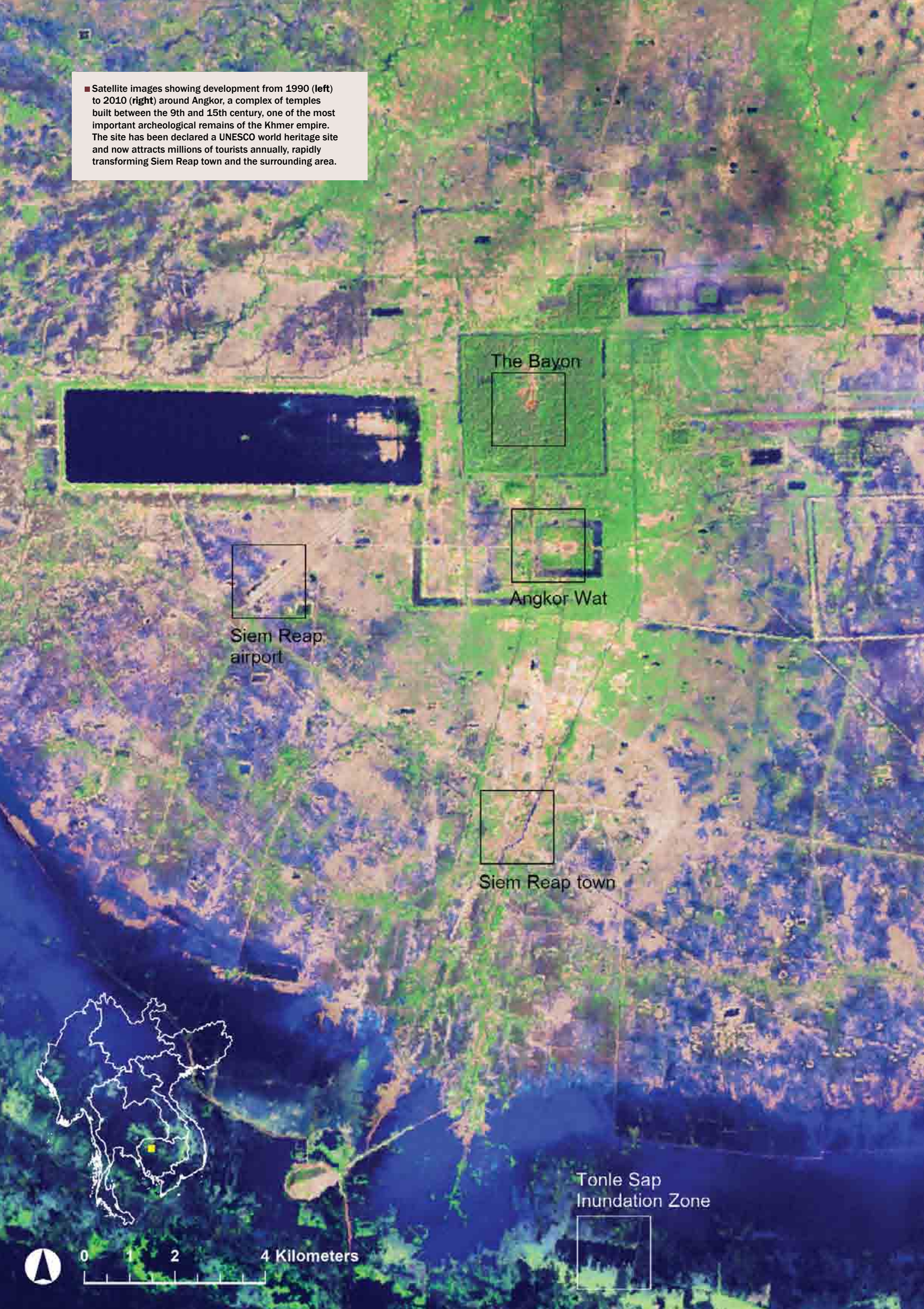
A popular destination in the Lao PDR is the town of Luangprabang, famous for its unique, well-preserved townscape set on the banks of the Mekong River. Straddling the Mekong in the southern Lao PDR is the Champasak cultural landscape and Wat Phou Temple complex. More than 1,000 years ago the ancient Khmer shaped the land here to express the Hindu vision of the relationship between nature and humanity.

Although it currently receives the lowest number of international tourists, the Republic of the Union of Myanmar is rich in attractions, including the Shwedagon Pagoda in Yangon. This magnificent 98-meter Buddhist shrine is plated with over 30 tons of gold. Mandalay and Bagan are acclaimed for their Buddhist temples and fine crafts.

Bangkok, the capital of Thailand is the main gateway to the GMS and has several attractions that should not be missed. The first stop for most visitors is the spectacular Grand Palace and Temple of the Emerald Buddha. Across the Chao Phraya River is the Temple of the Dawn, famous for its Jataka murals that depict the previous lives of Buddha and convey lessons on moral conduct and good behavior. Thailand's second largest city and major tourist destination is Chiang Mai. Here, visitors flock to Wat Doi Suthep, a mountaintop temple 1,000 meters above sea level. South of Bangkok, Thailand's Andaman Sea beaches are the major attraction. The Similan Islands National Park is one of world's top scuba diving destinations.

Upper: Forest canopy walk, Xishuangbanna, Yunnan PRC. **Lower:** A young tourist photographed with two elephants in Yunnan, PRC. **Next page:** Detail of the spectacular Bayon Temple, Cambodia.

■ Satellite images showing development from 1990 (**left**) to 2010 (**right**) around Angkor, a complex of temples built between the 9th and 15th century, one of the most important archeological remains of the Khmer empire. The site has been declared a UNESCO world heritage site and now attracts millions of tourists annually, rapidly transforming Siem Reap town and the surrounding area.



The Bayon
Angkor Wat
Siem Reap airport
Siem Reap town
Tonle Sap Inundation Zone
0 1 2 4 Kilometers

Upper: Temples at the UNESCO World Heritage Site, Luangprabang, Lao PDR. **Lower:** Tea leaf drying in Xishuangbanna, Yunnan, PRC, along the "Tea Caravan Trail."

While GMS tourism growth is predominately based on leisure travel to the subregion's cultural and natural attractions, the gaming industry is also expanding rapidly. There are currently at least 32 casinos in the border areas of the Lao PDR and Cambodia, with most clients originating in the PRC and Thailand where casino gambling is illegal. Viet Nam is also actively pursuing development of integrated casino-resort projects, including a $5 billion venture in Da Nang and a 9,000-room, $4.2 billion project on a pristine strip of the southern coast in Ba Ria–Vung Tau.

The business of GMS tourism is predominantly led by private enterprise, although many tour companies and hotels in the PRC, Myanmar, and Viet Nam have partial or total state ownership. The International Finance Corporation reports that Thailand is the easiest place in the subregion to start a business, ranking it 18 out of 183 countries evaluated. In comparison, Viet Nam ranked 78, and Cambodia 147. The Lao PDR trailed its neighbors with a ranking of 171. Despite these rankings, Cambodia, Lao PDR, and Viet Nam added a total of 92,084 hotel rooms between 2006 and 2009.

In this context of highly favorable strengths and opportunities—supportive tourism investment policies, abundant private investment capital, outstanding natural and cultural tourism assets, improved subregional connectivity, and increasing affluence in Asia—it is highly likely that GMS tourism will continue to expand in the coming decades if threats to the industry can be managed. These include environmental degradation at key tourist sites, inadequate management and protection of cultural resources, effects of climate change, and communicable disease epidemics. To address these threats requires significant investments in infrastructure, human resources, and policy dialogue between the GMS countries.

Multicountry Tour Circuits

To help spread the benefits of tourism to less developed areas, GMS countries have prioritized the development of thematic multi-country tour circuits that span the region. Two popular routes are the historically significant Tea Caravan Trail that links attractions in the mountains of Yunnan Province of the PRC, the northwestern Lao PDR, and northern Thailand; and the Mekong Discovery Trail, a network of ecotourism adventures where visitors can get a taste of local life along the Mekong River in northeastern Cambodia and southern Lao PDR.

Human Resource Development

Upper: Agricultural research training, Kasetsart University, Thailand. **Lower:** A classroom in Sa Thay High School, Viet Nam, with access to internet.

The Greater Mekong Subregion (GMS) is developing rapidly in the context of an emerging global economy. Consequently, education and training systems in GMS countries are under increasing pressure to provide the human resources needed to sustain continued growth; health systems are struggling to meet expanding demands for health care in the face of increasing income inequality; and cross-border labor migration is growing rapidly to exploit income-earning opportunities and to meet labor shortages within the GMS. In addition, the cross-border transmission of communicable diseases (some emerging, some existing) and human and drug trafficking are increasing concerns in the subregion. There is also growing concern about the social and health impact of rapid growth and subregional integration in border areas, many of which are inhabited predominantly by highly vulnerable ethnic groups.

Although GMS economic growth has been rapid (averaging over 6% per annum in recent years), it has also been unbalanced within the subregion. There are still substantial differences in levels of income and earnings among GMS countries and in the degrees of development of their social sectors. For example, per capita gross domestic product (GDP) ranged from $742 to about $5,000 among the six GMS countries in 2010, while values of the Human Development Index ranged from 0.483 to 0.682 in 2011. These differences provide a strong rationale for subregional cooperation.

However, the gaps also make effective cooperation difficult to achieve in some areas. There is a risk that subregional cooperation can result in an unequal distribution of the benefits of GMS human resource development (HRD) cooperation among countries, as well as within countries between the poor and the nonpoor, if effective countermeasures are not adopted.

There is an urgent need to reform, strengthen, and harmonize GMS vocational and technical training standards, and to harmonize labor migration policies in order to meet labor demand across the region and provide skilled and unskilled workers

■ **Upper:** Prenatal care at a clinic in the central highlands, Viet Nam. **Lower:** Training village patrols, Biodiversity Conservation Corridors Initiative, Yunnan, PRC.

with cross-border employment opportunities. However, cross-border labor migration increases the risk of spreading infectious diseases, such as tuberculosis and HIV/AIDS, from one country to another. These risks are heightened by the fact that there are large differences among GMS countries in the prevalence of such communicable diseases. Migrants also have difficulties accessing education and health services while residing in another country. The absence of systematic information about labor markets in the subregion makes it more difficult for GMS countries to provide appropriate training and information to their populations to enable them to exploit cross-border opportunities in skilled employment.

HRD involves various activities that provide vital inputs to a growing economy, including education and training, and health and nutrition services that enhance productivity or prevent catastrophic disease outbreaks that can lower economic growth. The main instruments of HRD are (i) investments in education, health, labor and migration, and social development that improve people's productivity in an equitable manner; and (ii) national, regional, and international policies to support that goal. Because HRD increases people's productivity (creates human and social capital), a more equitable distribution of HRD outcomes both between and within countries contributes to poverty reduction, political stability, and national security. HRD provides opportunities for ethnic groups, women, and other vulnerable segments of the population. Finally, HRD contributes directly to human welfare. For example, most people place a very high value on good health, literacy, personal security, and social inclusion. HRD contributes to these by not only reducing income poverty but also satisfying basic human needs.

Opportunities for Human Resource Development Cooperation

The GMS consists of a group of geographically contiguous countries, which are increasingly linked along several transport corridors that provide unique opportunities for economic cooperation and integration in such sectors as agriculture, energy, transport, and tourism. These opportunities extend well beyond the areas immediately bordering the Mekong River and are not available in either smaller or larger regional and international groupings, such as the Mekong River Commission, the Association of Southeast Asian Nations (ASEAN), or Asia-Pacific Economic Cooperation.

A GMS Human Resource Development Strategic Framework and Action Plan (2009-2012) was approved in 2009. HRD cooperation and integration within the GMS will (i) contribute to broad economic growth and sustainable social development, (ii) address problems and needs growing out of increased regional connectivity and integration in other sectors, and (iii) help the process of further integration. HRD cooperation is viewed as an important way to support economic growth and social development, and ensure that the benefits of regional cooperation and integration reach the poor. For example, cross-border labor migration has the potential to yield substantial economic benefits to GMS sending and receiving countries and to promote poverty reduction by providing higher income-earning opportunities for the poor.

Harmonization. Different national HRD regulations, standards, policies, and procedures are in some cases a constraint to further GMS integration and economic growth. In these cases, subregional harmonization can assist the cross-border flow of investments, goods and

services, workers, and students. Examples are (i) standardization of labor regulations (e.g., minimum conditions of employment and regulation of child labor); (ii) food and drug regulation; (iii) border health certification; (iv) cross-border migration regulations and procedures (e.g., registering cross-border workers, employment contracts, ensuring migrants' access to social services, and regulating the activities of private recruitment companies); (v) standardizing teacher training in key areas, such as technical training, language, portability of educational and training qualifications across borders (e.g., the transfer of credits among GMS universities); and (vi) mutual recognition of skills and qualifications in key occupations to facilitate cross-border migration of skilled workers. Although the potential benefits from harmonization in these and other HRD areas are large, they may take considerable time to achieve.

Cross-border Issues. There is an important cross-border dimension to many HRD issues affecting the subregion. Some of these issues have become more urgent as the result of growing subregional connectivity. An important example is the control of infectious diseases. Some communicable diseases (e.g., HIV/AIDS, tuberculosis, and severe acute respiratory syndrome [SARS]) are easily transmitted across borders by migrants and travelers. Avian influenza, an important emerging disease with potentially devastating economic and health impacts, can be transmitted by infected poultry traded across borders. Some vector-borne infectious diseases, such as malaria and dengue fever, cannot be effectively controlled in border areas unless they are controlled on both sides of the border. Other important cross-border HRD issues include (i) the illegal drug trade, which is the main channel of HIV/AIDS infection in some GMS countries; (ii) cross-border trade in fake drugs; (iii) cross-border trafficking of women and children; and (iv) cross-border travel to obtain medical care. Although much of the effort needed to address these problems is national, regional cooperation is also needed. Several GMS projects have already been implemented to address such cross-border issues, including regional projects to control communicable diseases and to study the problem of cross-border human trafficking.

Additional Value through Subregional Cooperation. Some HRD activities involve significant economies of scale or public goods or provide other opportunities that can be most effectively exploited through subregional cooperation. Examples include (i) regional disease surveillance, (ii) various types of specialized training or research, (iii) information and communication technology initiatives in education and health (e.g., use of distance learning technologies in training institutions), (iv) quality testing of pharmaceuticals and the manufacture of vaccines, (v) provision of regional labor market information, and (vi) cooperation in developing information and communication materials for ethnic groups (e.g., educational radio programs for ethnic groups in cross-border areas). Development management training for GMS government officials under the Phnom Penh Plan for Development Management is a highly successful example of the additional value that can be obtained through subregional activities. In this case, the value comes from (i) developing a common GMS approach to problem solving (by exposing GMS government managers to a common curriculum), (ii) developing foreign language skills

■ **Upper:** Research on new crop varieties, Kasetsart University, Thailand. **Lower:** Education for farmers about avian flu, Lao PDR.

Phnom Penh Plan

The Phnom Penh Plan for Development Management is a pioneering program that supports building a critical mass of highly competent and qualified junior-, middle- and senior-level policy makers, development planners and managers to lead and drive socioeconomic development in the Greater Mekong Subregion (GMS). The Phnom Penh Plan supports learning programs on a range of topics specifically designed to address the needs and enhance the competencies of the GMS civil service, a fellowship program in prestigious learning institutions for contextual immersion, a research program that supports new analytical insights for more informed policy choices, and an alumni program for continuous networking and expansion of professional contacts and lifelong learning. The Phnom Penh Plan also promotes access to development information through the establishment of learning resource centers, maintenance of a website, and publication of a newsletter and the Journal of Greater Mekong Subregion Development Studies. It promotes discussion of key subregional development issues and sharing of insights and experiences through the GMS Development Dialogue.

■ **Upper left:** Examining plant tissues in an agricultural college, Thailand. **Lower left:** School boys display souvenirs they made from natural forest products, Tenassarim, Thailand. **Above right:** Students at Kon Tum Provincial Ethnic High School, Viet Nam.

among government management participants that can lead to improved communication among GMS government managers in a given area, and (iii) forging personal ties between GMS managers that can contribute to cooperative problem solving.

Exchange of Information and Experience. Most GMS countries face many common HRD challenges (or have faced them in the recent past), such as the need to strengthen priority public health and basic education services. It is clearly useful for GMS countries and strategic partners to share their experience and approaches to dealing with these problems. Examples include (i) strengthening education and health systems, (ii) improving access to education and health services in remote areas, (iii) food and drug controls, (iv) noncommunicable disease control (including road safety), (v) quality assurance in education and health services, (vi) governance reforms in education, (vii) national planning and results monitoring in education and health, (viii) decentralizing education and health services, (ix) developing social security systems and other social protection mechanisms, and (x) public administration reform. Information, good practices, and experience can be exchanged through meetings and forums, strengthened institutional links and networks, training, and related activities under the Phnom Penh Plan, and by using advanced information and communication technologies to disseminate information.

HRD Thrusts Under the GMS Strategic Framework 2012–2022

The GMS Strategic Framework 2012–2022 includes activities that contribute to meeting the HRD goals of the GMS countries through subregional programs on education and skills development, and labor and health issues. One major accomplishment has been the Phnom Penh Plan for Development Management to build capacity among GMS government officials. A second major accomplishment has been carrying out projects on the prevention and control of communicable diseases, including HIV/AIDS. A GMS Human Resource Development Strategic Framework and Action Plan was approved in 2009. During 2003–2011, a total of 1,698 persons from the GMS countries received training that covered some 89 learning programs and themes.

GMS strategies in other sectors have frequently cited the need for complementary investments in HRD. The GMS Tourism Strategy, for example, estimates that 2.5 million personnel will need to be trained in tourism during 2006–2015. Similarly, the benefits from improved connectivity in the transport sector depend critically on the education levels of the population residing along transport corridors.

■ **Upper and lower: Handicraft training at the Queen Sirikit Center, Tenasserim, Thailand.**

GMS National HRD Achievements and Plans

Cambodia. Cambodia has made significant achievements in education, health, labor and migration, and social development. The country's priorities for subregional HRD cooperation are harmonization of standards in education and skills training, skills assessment for migrant workers, harmonization of labor migration policies to meet subregional labor demand, provision of cross-border employment opportunities for skilled and unskilled workers, formulation of instruments to implement the ASEAN Declaration on Protection and Promotion of the Rights of Migrant Workers, enhancement of health promotion activities on disease prevention and epidemic preparedness, and prevention of child labor and human trafficking.

People's Republic of China. The PRC has made significant progress in HRD cooperation. In health, the PRC hosted the 2nd GMS Public Health Forum in 2009 and conducted cross-border health cooperation and capacity building programs. In education, the PRC provided scholarships to neighboring GMS countries, conducted short-term training and exchange programs, and continued financial support to the Phnom Penh Plan for Development Management. Seminars were held to promote cooperation in labor and migration. Challenges relate to the negative impact of subregional connectivity and globalization on communicable diseases, irregular migration, and issues relating to women and ethnic minorities. Continued support from the Asian Development Bank and other GMS member countries on health concerns, creation of educational cooperation platform, and training for immigration officers will be stressed in future work plans.

Lao People's Democratic Republic. The Lao People's Democratic Republic (Lao PDR), in collaboration with its development partners, has made significant progress in key areas of education and health development. In education, the country faces a lack of practical skilled teachers, expertise in curriculum reform, and competency standards for teachers, among other problems. In health, dengue has become a major public health issue, HIV/AIDS is on the increase, and so are noncommunicable diseases and road traffic-related injuries. Future activities in HRD could include competency-based training/assessment and development of competency standards; implementation of the GMS qualification framework; trialing a GMS skills and qualification recognition system; initiatives to address the burden of noncommunicable diseases, injuries, and mental illness; and control of communicable disease outbreaks expected as a result of climate change.

■ **Upper:** Karen lady and her embroidery at the Queen Sirikit Center, Tenasserim, Thailand. **Lower:** Rural school, Yunnan, PRC.

Myanmar. Myanmar has made significant achievements in promoting higher education, improving access to education in border areas, safe labor migration and anti-trafficking, social protection for disadvantaged groups (women, people with disability, elderly, and children), and disease prevention and control. Myanmar's priorities for HRD cooperation are developing partnerships and resource networking; collaboration in research and faculty development; mutual recognition of technical skills; improvement of technical teaching skills; establishment of quality assurance systems; improved legal, labor migration management; strengthening of labor market information systems; enhanced social protection for migrant workers; strengthened collaboration in communicable disease control; and exchange of knowledge and experience.

Thailand. Thailand's key achievements in HRD include work on skills development and mutual recognition of vocational skills, bilateral agreements with other GMS countries (Cambodia, Lao PDR, Myanmar, and Viet Nam) in strengthening cooperation against human trafficking, and agreements on HIV prevention at cross-border areas in the GMS. With regard to policy issues and emerging challenges in HRD, Thailand's priorities are prevention and control of communicable diseases, setting up competency standards in preparation for the liberalization of the ASEAN labor market, and combating human trafficking. Under its bilateral country assistance programs, Thailand has extended soft loans and provided short-term training and scholarship programs on various topics in health and skills development to other GMS countries.

Viet Nam. Viet Nam has a master plan on vocational training, which targets 1 million rural workers up to 2020. The 2008 economic crisis affected vulnerable groups, especially workers in small and medium-scale enterprises and temporary and women workers. To recover and prepare for future productivity growth and competitiveness, there is a critical need for short-term yet sustainable measures to improve employability of retrenched workers and to invest in their re-training and re-skilling. The plan is to develop vocational training systems at all levels and invest in facilities for these workers. The country is concentrating on poverty reduction and gender main steming in order to help workers, especially vulnerable workers, gain access to social and information services. While the quality of the country's workforce has been improving, the ability of its overseas workers to secure higher paying jobs still faces challenges.

Climate Change and Natural Disasters

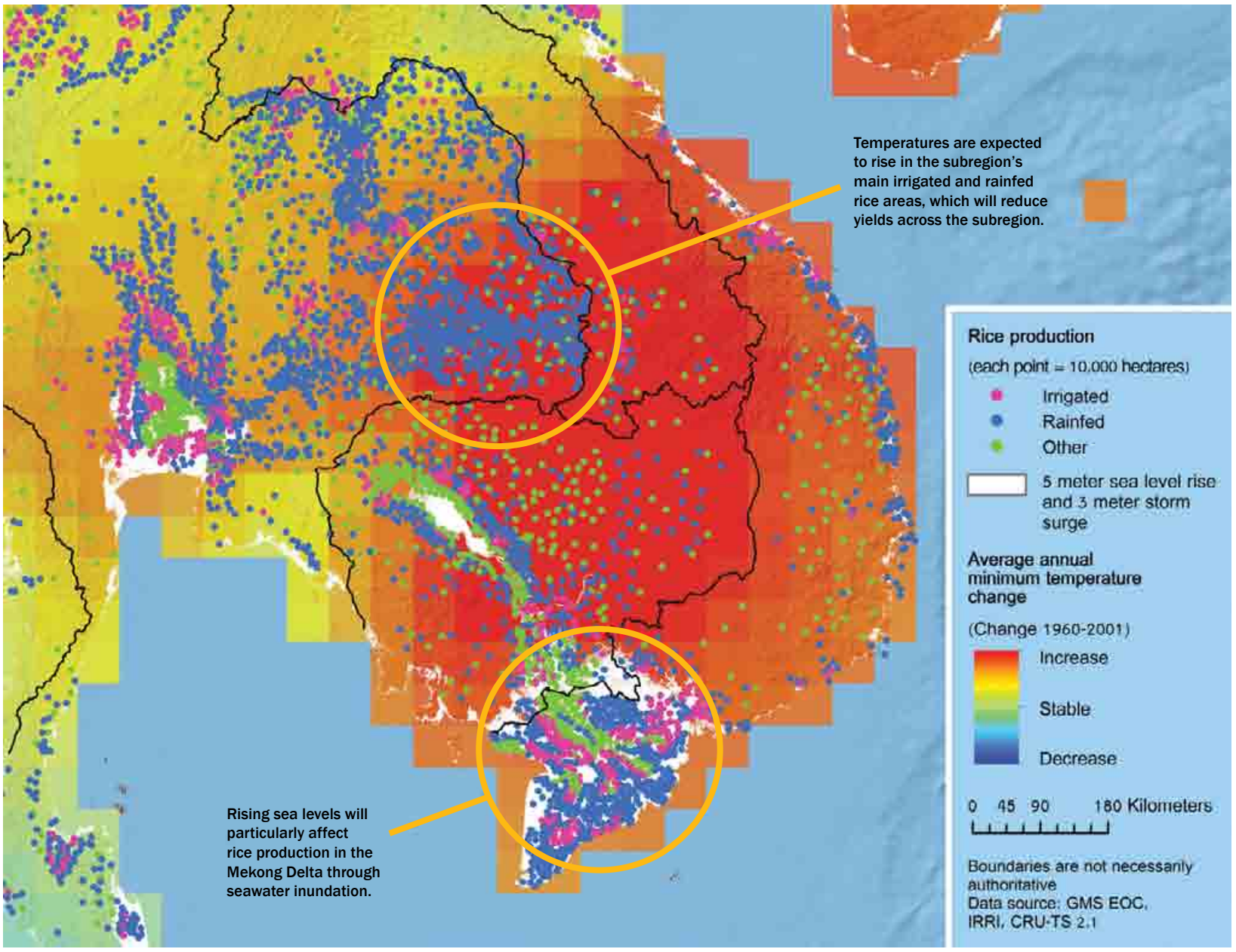
The Greater Mekong Subregion (GMS) has almost 5% of the global population and produces less than 2% of global energy-related fossil fuel emissions; per capita emissions ranking among the lowest in the world. With the exception of the People's Republic of China (PRC), greenhouse gas (GHG) emissions per capita from energy use in all the GMS countries (0.2–4.19 tons of carbon dioxide per capita) were lower than the global average of 4.76 tons per capita in 2008. However, in terms of land-use change, the subregion accounts for close to 6% of forestry-related greenhouse gas emissions even though it has only 3% of the world's forest area. All the GMS countries grow rainfed and/or irrigated rice and rice fields are a major source of atmospheric methane, which has 21 times more global warming potential than the same quantity of carbon dioxide. Methane emissions need to be monitored in the GMS countries.

Climate change has important implications both for economic development in the GMS and ecosystem services. It will affect infrastructure, such as energy and transport, in addition to life, property, and other assets across the GMS. Extreme weather events have a significant impact on GMS countries and are likely to increase. Across the subregion, temperatures have risen by 0.5–1.5ºC in the past 50 years. Wet season rainfall will increase while dry season rainfall will decrease.

The Intergovernmental Panel on Climate Change (IPCC) projections indicate a sea level rise of 0.6 meters or more by 2100, and this would accelerate if the present rate of ice melt from Greenland and Antarctica increases. Beyond 2100, sea level could rise by up to 7 meters. Major GMS investments in energy and transport, particularly in the Mekong Delta and coastal areas, are likely to be vulnerable to changes like sea level rise. Preliminary studies suggest that several billions of dollars worth of ongoing and planned GMS transport and energy projects are located partially or fully in areas most vulnerable to a sea level rise of 1 meter.

Upper: The floods in Bangkok, Thailand, 2011. **Lower:** Dense smoke pouring from cement factory in Vang Vieng, Lao PDR.

Climate Change and Rice Production in the Greater Mekong Subregion



The cost of climate change could reach nearly 7% of GDP per year by 2100 in Thailand and Viet Nam, significantly higher than the global average. In Cambodia, the 2011 floods alone caused an estimated $451 million in damage and $174 million in losses. Between 1966 and 2000, Lao PDR experienced about 30 extreme flood events, with one in 2008 causing a loss of $58 million. All the GMS countries are particularly vulnerable to climate change because their populations are largely agrarian and agriculture contributes more than a third of regional GDP; rural communities in the GMS depend directly on natural resources: crops and livestock, forests, water, biodiversity, and other ecosystem services.

Climate change projections for Cambodia, using global climate models developed by the Center for Climate Systems Research and Centre for Australian Weather and Climate Research, show an increase in temperature of between 1.3–2.5ºC by 2100 and a 3%–35% increase in annual rainfall.

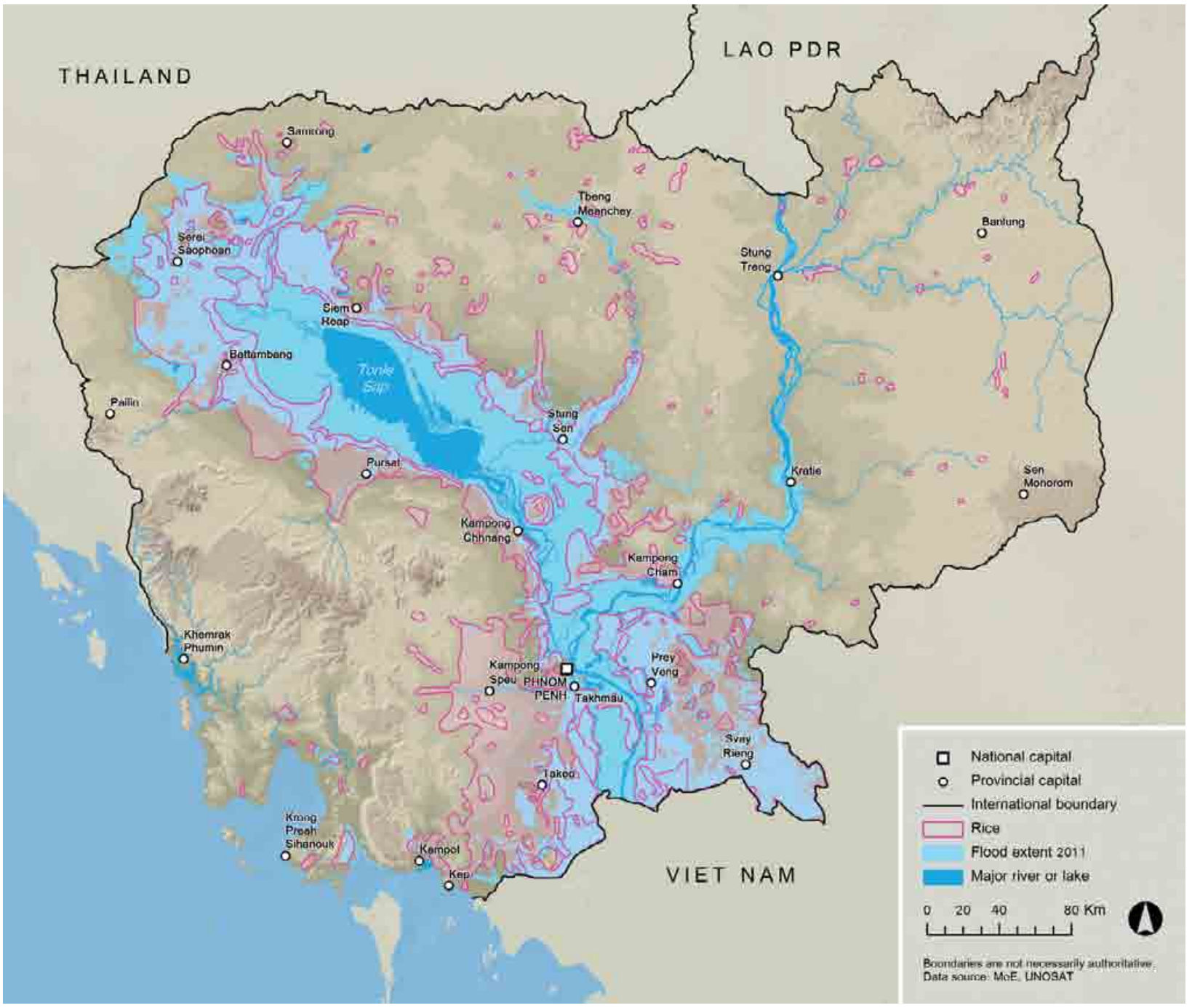
Cambodia's agricultural production system depends on the annual flooding and recession of Tonle Sap and is, therefore, particularly sensitive to potential changes in local climate and monsoon regimes. If global GHG emissions remain high, projections suggest that the rainy season will start later although wet season rainfall will increase, dry season rainfall will decrease, and extreme weather events will become more frequent. These changes may lead to more intense flood pulses and damage agriculture, infrastructure, and floodplain vegetation as well as reduce the fertile land area suitable for agriculture. For example, in Cambodia's Koh Kong Province, rainfall in four main river basins is predicted to increase by 2%–15%, increasing water flow by 2–10 cubic meters per second.

Temperature increase alone will reduce rice yields. The International Rice Research Institute has found that rice yields decline by 10% for each 1°C increase in growing-season minimum (night-time) temperature. In Cambodia, projections show that continuing high global GHG emissions will result in a fall in rice yields by 5% by 2020, 25% by 2050, and 45% by 2080 compared to current levels. Cambodia's rice exporting ability would be severely affected after 2020.

Sea level rise would affect coastlines around the GMS, particularly in Cambodia and Viet Nam, where large parts of the Mekong Delta would be severely affected. For example, a rise in sea level of 1 meter would put 44 square kilometers of Cambodia's Koh Kong Province (0.4% of total provincial area) permanently under water and contribute to the flooding of about 56% of settlement areas. In addition to the profound damage to the coastal

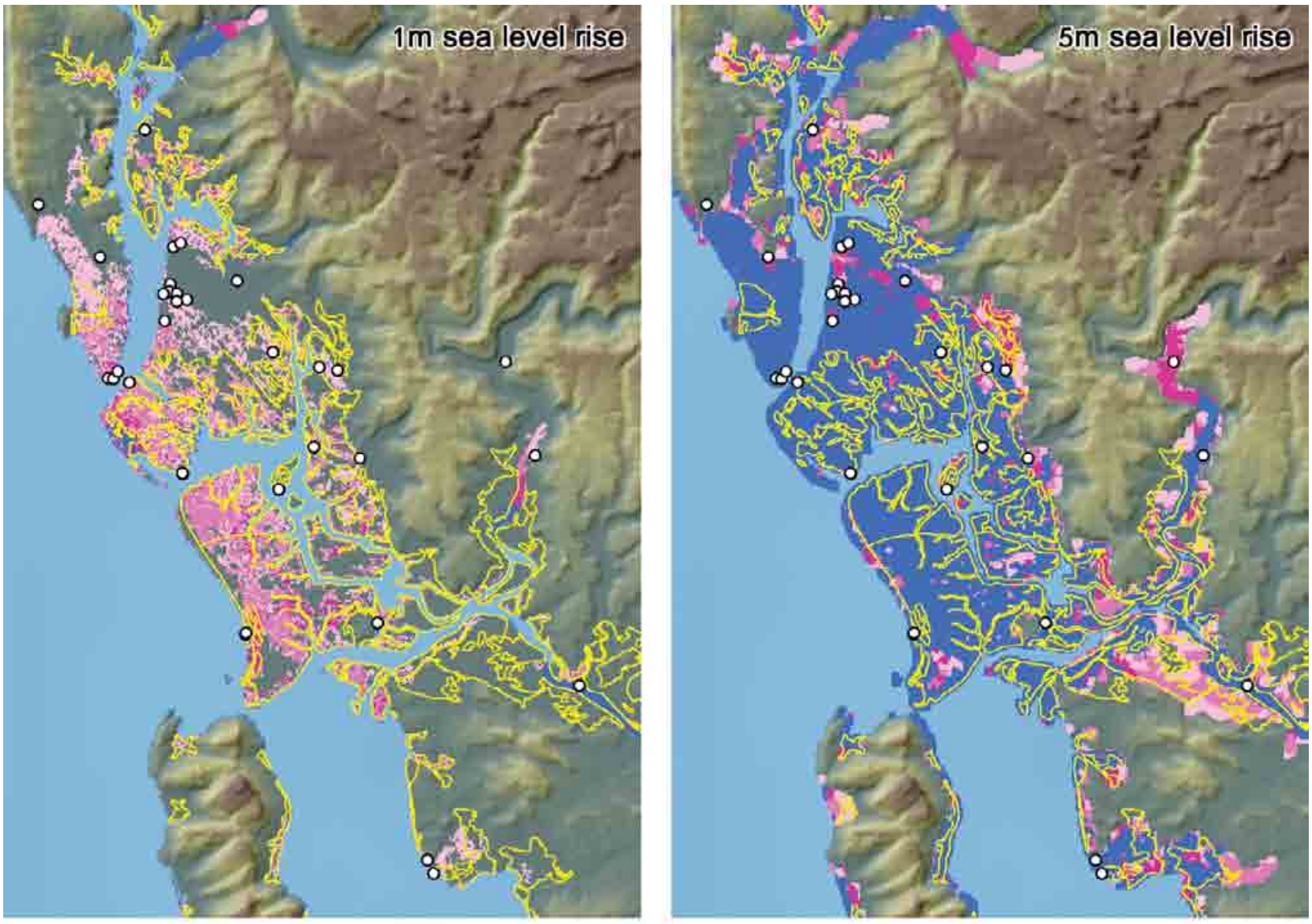
Previous page: Seasonal flooding in Tonle Sap, Cambodia.

Cambodia - Areas Affected by the 2011 Flood



Right: Mangrove walkway in Peam Krasaob, Koh Kong, Cambodia, part of a community initiative to protect and restore local mangrove forests.

Peam Krasaob, Koh Kong, Cambodia: Areas Potentially Affected by Sea Level Rise



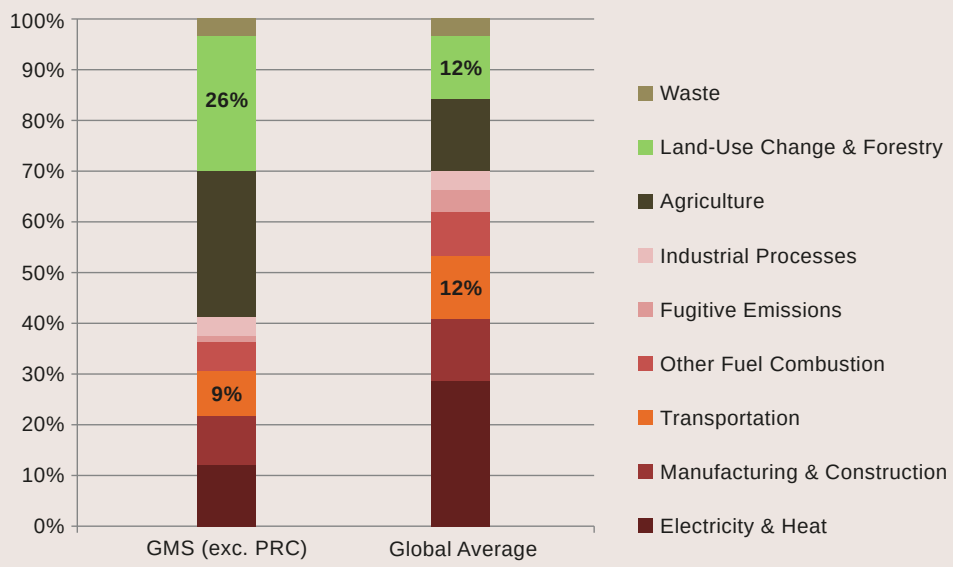
■ Mangroves along Cambodia's southern coast are threatened by rising sea levels.

ecosystem and economies, potential economic loss from damage to infrastructure would be manifold. Coastal communes like Peam Krasaob in Koh Kong Province require infrastructure adaptation measures, such as development of flood protection dikes that assist in regaining land for rice cultivation and reducing seawater intrusion, cement water tanks to harvest rain for community and household supply of potable water, introduction of short-period, salt-tolerant rice varieties in areas affected by seawater intrusion, and community mangrove restoration.

Viet Nam's annual average surface temperature has increased by approximately 0.5–0.7ºC over the past 50 years, while the sea level along its coastline has risen by approximately 20 centimeters. By the end of the century, rising sea levels in the Mekong Delta, where nearly half of Viet Nam's rice is grown, may inundate about half (1.4 million hectares) of the delta's agricultural lands. A sea level rise of 1 meter would inundate a quarter of Ho Chi Minh City, home to more than 6 million people.

Transport is one of the causes of GHGs and was responsible for 12% of GHGs globally in 2007. Transport was responsible for 9% of GHG emissions in the subregion in 2005; various projections show

Greenhouse Gas Emissions Profile of the GMS (excluding the PRC)



GHG = greenhouse gas, GMS = Greater Mekong Subregion. PRC = People's Republic of China.
Source: World Resources Institute. 2010. *Climate Analysis Indicators Tool (CAIT) Version 8.0*. Washington, DC.

■ **Burning and clearing forest in the Cardamon Mountains, Cambodia. Land-use change is a major source of greenhouse gas emissions in the GMS.**

that in South and Southeast Asia, GHG emissions from transport will see a three- to five-fold increase by 2030 (if no new policies are introduced to tackle these emissions), making Asia responsible for 31% of global transport emissions by 2030.

Land-use change and deforestation in the GMS countries were responsible for 26% of their GHG emissions in 2005. Enforcement of protection in protected forest areas would help avoid much of these emissions by halting deforestation. In some areas, regeneration and replanting is, however, contributing to increasing carbon stocks. Additional environmental benefits will accrue from water conservation, reduced soil erosion, and improved biodiversity conservation, all of which will also enhance potential tourism value.

At present, the GMS is poorly equipped to cope with the impacts of climate change. Addressing climate change in social and economic development plans is the most serious challenge facing the GMS. However, the impacts of climate change are broadly common to all the countries. Thus, there are benefits to be gained for all the peoples of the subregion in exchanging knowledge, experience, approaches on planning, and implementation of adaptation to climate change.

There is a need to conserve energy and raise energy efficiency so that carbon emission per unit of GDP decreases. Development of renewable energy sources to increase the share of non-fossil fuels needs to be vigorously tackled. And there is a need to increase carbon sequestration in forests by increasing protection and reforestation. Developing a green economy fostering a low-carbon and recycling economy and popularizing environmentally-friendly technologies will go a long way to maintain emission levels and meet targets of reducing GHGs in the GMS.

Natural Disasters

The GMS is vulnerable to forest fires, landslides, flashfloods, earthquakes, and typhoons. Each year, millions of people are affected by such hazards in the subregion.

In Cambodia, damaging floods have occurred in the last decade: in 2001, 2002, 2006, 2010, and 2011, the 2011 flood being the worst, as the Mekong River and Tonle Sap overflowed, affecting over 1.5 million people, displacing 214 000, and causing the loss of 247 lives. The floods also damaged over 400,000 hectares of paddy fields,

■ **Damage from the December 2004 tsunami on the southern coast of Thailand. The area featured many beachfront resorts and more than 1,000 tourists and residents were killed by the waves.**

as well as transport and agricultural infrastructure, including irrigation systems.

In Guangxi Zhuang Autonomous Region, rising temperatures, changed rainfall distribution, and increasing frequency and intensity of extreme weather events have led to massive flooding, landslides, and drought, causing damage to property and human life. There has also been an increase in rock desertification, degradation of forests, and damage to coastal marine resources.

Myanmar has experienced many natural disasters in recent years, including typhoons, earthquakes, floods, and fires. Major events include the Taungdwingyi earthquake in 2003; the Indian Ocean tsunami in 2004; typhoon Mala in 2006; and typhoon Nargis in 2008—Nargis caused the loss of 84,537 lives, with 53,836 persons missing and $4.1 billion damage to property. However, fires are the most frequent disasters, accounting for 71% of all disasters within the country; storms and floods account for 11% and 10% of the disasters, respectively; while other events, including earthquakes, and landslides account for the remaining disasters.

In Thailand, the Indian Ocean tsunami of 2004 and the disastrous floods of 2011 affected large parts of the country, with many losses in lives, property and production output, affecting the economy seriously. Relative sea level has increased 13–150 millimeters per year in the Chao Phraya Delta.

The El Niño and La Niña phenomena have caused increasingly adverse impacts on Viet Nam. Natural

■ **Upper:** Drought in central Cambodia. **Lower:** Bangkok's old Don Muang airport was inundated in the devastating November 2011 floods.

disasters, especially storms, floods, and droughts, have been increasing in frequency and intensity. These have caused great loss of life, property, and socioeconomic and cultural infrastructure, as well as environmental degradation. During 1980–2009, the losses from these sources included 15,917 deaths, over 69 million affected people, and damage of approximately $7.3 billion.

Land subsidence from groundwater abstraction and sediment losses due to upstream dams are already causing the region's deltas to sink and sea level rise is exacerbating the problem.

Regional Cooperation:
Challenges and Opportunities

Economic development and environmental protection are highly complex and intertwined issues. A development strategy has to rest on productivity improvements while ensuring that the environment and natural resources continue to benefit the people of the subregion. Protecting the environment alone is not sufficient; development is necessary to lift the subregion out of poverty. The emphasis must be on sustainable development and the corresponding trade-offs that this entails, and on ensuring that development is equitable and benefits all segments of society.

Gross domestic product (GDP) in the subregion has grown at over 8% per year on average during the past 2 decades or so, real per capita incomes have more than tripled during the same period, poverty incidence in Greater Mekong Subregion (GMS) countries based on national poverty lines has declined substantially, and GMS countries have made major progress in meeting the other Millennium Development Goals. GMS economies have also become much more open, as measured by the increase in the trade–to–GDP ratio and the stock of foreign direct investment. Research shows that the pace and distribution of poverty reduction in the GMS have resulted from growth in the services sector rather than the agriculture and manufacturing sectors as in the past.

However, balancing economic growth with environmental sustainability is a tough challenge.

Economic growth and development impacts over the past decade in the GMS underline the importance of conserving the natural capital base for sustaining ecosystem services necessary to maintain water flows for food production and energy security, health, and general well-being and prosperity of the peoples in the GMS.

The food-water-energy nexus provides a coherent framework for charting a new course of action for subregional 'green' economic development. Based on current projections, planned hydropower development in the GMS will be less

Upper: Ho Chi Minh City, Viet Nam, viewed from the Saigon River. **Lower:** Trucks line up at the border between Guangxi, PRC, and Viet Nam.

■ **Upper:** Urban development in Ha Noi, Viet Nam. **Lower:** First Thai-Lao Friendship Bridge over the Mekong River, connecting Nong Khai Province, Thailand, with Vientiane Prefecture, Lao PDR.

than 10% of its potential; agriculture capacity is similarly unrealized with average crop yields at 25%–30% of their potential. Water is at the heart of the nexus. As a critical resource for energy and food security, it underpins the shift toward green and pro-poor development pathways. With much of the subregional economies dominated by low-income and rural populations, there is a danger that GMS countries may become stuck in a 'low investment' trap, with limited capacity to raise revenues and scarce public funds to invest in developing water infrastructure for effective irrigation and energy generation.

Balancing energy needs with water infrastructure as part of a long-term investment strategy to stabilize and apportion water resources effectively will be critical. Accelerating regional integration can catalyze much required private investments and provide the benefit of extended supply chains and market access.

With regard to food security, the combination of increasing commodity prices, energy demand, and costs of inputs is influencing market prices, while supply factors, including land and water resource constraints, are affecting production, trade, and access. The predominant use of water is for agriculture (70%–80%), and there is large wastage in the process of growing, transporting, and storing food and food products (up to 50%). Even under the most optimistic scenario of technology improvements, water demand for agriculture is projected to increase by 20%–30% by 2050. 'Business as usual' will not suffice—innovations and technology investments in crop productivity and water-use efficiency will be necessary to address the impacts of higher prices and water availability.

Environmental and social externalities and risks will have to be managed effectively to realize agriculture and hydropower-driven economic growth potential. In the energy sector, opportunities for strategic long-term energy planning and integrating environmental and social objectives need to be pursued. Environmental criteria could define the limits and opportunities in ways to increase energy production and improve energy efficiency; this would increase flexibility in energy supply and optimize the share of renewable energy sources.

The GMS is poised to grow at 7.5% over the current decade, doubling its economic output by 2020. However, increasing resource constraints, in particular finite land and (renewable) water resources, suggest that sustainable resource management and increasing resource efficiencies will need to underpin future development. External private and public sector investments are essential to stimulate increased agricultural productivity and water resources management, and to unlock the energy potential for power development.

Transboundary Challenges

Water Resources. The use of water resources is one of the most sensitive subregional issues. The GMS countries will be affected by construction of dams on the Mekong main stem and its tributaries. The specific concern from a subregional point of view is the alteration of the natural hydrological cycle; the impact this may have on downstream water levels and sedimentation; and the disruption of fish productivity, fish migration, and fish catches. Further development of the agriculture sector will depend significantly on increasing the area of cropland under irrigation to intensify production. Irrigation schemes invariably mean dams and water diversions with consequent impact on fish and fish habitats. The alternative is to rely on groundwater, with much uncertainty about long-term sustainability. The danger is that water volume in the lower Mekong River will decline if deforestation trends continue and water from the river and its tributaries is used for big irrigation schemes. This problem would be exacerbated by impacts of climate change, such as intense and prolonged dry periods.

Cross-border Energy Trade. Vast energy resources in Yunnan Province of the PRC and in the Lao PDR are currently under development or have already been commissioned. Myanmar also has vast potential for hydropower development, with many projects now at the planning and construction stage. Most of this energy will likely be exported to Thailand and Viet Nam. Economic and political stability in the subregion, as well as harmonious intercountry relations, is prerequisite to allay importers' concerns about the security of supply and to minimize exporters' risk as regards the viability of long-term contracts. However, much of the social and environmental impact associated with the development of hydropower projects will be borne by the exporting countries: their people will be resettled, their lands will be inundated, and their fisheries will be disrupted.

Upper: Highway construction, Xishuangbanna, Yunnan, PRC, part of the GMS North-South transport corridor. **Lower:** Logs going to sawmill, Champasak, Lao PDR. The timber trade is another sensitive transboundary concern.

Cross-border Trade in Forest and Wildlife Products. Although the six GMS countries all have their own forests, trade in logs, timber, and wildlife products is transboundary. As one of them takes steps to conserve its forest resources, the pressure to harvest in others increases. The illegal cross-border trade in wildlife and rare and endangered species complicates efforts to protect biodiversity. Another problem is the geography of ecoregions. Although they are the appropriate entities for conservation planning, they rarely fall neatly within international boundaries. A major step has been establishment of Biodiversity Conservation

■ Renewable energy: experimental biodiesel production plant, Bangkok, Thailand.

Corridors around the subregion, discussed below. Protection of forest resources and wildlife requires enhanced collaboration between GMS countries in tackling illegal trade in forest and wildlife products.

Urban and Industrial Pollution. Water and air pollution in the subregion tends to be localized, but raises significant issues. Poor sanitation because of inadequate sewage and solid waste management affects water quality in adjacent water bodies, which leads to contamination of groundwater. The basic sewage and drainage systems in many of the subregion's larger urban areas have not been well maintained. The rapid growth of the industrial and agroindustrial economy has created serious pollution problems in the air, on the surface, and in the groundwater in major metropolitan areas. This is compounded when coal-fired power plants generate local and subregional sulfur dioxide pollution. Similarly, the growing industrial sector is creating new challenges for the disposal of industrial effluents and management of industrial solid wastes, in particular, hazardous waste.

Avian Flu and Other Epidemics. The outbreak of avian flu in developing Asia in late 2003 to early 2004, following the scare caused by severe acute respiratory syndrome (SARS) in early 2003, attracted attention from policymakers, the international community, and the media. Since then, the lessons of SARS control have been internalized, and by and large, there has been little panic over avian flu, an important reason being avian flu has so far been largely confined to poultry. However, two important scenarios need to be monitored: (i) avian flu is confined to animals, leading to production and income losses; or (ii) the avian flu virus (H5N1) mutates into a human virus, which could then result in escalation into a SARS-type crisis. The Regional Communicable Diseases Control project in Cambodia, Lao PDR, and Viet Nam helps develop comprehensive national surveillance and response systems in the three countries and develop community-based models for controlling outbreaks of emerging infectious diseases and selected endemic diseases. This model needs expanding across the region.

HIV/AIDS. Increased connectivity and regional integration in the GMS have improved the quality of people's lives, but have also created opportunities for the spread of HIV and other communicable diseases within and across the GMS borders. Although the HIV epidemics vary within and between countries, they are centered on common risk behavior, namely, unprotected sex and the sharing of contaminated needles and syringes by injecting drug users. Newfound freedoms, disposable income, and sometimes exploitation or abuse faced by migrant and mobile populations, such as road transport workers, may lead some to engage in such high-risk behavior. The GMS countries have signed a Memorandum of Understanding for Joint Action to Reduce HIV Vulnerability Related to Population Movement that includes a commitment to allocate 1% of construction costs to fund HIV prevention initiatives. However, the GMS countries need to continue to press for strengthened commitments from development partners, as well as private and public contractors, to scale-up HIV prevention and mitigation efforts associated with infrastructure projects.

Migrant Labor. The magnitude, scope, and scale of regional migration are not fully known because much of it is undocumented or underground. Around 1 million Burmese and 180,000 workers each from Cambodia and the Lao PDR work in Thailand, mostly entering illegally to find "3D" (dirty, difficult, and dangerous) jobs that Thai workers would rather not do. Many migrants from the PRC (particularly Yunnan) and Viet Nam are found in the Lao PDR and Cambodia. Migration within the GMS is characterized by informal flows of unskilled labor for economic rather than any other reasons. Governments of the GMS countries will be in a better position to make sound policy on labor migration and employment planning if they have common information and understanding of current problems. The situation may get worse with climate change-induced migration that is highly likely as global warming takes its toll on low lying coastal areas, deltas, and drought stricken areas in the GMS.

Human Trafficking. Trafficking of persons is a worldwide crime affecting countless numbers of people. A significant proportion of this trafficking affects the GMS countries of Cambodia, Lao PDR, Myanmar, Thailand, and Viet Nam. Trafficking is distinguished from illegal migration and people smuggling by the exploitation and abuse that is its end result. Coercion, deception, threats, or use of force characterize the trafficking process, resulting in its victims being subjected to exploitation

■ Bus service between Vientiane Lao PDR, and Udonthani, Thailand at a border crossing.

and abuse. Trafficking has a particularly severe impact on children who are the most vulnerable members of society. The overwhelming majority of trafficking victims surveyed are girls aged between 12 and 18 years of age and most of them end up in forced prostitution. Most victims come from rural areas, although some are from extremely remote areas or from situations of severe poverty. The countries of the GMS need concerted efforts to combat human trafficking.

Global Context

In tackling these subregional and transboundary challenges, the GMS countries have many 'models' from which to draw solutions, since most challenges are not unique to the subregion but rather are common topics of global and regional development as seen in the following.

Rio + 20. The need for economic development to proceed in a way that does not compromise the sustainability of the planet's environmental and resource endowments was highlighted at a major world conference in 1992—the United Nations Conference on Environment and Development, or Earth Summit, attended by governments of 178 nations and held in Rio de Janeiro, Brazil. Agenda 21, a wide-ranging blueprint for action to achieve development worldwide, was one of the main outcomes of the conference. Twenty years later, another United Nations Conference on Sustainable Development, popularly known as Rio + 20, with representatives from 191 UN member states and observers, including 79 heads of state or government, took place in Rio de Janeiro in June 2012. One outcome from this conference was a document entitled "The Future We Want."

Among other things, the document calls for a 10-year framework of programs on sustainable consumption and production, options on an effective sustainable development financing strategy, and a mechanism to promote the development, transfer, and dissemination of clean and environmentally sound technologies. The agreement considers the green economy one of the important tools; each country should choose an appropriate approach to resource efficiency, equitable growth, and job creation. Governments, private sector, civil society, multilateral development banks, and other groups made financial commitments toward a green economy but the conference did not identify significant means of implementation or establish concrete targets or a "roadmap" for such an economy.

International Organizations. The United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) is responsible for regional cooperation and integration in the Asia-Pacific region. In the area of environment and sustainable development, ESCAP contributes to strengthening national capacities to design and implement policies and strategies. Its initiatives include a two-phase project to integrate environmental and socioeconomic planning and to involve stakeholders through national councils for sustainable development.

The United Nations Development Programme (UNDP) cooperates closely with ESCAP to promote and implement the UN agenda. UNDP's projects are funded under the Global Environment Facility and assisted by the Capacity 21 Program, which was key to the creation of numerous local and national sustainable development strategies under Agenda 21.

■ The Mekong River at Chau Doc, Viet Nam.

The United Nations Environment Programme (UNEP) is very active in sustainable development. UNEP has supported projects in the subregion in partnership with regional organizations and other institutions, including the Asian Development Bank (ADB). Its Regional Resource Centre for Asia and the Pacific worked closely with ADB, ESCAP, and UNDP for the World Summit on Sustainable Development in 2002, involving preparation of subregional and regional sustainable development platforms. UNEP has been co-implementing projects under the GMS program (see below) and is supporting the formulation of national sustainable development strategies in the subregion.

Mulltilateral Development Banks. The GMS Program of Economic Cooperation was set up with assistance from ADB. Both the World Bank and ADB are active in all six countries of the GMS and collaborate on multilateral programs, such as the Climate Investment Funds, as well as on projects funded by the Global Environment Facility. Current partnerships include the Pilot Program for Climate Resilience, Forest Investment Program, and Sustainable Forest Management in the GMS. Through their individual country programs, the two banks are involved in many multisectoral programs, including climate change and natural resource management.

Regional Cooperation

The case for economic cooperation among countries with shared borders has long been recognized as contributing to creation of larger markets for national producers and consumers and to allow for economies of scale by reducing barriers to trade, capital, and labor. Regional cooperation is particularly relevant for land-locked countries, enabling them to integrate with external markets. Cooperation is also necessary to deal effectively and in a consistent manner with the many transboundary challenges that affect their economy, environment, and productivity.

Increased recognition of regional cooperation is manifest in the evolution of regionalism both within Asia and more broadly. New institutions have emerged while others have become more vigorous. The GMS Economic Cooperation Program itself is a prime example. Also, GMS countries are members or observers of one or more 'regional' organizations, such as the Asia-Pacific Economic Cooperation, Association of Southeast Asian Nations (ASEAN), ESCAP, East Asia Summit, MRC, and South Asian Association for Economic Cooperation. There are program complementarities and synergies to be explored between the GMS countries within this expanding Asian regionalism.

ASEAN. All the countries except the PRC are members of ASEAN, and the PRC is part of the ASEAN + 3 network. The ASEAN Vision 2020 calls for "a clean and green ASEAN with fully established mechanisms for sustainable development to ensure the protection of the region's environment, the sustainability of its natural resources and the high quality of life of its peoples." ASEAN has set up a number of Ministerial Meetings and working groups to help achieve this vision.

Mekong River Commission. The MRC (see Chapter 6) provides a mechanism for coordinated and cooperative efforts to utilize, manage, and conserve the water and related resources of the lower Mekong River Basin. It provides scientific information and policy advice and has three core programs: the Basin Development Plan, the Water Utilization Program, and the Environment Program that together cover all aspects of use of the Mekong River and its linkages to other components of the natural environment.

GMS Economic Cooperation Program

The GMS (Chapter 1) Economic Cooperation Program has been operating since 1992 and has achieved noteworthy successes in fostering regional cooperation in a region that, at the commencement of the program, was emerging from a period of prolonged regional conflict. By the end of its second decade, the program had implemented 55 investment projects with a total cost of about $14 billion, involving subregional road, airport, and railway improvements; hydropower projects for cross-border power supply; tourism infrastructure development; and communicable disease control. The GMS program has built a reputation as a flexible results-oriented project-delivering vehicle for promoting regional cooperation and contributing to economic growth and poverty reduction as well as meeting the needs of regional public goods. Its strategic framework for 2012 to 2022 is "increased economic growth, reduced poverty, and environmental sustainability across the GMS." The GMS program will continue to focus on a broad range of sector and multisectoral priorities, including support for human resources development initiatives that will help GMS integration while addressing any negative consequences of greater integration.

Economic Corridors. An important feature of the GMS program is the development of economic corridors passing through two or more of the countries to stimulate the growth of investment and production facilities in various areas. The corridors, centered on a number of transport corridors (see Chapter 13), are planned to contribute to improving agriculture, industry, and service sector development and trade, and the overall promotion of GMS cooperation to help realize the region's potential. For each corridor, there is a need for carefully planned investments in urban development, improving the network of feeder and rural roads, and developing other transport modes. Further development of the corridors must also take due account of food and energy security and climate change concerns. This will require scaling-up the management of natural resources, including biodiversity, land management, and integrated water resources management through river basin, watershed, and landscape approaches.

Environment and Biodiversity Conservation Corridors. The GMS includes a Working Group on Environment that oversees implementation of the GMS Core Environment Program. GMS countries have identified three priority issues for cooperation:

- *Biodiversity conservation and poverty alleviation*. With infrastructure and other development as major drivers of ecosystem fragmentation and destruction and with poverty alleviation at the core of the GMS countries developmental efforts, it will be important to expand biodiversity conservation and pro-poor activities, especially among the vulnerable upland communities and as a means of ensuring biodiversity conservation.

- *Climate change adaptation and mitigation*. GMS countries are also concerned about potential weakening of food and energy security due to climate change. Increasing weather variability is also likely to affect ecosystem services and consequently the poor communities that depend on them.

Upper: Thai customs officer at Chiang Saen, Thailand, inspects goods shipped down the Mekong River from Yunnan, PRC. **Lower:** Testing ducks for avian flu, Lao PDR.

Transport Corridors, Biodiversity Landscapes, and Biodiversity Corridor Pilot Sites in the Greater Mekong Subregion

Economic Corridor

- Central
- East-West
- Eastern
- Eastern Extension
- North-South
- North-South Extension
- Northeastern
- Northern
- Southern Coastal
- Southern
- Western

- Biodiversity Conservation Corridor
- Biodiversity Conservation Landscape
- Protected area

0 125 250 500 Kilometers

Boundaries are not necessarily authoritative. Data source: GMS EOC, UN FAO GAUL

- Furthermore, major destruction of biomass in recent years from the subregion's forests is frustrating efforts to control greenhouse gas emissions.

- *Capacity development.* Greater knowledge, skills, and awareness in environmental matters are needed throughout the GMS. This will be addressed through Biodiversity Conservation Corridor projects and the environmental education network, involving the participation of young GMS national researchers, with support from GMS universities and civil society.

The Biodiversity Conservation Corridors Initiative is the flagship activity under the GMS Core Environment Program. It seeks to address strain on biodiversity landscapes resulting from nearby economic corridor development that has caused ecosystem fragmentation and biodiversity loss. The approach is to undertake forest protection and rehabilitation measures with alternative livelihood development. This integrated approach seeks to improve habitat connectivity and ecosystem functionality while at the same time reducing rural poverty. There are eight pilot sites (see map).

About 1.3 million hectares are now under the corridor sustainable management regime, resulting in improved natural, social, physical, human, and financial assets of communities living in these areas. These outcomes required, at different governance levels, new policies, strengthening institutions and capacities, promoting participatory methods on conservation practices, and developing livelihood opportunities to reduce dependence on forest resources. Local instruments included community development funds, community protected areas, and participatory land-use planning. These efforts will be expanded at a landscape level across the GMS.

Agriculture. Under the GMS Core Agriculture Support Program, GMS countries have agreed on a new strategy to address emerging regional challenges to agricultural development, including ongoing trade liberalization, changing market demands, degradation of natural resources, the contribution of agriculture to climate change, the impact of climate change on the sector, and global concerns about food security. The three pillars of the strategy are:

- *Pillar 1: Building global competitiveness in food safety and modernizing agricultural trade* by promoting agricultural trade and agribusiness investment in the GMS economic corridors through harmonized food safety standards based on international standards, traceability systems and e-commerce, and a community-based participatory approach.

- *Pillar 2: Promoting climate-friendly agriculture and natural resource management* by supporting climate-resilient farming systems; a weather-based insurance system; and control of transboundary invasive species, pests, and animal diseases.

■ Villagers building a check dam in the forest to store water for their crops, Biodiversity Conservation Corridors Initiative, Tenasserim, Thailand.

- *Pillar 3: Promoting agriculture as a leader in rural renewable energy technology and eco-friendly cross-border supply chains* through a regional bioenergy regulatory framework and harmonized standards, biomass technologies and fertilizers for carbon credit, and ecolabeling systems for market access.

The agriculture sector is still seen by experts as providing the best opportunity to optimize climate mitigation and adaptation linkages. Innovative agricultural technology, and 'energy-smart' and 'climate-friendly' agriculture that can enhance yields and improve energy efficiency while strengthening climate resilience need to be promoted. The private sector has a big role to play in such development.

Transport. Transport will remain at the forefront of the GMS program and is guided by a strategy that focuses on the development of priority road transport, specifically by

- encouraging multimodal systems, particularly road and rail;
- improving road safety and addressing the broader social dimensions;
- considering climate change issues (such as controlling greenhouse gas emissions through freight traffic management);
- addressing the nonphysical barriers (such as policies) to cross-border transport; and
- promoting the development of economic corridors.

Energy. Given the widespread energy poverty of the GMS and recent global developments—such as financial turmoil, fluctuating energy prices, pressures on the environment,

■ **Upper:** Adventure tourism. Biking along the Mekong in Cambodia. **Lower:** Food processing livelihood training, Tenasserim, Thailand.

geopolitical uncertainties of energy supply, and interconnectedness of global energy markets—GMS countries have never felt a stronger need than now for an integrated approach to delivering sustainable, secure, and competitively priced energy. Priority regional initiatives for both hardware and software improvements across the energy sector have been identified as part of a GMS 'Energy Road Map' and include (i) promoting environmentally sustainable regional power trade planning, coordination, and development; (ii) improving energy efficiency through demand-side management and energy conservation; (iii) promoting the development of renewable energy resources, such as biogas, solar, wind, hydro, and geothermal, and clean fuels such as compressed natural gas; and (iv) promoting policies toward renewable energy development and energy efficiency.

Tourism. The overall aim of GMS tourism cooperation is to "develop and promote the Mekong as a single destination, offering a diversity of quality and high-yielding subregional products that help to distribute the benefits of tourism more widely; add to the tourism development efforts of each GMS country; and contribute to poverty reduction, gender equality and empowerment of women, and sustainable development, while minimizing any adverse impacts." The spatial strategy has been revised to focus more directly on segments of the Mekong River tourism corridor and linked circuits. The GMS Tourism Working Group reviews the progress of priority programs and projects, exchanges lessons learned from projects, coordinates with development partners, and reports to the GMS tourism ministers and senior officials. It also interacts with GMS working groups in other sectors.

Human Resources Development. Sustainable development cannot be achieved without capacity building and skills transfers. The GMS program's strategic framework and action plan for human resource development aims to (i) support human resources development initiatives that directly assist subregional cooperation and integration, such as managing labor migration and harmonizing labor standards; and (ii) address cross-border issues directly linked to GMS integration, such as cross-border transmission of communicable diseases and human trafficking.

Information Resources

Additional information on the contents of the previous chapters of the atlas is contained in this section, in the form of tables and references.

Economic, Social, and Environmental Statistics for the Greater Mekong Subregion

Sets of statistical tables are provided that present environment and development indicators of the subregional countries. The tables follow the sequence of chapters and provide numerical information on the topics in each chapter. The chapters begin with general information on the subregion and member countries, followed by information about the peoples of the subregion, environment and natural resources, development issues, and finally, addressing development and environmental challenges. Whenever possible, data are presented by country, in a time series for each of the indicators.

Literature and Other Sources of Information

A list of references is provided to the main literature and internet sites used in preparation of the text of the atlas chapters. They also complement the sources shown under tables in the text. The references are ordered by chapter. Note that some internet sites and the information they contain change over time; dates on which such sites were accessed are shown after the internet address.

Upper: Sun drying crops in a Dai village, Yunnan Province, PRC. **Lower:** Wat Phra Kaew, or Temple of the Emerald Buddha, in the Grand Palace, Bangkok, Thailand.

List of Tables

Table No.	Title
Chapter 1 Greater Mekong Subregion	
1.1	GDP, 2000–2010
1.2	Growth Rate of GDP, 2000–2010
1.3	Per Capita GDP, 2000–2010
1.4	GDP per Capita Annual Growth, 2000–2010
1.5	Agriculture, 2000–2010
1.6	Industry, 2000–2010
1.7	Service Sector, 2000–2010
1.8	Average Exchange Rate, 2000–2010
1.9a	Demographic Data by Country–Cambodia
1.9b	Demographic Data by Country–Guangxi, PRC
1.9c	Demographic Data by Country–Yunnan, PRC
1.9d	Demographic Data by Country–Lao PDR
1.9e	Demographic Data by Country–Myanmar
1.9f	Demographic Data by Country–Thailand
1.9g	Demographic Data by Country–Viet Nam
Chapter 4 Poverty And Environment	
4.1	Human Development Index Value, 2000–2010
4.2	Total Population, 2000–2010
4.3	Total Population Growth Rate, 2000–2010
4.4	Urban Population, 2000–2010
4.5	Urban Population Growth Rate, 2000–2010
4.6	Urban Population, 2000–2010
4.7	Population in Largest City, 2000–2010
4.8	Population Growth Rate in Largest City
4.9a	MDG Indicators–(Goal 4) Under-Five Mortality Rate, 2000–2010 (per 1,000 live births)
4.9b	MDG Indicators–Infant Mortality Rate, 2005–2010 (per 1,000 live births)
4.9c	MDG Indicators–Proportion of 1-Year-Old Children Immunized against Measles, 2000, 2005, 2010
4.9d	MDG Indicators–(Goal 5) Proportion of Births Attended by Skilled Health Staff, 2007–2010
4.9e	MDG Indicators–(Goal 6) Combat HIV/AIDS, Malaria, and Other Diseases
4.9f	MDG Indicators–Incidence of Tuberculosis (TB) per 100,000 People, 2000–2010
4.9g	MDG Indicators– Proportion of TB Cases Detected under DOTS, 2000–2010
4.9h	MDG Indicators–GDP per Unit of Energy Used, 2000–2009
4.9i	MDG Indicators–Proportion of Population with Sustainable Access to an Improved Water Source, 2000–2010
4.9j	MDG Indicators–Proportion of Population with Access to Improved Sanitation, 2000–2010
49k	MDG Indicators–(Goal 8) Net Official Development Assistance Received, 2000–2010
4.9l	MDG Indicators–Other Indicators
4.9m	MDG Indicators–Life Expectancy at Birth, 2000–2010
4.9n	MDG–Indicators–People Living with HIV, 15–49 Years Old, 2000–2009
Chapter 5 Geology	
5.1	Mining Sector Share of GDP, 2000–2010
5.2	Mineral Production in GMS Countries, 2010
Chapter 6 River Basins And Wetlands	
6.1	Contribution of Discharges by Country to Mekong River Basin
6.2	Major Rivers of Guangxi, PRC
6.3	Area of Wetlands of Guangxi, PRC, 2010
6.4	Major Lakes of Yunnan, PRC
6.5	Major Rivers of Yunnan, PRC
6.6	Area of Wetlands of Yunnan, PRC
6.7	Main Rivers in Lao PDR
6.8	River Basins and Annual Discharge, Lao PDR
Chapter 8 Biodiversity	
8.1	Total Forest Area, 1990–2010
8.2	Primary Forest Area, 2000, 2005, 2010
8.3	Other Naturally Regenerated Forest, 2000, 2005, 2010
8.4	Other Wooded Land Area, 2000, 2005, 2010
8.5	Planted Forest, 2000, 2005, 2010
8.6	Annual Reforestation/Plantation, 2000–2010
8.7	Annual Timber Harvest, 2000–2010
8.8	Industrial Roundwood Production, 2000–2010
8.9	Fuelwood Production, 2000–2010
8.10	Annual Timber Exports, 2000–2010
8.11	Total Export Value of Forest Products, 2000–2010
8.12	Number of Species and Threatened Species, by Country
8.13	Terrestrial Protected Areas 2000–2010
8.14	Terrestrial Protected Area, Share of Total Area 2000–2010
8.15	Ecosystem Service Values in Biodiversity Corridors
Chapter 9 Agriculture, Fisheries, And Food Security	
9.1	Fisheries–Total Aquaculture Production (inland and marine), 2000–2010
9.2	Fisheries–Total Capture Fisheries Production (inland and marine), 2000–2010
9.3	Fisheries–Total Production from All Sources, 2000–2010
Chapter 10 Water Availability, Demand, And Usage	
10.1	Annual Availability of Water Resources Per Capita, 2002, 2007, 2009, 2010
10.2	Water Resources–Total Internal Renewable, 2002, 2007, 2009, 2010 (surface+ground)
10.3	Water Resources: Total Internal Renewable per Capita, 2002, 2007, 2009, 2010 (surface + ground)
10.4	Surface Water Produced Internally, 2002, 2007, 2009, 2010
10.5	Groundwater Produced internally, 2002, 2007, 2009, 2010
10.6	Water Flows from Other Countries, 2002, 2007, 2009, 2010
10.7	Annual Freshwater Withdrawals, 2000, 2007, 2009
10.8	Water and Sanitation Coverage, 2004 and Projected to 2015
Chapter 11 Energy	
11.1	Total Final Energy Consumption, 2010 and 2025
11.2	Total Primary Energy Production, 2010 and 2025
11.3	Assumptions for Main Stem Mekong River Dam Construction
11.4	Electricity Sources–Cambodia, 2000–2009
11.5	Electricity Production–Cambodia, 1990–2009
11.6	Energy Generated by Type of Generation–Cambodia, 2010
11.7	Hydropower Potential–Cambodia
11.8	Current Installed Energy Capacity–Cambodia, 2000–2010 and to 2025
11.9	Electricity Production–Guangxi and Yunnan, PRC, 1995–2010
11.10	Electricity Consumption–Guangxi and Yunnan, PRC, 1995–2010
11.11	Sources of Energy Production and Consumption–Guangxi, PRC, 1990–2010
11.12	Sources of Energy Production and Consumption–Yunnan, PRC, 1990–2010
11.13	Hydropower Development–Lao PDR
11.14	Electricity Consumption–Lao PDR, 2001–2010
11.15	Electricity production, Import, and Export–Lao PDR, 2001–2010
11.16	Sources of Electricity–Myanmar, 2000–2010
11.17	Energy Generated by Type of Generation–Myanmar, 2000–2010
11.18	Existing Hydropower Installations–Myanmar
11.19	Existing Coal-Fired Power Station–Myanmar
11.20	Existing Gas Turbine and Thermal Power Stations–Myanmar
11.21	Hydropower Projects under Construction–Myanmar
11.22	Future Hydropower Projects to be Implemented by Foreign Investment–Myanmar
11.23	Future Coal-Fired Thermal Power Stations–Myanmar
11.24	Energy Consumption–Thailand, 2000–2010
11.25	Sources of Electricity–Thailand, 2000–2009
11.26	Sources of Electricity–Viet Nam, 2000–2009
11.27	Electricity Production and Consumption–Viet Nam, 1990–2010

Table No.	Title
Chapter 12 Urbanization	
12.1	Particulate Matter (PM10) in Ambient Air by Country, 2000–2009
12.2	Ambient Air Concentrations–Phnom Penh, Cambodia, 2000–2010
12.3	Phnom Penh Waste Generation, 2003–2007
12.4	Discharge and Disposal of City Sewage–Yunnan 2011
12.5	Average per Capita Waste Production in Five Large Cities, Lao PDR, 2004
12.6	Waste Collection in Five Large Cities, Lao PDR, 2008
12.7	Ambient Air Concentrations–Myanmar Cities, 2008
12.8	Solid Waste Generation and Collection–Yangon, Myanmar, 2010
12.9	Air Pollutant Emissions–Mass Loadings–Thailand, 2000–2009
12.10	Solid Waste Generation and Collection–Thailand, 2006–2008
12.11	Hazardous Waste Generation–Thailand, 2000–2008
12.12	Radioactive Waste Generation–Thailand, 2002–2008
12.13	Air Pollutant Emissions–Viet Nam, 1995, 2000, 2005
12.14	Solid Waste Generation–Viet Nam, 2003 and 2008
Chapter 13 Transport	
13.1a	Total Length of Road Network by Country, 2000–2010
13.1b	Length of Paved Road by Country, 2000–2010
13.2	Number of Registered Road Motor Vehicles by Country, 2000–2010
13.3	Road Passengers by Country, 2000–2010
13.4	Road Freight, 2000–2010
13.5a	Number of Traffic Accidents by Country, 2000–2010
13.5b	Number of Traffic Accident Casualties by Country, 2000–2010
13.6	Railway Route Length, 2000–2010
13.7	Number of Railway Passengers, 2000–2010
13.8	Railway Freight, 2000–2010
13.9a	Number of Inland Waterway Passengers, 2000–2010
13.9b	Inland Waterway Passengers Carried, 2000–2010
13.9c	Freight Carried on Inland Waterways, 2000–2010
13.10a	Airline Passengers Carried (domestic + overseas), 2000–2010
13.10b	Air Freight Transported (domestic + overseas), 2000–2010
13.11	Transport Share of GDP, 2000–2010
13.12a	Pump Price for Diesel Fuel by Country, 2000–201
13.12b	Pump Price for Gasoline by Country, 2000–2010
13.13	Motor vehicles per 1,000 Persons, 2003–2009
Chapter 14 Tourism	
14.1	Top 10 GMS Tourist Destinations
14.2a	International Tourist Arrivals, 2000–2010
14.2b	Growth in GMS International Tourist Arrivals, 2000–2010
14.3	International Tourist Receipts, 2000–2010
14.4	Tourists' Average Length of Stay, 2000–2010
14.5	Average Expenditure per Tourist per day, 2000–2010
Chapter 15 Human Resource Development	
15.1a	Primary Education, Number of Pupils, 2000–2010
15.1b	Secondary Education, Number of Pupils, 2000–2010
15.1c	Tertiary Education, Number of Students per 100,000 Inhabitants
15.2	Central Government Expenditure for Education, 2000–2010
15.3a	Number of Primary Schools, 2000–2010
15.3b	Number of Secondary Schools, 2000–2010
Chapter 16 Climate Change And Natural Disasters	
16.1a	Carbon Dioxide Emissions, 2000–2008
16.1b	Carbon Dioxide Emissions per Person, 2000–2009
16.2a	Natural Hazards, 2000–2010–Cambodia
16.2b	Natural Hazards, 2000–2010–Guangxi, PRC
16.2c	Natural Hazards, 2000–2010–Yunnan, PRC
16.2d	Natural Hazards, 2000–2010–Myanmar
16.2e	Natural Hazards, 2000–2010–Thailand
16.3a	Natural Disasters, 2000–2010–Number of Events
16.3b	Natural Disasters, 2000–2010–Number of Deaths
16.3c	Natural Disasters, 2000–2010–Persons Affected
16.3d	Natural Disasters, 2000–2010–Economic Damage

Chapter 1: Greater Mekong Subregion

Table 1.1: GDP, 2000–2010 ($ billion)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Cambodia	3.65	3.98	4.28	4.66	5.33	6.29	7.28	8.64	10.35	10.41	11.26	
PRC, Guangxi	25.12	27.54	30.49	34.08	41.48	48.62	59.52	76.55	101.04	113.58	141.35	
PRC, Yunnan	23.62	25.07	26.97	29.65	37.23	42.26	50.02	62.73	81.92	90.31	106.71	
Lao PDR	1.64	1.67	1.76	2.02	2.38	2.73	3.56	4.23	5.31	5.60	6.46	
Myanmar	8.91	6.48	6.78	10.47	10.57	11.99	14.50	20.18	31.37	35.23	45.38	
Thailand	122.73	115.54	126.88	142.64	161.34	176.35	207.09	246.98	272.58	263.71	318.91	
Viet Nam	31.18	32.52	35.10	39.56	45.45	52.93	60.93	71.11	90.30	93.17	103.58	
GMS Regional GDP ($ billion)	216.84	212.80	232.25	263.09	303.78	341.17	402.91	490.42	592.87	612.01	733.64	Average Growth
GMS Regional GDP Growth (%)		-1.86	9.14	13.28	15.47	12.31	18.10	21.72	20.89	3.23	19.87	13.21

Source: Guangxi Bureau of Statistics. 2011. *Guangxi Statistical Yearbook 2011*. Beijing; IMF. World Economic Outlook Database, April 2012.http://www.imf.org/external/pubs/ft/weo/2012/01/weodata/weoselgr.aspx (Accessed 3 July 2012); Yunnan Bureau of Statistics. Yunnan Statistical Yearbooks 2001-2011. Beijing.

Table 1.2: Growth Rate of GDP, 2000–2010 (%)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	8.77	8.04	6.69	8.51	10.34	13.25	10.77	10.21	6.69	0.09	5.96
PRC, Guangxi	7.90	8.30	10.60	10.20	11.80	13.20	13.60	15.10	12.80	13.90	14.20
PRC, Yunnan	7.50	6.80	9.00	8.80	11.30	8.90	11.60	12.20	10.60	12.10	12.30
Lao PDR	6.32	4.62	6.87	6.21	7.02	6.77	8.64	5.88	7.80	7.57	7.95
Myanmar	13.70	11.30	12.00	13.80	13.60	13.60	13.10	12.00	10.30	10.60	10.40
Thailand	4.75	2.17	5.32	7.14	6.34	4.61	5.09	5.04	2.48	-2.33	7.80
Viet Nam	6.80	6.90	7.10	7.30	7.80	8.40	8.20	8.50	6.30	5.30	6.80

Source: ADB. 2011. *Key Indicators for Asia and the Pacific 2011*. Manila; Guangxi Bureau of Statistics. 2011. *Guangxi Statistical Yearbook 2011*. Beijing; IMF. World Economic Outlook Database. http://www.imf.org/external/pubs/ft/weo/2011/02/weodata/index.aspx (Accessed 1 December 2011); World Bank. World Development Indicators and Global Development Finance. http://databank.worldbank.org/ddp/home.do?Step=1&id=4 (Accessed 1 December 2011); *Yunnan Statistical Yearbook 2001-2011*.

Table 1.3: Per Capita GDP, 2000–2010 (dollar/person, current $)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	295.00	319.00	340.00	367.00	417.00	487.00	558.00	656.00	760.00	753.00	830.00
PRC, Guangxi	561.84	610.87	671.25	745.05	901.09	1,048.84	1,269.89	1,613.27	2,108.20	2,349.19	2,986.56
PRC, Yunnan	576.09	605.68	648.07	708.94	846.86	954.48	1,120.33	1,394.09	1,808.63	1,982.28	2,326.74
Lao PDR	303.47	303.92	314.03	355.74	410.94	463.55	595.69	693.64	856.18	885.71	1,003.71
Myanmar	177.64	129.19	129.91	196.64	194.61	216.40	256.66	350.14	533.45	587.27	741.67
Thailand	1,983.32	1,854.25	2,020.34	2,261.27	2,603.36	2,825.33	3,296.09	3,917.89	4,300.03	4,151.30	4,992.43
Viet Nam	402.00	413.00	440.00	489.00	554.00	637.00	724.00	835.00	1,047.00	1,113.00	1,172.00

Source: Guangxi Bureau of Statistics. 2011. *Guangxi Statistical Yearbook 2011*. Beijing; IMF. World Economic Outlook Database, April 2012.http://www.imf.org/external/pubs/ft/weo/2012/01/weodata/weoselgr.aspx (Accessed 3 July 2012); Royal Government of Cambodia, Ministry of Planning, National Institute of Statistics. 2011. *National Accounts of Cambodia 1993-2010*. Phnom Penh; and World Data Bank. World Bank. World Development Indicators and Global Development Finance. http://databank.worldbank.org/ddp/home.do?Step=1&id=4 (Accessed 1 December 2011); Yunnan Bureau of Statistics. Yunnan Statistical Yearbooks 2001-2011. Beijing.

Table 1.4: GDP per Capita Annual Growth, 2000–2010 (%)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	3.20	8.20	6.50	8.00	13.50	16.90	14.60	17.60	15.80	-0.90	10.20
PRC, Guangxi	7.00	7.40	9.80	9.40	11.10	12.30	12.30	13.80	11.70	12.90	13.90
PRC, Yunnan	5.80	5.30	6.90	7.50	10.50	8.10	11.10	11.50	10.30	11.60	13.00
Lao PDR	6.32	4.62	6.87	6.21	7.02	6.77	8.64	5.88	7.80	7.57	7.95
Myanmar	11.50	9.10	9.80	11.60	11.30	13.60	4.90	3.40	1.60	3.00	3.20
Thailand	4.03	1.19	4.35	6.20	5.44	3.69	4.33	4.30	1.81	-2.94	7.15
Viet Nam	4.60	4.20	5.30	5.60	5.80	6.30	7.00	7.30	5.20	4.20	5.70

Source: ADB. 2011. *Key Indicators for Asia and the Pacific 2011*. Manila; Guangxi Bureau of Statistics. 2011. *Guangxi Statistical Yearbook 2011*. Beijing.

Table 1.5: Agriculture, 2000–2010 (% of GDP)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	37.90	36.70	32.90	33.60	31.20	32.40	31.70	31.90	34.90	35.70	36.00
PRC, Guangxi	26.80	25.29	23.85	23.35	23.82	22.90	21.75	21.32	20.71	18.80	17.60
PRC, Yunnan	22.30	21.70	21.10	20.30	20.40	18.90	18.80	18.40	17.93.	17.30	15.34
Lao PDR	48.54	45.54	42.69	41.03	39.03	36.70	32.44	33.15	32.47	32.46	30.81
Myanmar	57.20	57.10	54.50	50.60	48.20	46.70	43.90	43.30	40.30	38.10	36.40
Thailand	9.02	9.13	9.43	10.41	10.31	10.27	10.77	10.68	11.56	11.46	12.42
Viet Nam	24.53	23.24	23.03	22.54	21.81	20.97	20.40	20.34	22.21	20.91	20.58

Source: ADB. 2011. *Key Indicators for Asia and the Pacific 2011*. Manila; Government of Viet Nam. 2010. Viet Nam's Socio-Economic Development Strategy for 2011-2020. Ha Noi; Guangxi Bureau of Statistics. 2011. *Guangxi Statistical Yearbook 2011*. Beijing; *Viet Nam Statistical Yearbook 2010*.

Table 1.6: Industry, 2000–2010 (% of GDP)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	23.00	23.60	25.60	26.30	27.20	26.40	27.60	26.80	23.80	23.10	23.00
PRC, Guangxi	29.44	28.06	27.70	28.85	30.43	31.75	33.55	35.89	37.42	36.90	40.34
PRC, Yunnan	43.00	42.40	42.80	43.40	44.40	41.70	42.70	43.20	43.00	41.80	44.70
Lao PDR	19.07	18.27	19.48	21.32	20.51	23.52	29.83	28.69	27.86	26.54	27.35
Myanmar	9.70	10.60	13.00	14.30	16.40	17.50	19.30	20.40	22.70	24.60	26.00
Thailand	41.99	42.14	42.44	43.63	43.40	43.96	44.35	44.74	44.05	43.34	44.65
Viet Nam	36.73	38.13	38.49	39.47	40.21	41.02	41.54	41.48	39.84	40.24	41.10

Source: ADB. 2011. *Key Indicators for Asia and the Pacific 2011.* Manila; Government of Viet Nam, Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi; Guangxi Bureau of Statistics. 2011. *Guangxi Statistical Yearbook 2011*. Beijing; Statistical Communique on National Economic and Social Development of Yunnan 2000-2011.

Table 1.7: Service Sector, 2000–2010 (% of GDP)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	39.10	39.70	41.50	40.10	41.70	41.20	40.80	41.30	41.30	41.30	41.00
PRC, Guangxi	37.98	40.88	42.59	41.77	39.67	39.18	38.67	37.04	36.03	37.62	35.35
PRC, Yunnan	34.70	35.90	36.10	36.30	35.20	39.40	38.50	38.40	39.10	40.90	40.04
Lao PDR	32.39	36.19	37.83	37.65	40.46	39.77	37.73	38.16	39.67	41.00	41.83
Myanmar	33.10	32.40	32.50	35.10	35.50	35.80	36.80	36.30	37.10	37.30	37.60
Thailand	48.99	48.72	48.13	45.96	46.30	45.77	44.88	44.59	44.39	45.20	42.93
Viet Nam	38.74	38.63	38.48	37.99	37.98	38.01	38.06	38.18	37.95	38.85	38.32

Source: ADB. 2011. *Key Indicators for Asia and the Pacific 2011.* Manila; Government of Viet Nam, Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi; Guangxi Bureau of Statistics. 2011. *Guangxi Statistical Yearbook 2011*. Beijing; Statistical Communique on National Economic and Social Development of Yunnan 2000-2011.

Table 1.8: Average Exchange Rate, 2000–2010 (Local Currency per $)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia (riel)	3,840.75	3,916.33	3,912.08	3,973.33	4,016.25	4,092.50	4,103.25	4,056.17	4,054.17	4,139.33	4,184.92
PRC (yuan)	8.28	8.28	8.28	8.28	8.28	8.19	7.97	7.61	6.95	6.83	6.77
Lao PDR (kip)	7,887.64	8,954.58	10,056.30	10,569.00	10,585.40	10,655.20	10,159.90	9,603.16	8,744.22	8,516.05	8,258.77
Myanmar (kyat)	6.43	6.68	6.57	6.08	5.75	5.76	5.78	5.56	5.39	5.52	5.58
Thailand (baht)	40.11	44.43	42.96	41.48	40.22	40.22	37.88	34.52	33.31	34.29	31.69
Viet Nam (dong)	14,167.70	14,725.20	15,279.50	15,509.60	15,746.00	15,858.90	15,994.30	16,105.10	16,302.30	17,065.10	18,621.00

Source: ADB. 2011. *Key Indicators for Asia and the Pacific 2011.* Manila; Government of Viet Nam, Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi; Guangxi Bureau of Statistics. 2011. *Guangxi Statistical Yearbook 2011*. Beijing; Statistical Communique on National Economic and Social Development of Yunnan 2000-2011.

Table 1.9a: Demographic Data–Cambodia

Indicator	Unit	1990	1995	2000	2005	2010
Population	million	8.6	10.2	11.4 (1998)	12.8 (2004)	14.3
Population growth rate	%	2.8	4.8	2.5 (1998, MOP)	1.81 (2004)	1.5 (2008-2010)
Population density	persons/km^2	49	54 (1994. MOP)	69	74 (2004)	80
Crude death rate	per 1,000 people	15	–	12	9	8
Crude birth rate	per 1,000 people	41	–	30	24	22

– Data not available.
Source: ADB. 2011. *Basic Statistics.* Manila; Ministry of Planning (MOP). *Cambodia Statistical Yearbook 2010.* Phnom Penh; World Bank.

Table 1.9b: Demographic Data–Guanxgi, PRC

Indicator	Unit	1990	1995	2000	2005	2010
Population	million	42.42	45.43	47.51	49.25	51.59
Population growth rate	%	2.22	1.11	0.81	0.74	1.32
Population density	persons/km^2	179	192	201	208	195
Crude death rate	per 1,000 people	6.6	6.53	5.7	6.09	5.45
Crude birth rate	per 1,000 people	20.2	17.54	13.6	14.26	14.13

Source: Guangxi Bureau of Statistics. 2011. *Guangxi Statistical Yearbooks.* Beijing.

Table 1.9c: Demographic Data–Yunnan, PRC

Indicator	Unit	1990	1995	2000	2005	2010
Population	million	37.306	39.896	42.408	44.504	46.016
Population growth rate	%	1.568	1.273	1.148	0.797	0.654
Population density	persons/km^2	94.7	101.3	107.6	112.9	116.6
Crude death rate	per 1,000 people	7.92	8.03	7.57	6.75	6.56
Crude birth rate	per 1,000 people	23.6	20.75	19.05	14.72	13.1

Source: National Bureau of Statistics of China. *China Statistical Yearbook.* Beijing, Yunnan Statistical Yearbooks, and Statistical Communique on Economic and Social Development in Yunnan 2010.

Table 1.9d: Demographic Data–Lao PDR

Indicator	Unit	1990	1995	2000	2005	2010
Population	million	4.1	4.6	5.4	5.6	6.3
Population growth rate	%	2.7	2.6	2.0	1.7	2.2
Population density	persons/km^2	18.0	–	23.0	25.0	26.0
Crude death rate	per 1,000 people	16.0	–	9.0	7.0	6.0
Crude birth rate	per 1,000 people	45.0	–	30.0	26.0	23.0

– Data not available.
Source: World Bank 2010, http://data.worldbank.org/indicator; NSC Laos, http://nsc.gov.la/index2.php?option=com_content&view=article&id=37&Itemid=38&lang=en, for the Population figures.

Table 1.9e: Demographic Data–Myanmar

Indicator	Unit	1990	1995	2000	2005	2010
Population	million	40.78	44.74	50.13	55.4	59.78
Population growth rate	%	1.9	1.9	2.0	2.0	1.1
Population density	persons/km^2	62.0	68.0	76.0	84	87
Crude death rate	per 1,000 people	8.8	8.6	6.3	5.5	–
Crude birth rate	per 1,000 people	28.4	28.0	24.2	19	–

– Data not available.
Source: ADB. 2011. *Key Indicators for Asia and the Pacific 2011*; Myanmar Central Statistical Organization.2009. *Statistical Yearbook 2009*. Nay Pyi Taw.

Table 1.9f: Demographic Data–Thailand

Indicator	Unit	1990	1995	2000	2005	2010
Population	million	55.8	59.4	62.4	65.1	67.31
Population growth rate	%	1.6	1	0.8	0.9	0.6 (2009)
Population density	persons/km^2	109	–	122	126.9	131
Crude death rate	per 1,000 people	6	–	6	7	7
Crude birth rate	per 1,000 people	20	–	15	13	12

– Data not available.
Source: ADB *Basic Statistics 2011;* ADB. 2011. *Key Indicators for Asia and the Pacific 2010.* Manila; World Bank.

Table 1.9g: Demographic Data–Viet Nam

Indicator	Unit	2000	2005	2010
Population	million	77.63	82.39	86.93
Population growth rate	%	1.4	1.2	1.1
Population density	persons/km^2	236	249	262
Crude death rate	per 1,000 people	5.4	5.2	5.2
Crude birth rate	per 1,000 people	17.5	17.2	16.7

Source: ADB Basic Statistics 2011; ADB. 2011. Key Indicators for Asia and the Pacific 2010. Manila; World Bank.

Chapter 4: Poverty and Environment

Table 4.1: Human Development Index Value, 2000–2010

	2000	2005	2006	2007	2008	2009	2010
Cambodia	0.438	0.491	0.501	0.508	0.513	0.513	0.518
Lao PDR	0.448	0.484	0.491	0.5	0.507	0.514	0.52
Myanmar	0.38	0.436	0.448	0.459	0.468	0.474	0.479
Thailand	0.626	0.656	0.661	0.67	0.672	0.673	0.68
Viet Nam	0.528	0.561	0.568	0.575	0.58	0.584	0.59

Source: Human Development Index value: based on data from United Nations Department of Economic and Social Affairs, UNESCO Institute for Statistics, World Bank, and Inernational Monetary Fund.

Table 4.2: Total Population, 2000–2010 (million)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	12.5	12.6	12.8	13	13	13.3	13.5	13.7	13.9	14.1	14.3
PRC, Guangxi	47.51	47.88	48.22	48.57	48.89	49.25	49.61	50.02	50.49	50.92	51.59
PRC, Yunnan	42.41	42.87	43.33	43.76	44.15	44.50	44.83	45.14	45.43	45.71	46.02
Lao PDR	5.09	5.19	5.3	5.4	5.51	5.62	5.75	5.87	6.00	6.12	6.23
Myanmar	50.13	51.14	52.17	53.22	54.3	55.40	56.52	57.50	58.38	59.13	59.78
Thailand	62.2	62.8	63.4	64.0	64.5	65.1	65.6	66.0	66.5	66.9	67.3
Viet Nam	77.11	78.12	79.08	80.00	80.95	81.91	82.85	83.76	84.67	85.57	86.48

Source: ADB. 2011. *Key Indicators for Asia and the Pacific 2011.* Manila; Guangxi Bureau of Statistics. 2011. *Guangxi Statistical Yearbook 2011.* Beijing; Yunnan Bureau of Statistics. 2011. *Yunnan Statistical Yearbook 2011.* Beijing.

Table 4.3: Total Population Growth Rate, 2000–2010 (%)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.6	1.5
PRC, Guangxi	0.81	0.78	0.71	0.73	0.66	0.74	0.73	0.83	0.94	0.85	1.32
PRC, Yunnan	1.15	1.10	1.06	0.98	0.90	0.80	0.69	0.69	0.63	0.61	0.65
Lao PDR	2.0	2.0	2.0	2.0	2.0	2.0	2.2	2.1	2.2	2.1	1.7
Myanmar	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.80	1.50	1.30	1.1
Thailand	0.7	1.0	0.9	0.9	0.9	0.9	0.7	0.7	0.7	0.6	0.6
Viet Nam	1.4	1.3	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1

Source: ADB. 2011. *Key Indicators for Asia and the Pacific 2011.* Manila; Guangxi Bureau of Statistics. 2011. *Guangxi Statistical Yearbook 2011.* Beijing; Yunnan Bureau of Statistics. 2011. *Report on Population Development Since the 16th Congress in Yunnan.* Kunming. Yunnan Bureau of Statistics. 2011. *Communique on Major Data of the Sixth National Population Census of Yunnan.* Kunming.

Table 4.4: Urban Population, 2000–2010 (million)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	2.10	2.21	2.31	2.42	2.53	2.63	2.75	2.86	2.98	3.10	3.22
PRC, Guangxi	13.37	13.50	13.65	14.11	15.50	15.67	16.35	17.28	18.38	19.04	18.49
PRC, Yunnan	9.91	10.7	11.3	11.6	12.4	13.1	13.7	14.3	15.0	15.5	16.0
Lao PDR	1.17	1.25	1.33	1.41	1.49	1.58	1.67	1.76	1.86	1.96	2.06
Myanmar	–	–	–	–	–	–	17.24	17.57	17.89	18.134	–
Thailand	19.64	20.03	20.41	20.80	21.18	21.54	21.96	22.36	22.75	23.13	23.50
Viet Nam	18.73	19.3	19.87	20.73	21.6	22.33	23.05	23.75	24.67	25.58	26.22

– Data not available.
Source: ADB. 2011. *Key Indicators for Asia and the Pacific 2011.* Manila; Government of Myanmar, Ministry of Agriculture and Irrigation, Department of Agricultural Planning. 2011. *Myanmar Agriculture at a Glance 2011.* Nay Pyi Taw; Government of Viet Nam, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010.* Ha Noi; Guangxi Bureau of Statistics. 2011. *Guangxi Statistical Yearbook 2011.* Beijing; World Bank. World Development Indicators and Global Development Finance. http://databank.worldbank.org. (Accessed 20 July 2012); Yunnan Bureau of Statistics. 2011. *Yunnan Statistical Yearbook 2011.* Beijing.

Table 4.5: Urban Population Growth Rate, 2000–2010 (%)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	5.1	4.9	4.7	4.4	4.3	4.1	4.3	4.1	4.0	4.0	3.9
PRC, Guangxi	–	–	–	–	–	–	–	–	–	–	–
PRC, Yunnan	–	–	–	–	–	–	–	–	–	–	–
Lao PDR	6.1	6.51	6.18	5.91	5.7	5.53	5.67	5.51	5.35	5.17	5
Myanmar	–	–	–	–	–	–	–	1.91	1.82	1.36	–
Thailand	1.7	1.94	1.92	1.88	1.8	1.71	1.91	1.81	1.72	1.65	1.61
Viet Nam	3.32	3.06	2.97	4.29	4.23	3.38	3.20	3.04	3.90	3.69	2.5

– Data not available.
Source: Government of Viet Nam,General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010.* Ha Noi; World Bank. World Development Indicators and Global Development Finance. http://databank.worldbank.org. (Accessed 20 July 2012).

Table 4.6: Urban Population, 2000–2010 (% of total population)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	–	16	–	16	16	17.7	17.8	17.8	19.5	19.5	19.5
PRC, Guangxi	28.15	28.20	28.30	29.06	31.70	33.62	34.64	36.24	38.16	39.20	40.11
PRC, Yunnan	23.37	25.00	26.08	26.51	28.09	29.44	30.56	31.68	33.02	33.91	34.78
Lao PDR	22.0	23.1	24.2	25.2	26.3	27.4	28.6	29.7	30.9	32.0	33.2
Myanmar	28	28.52	29.04	29.56	30.08	30.6	30.51	30.55	30.65	30.66	30.7
Thailand	31.1	31.34	31.58	31.82	32.06	32.3	32.64	32.98	33.32	33.66	–
Viet Nam	24.12	24.55	24.99	25.76	26.53	27.10	27.66	28.20	28.99	29.74	30.17

– Data not available.

Source: ADB. 2011. *Key Indicators for Asia and the Pacific 2011*. Manila; Government of Viet Nam,General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi; Guangxi Bureau of Statistics. 2011. *Guangxi Statistical Yearbook 2011*. Beijing; World Bank. World Development Indicators and Global Development Finance. http://databank.worldbank.org. (Accessed 20 July 2012); Yunnan Bureau of Statistics. 2011. *Yunnan Statistical Yearbook 2011*. Beijing.

Table 4.7: Population in Largest City, 2000–2010 (million)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Bangkok	5.68	5.73	5.78	5.84	5.63	5.66	5.70	5.72	5.71	5.70	5.70
Ha Noi	–	–	–	–	–	3.13	–	3.23	6.38	6.47	6.56
Ho Chi Minh	–	–	–	–	–	6.23	–	6.73	6.95	7.20	7.40
Kunming	4.81	4.87	4.95	5.01	5.03	6.09	6.15	6.19	6.24	6.28	6.44
Nanning	2.94	2.95	2.98	6.15	6.49	6.60	6.72	6.84	6.92	6.98	6.87
Phnom Penh	1.16	1.20	1.23	1.27	1.31	1.35	1.39	1.44	1.48	1.52	1.56
Yangon	5.80	–	6.06	6.19	6.32	6.46	6.60	6.72	6.85	6.94	–

– Data not available.

Note: Yangon data refers the whole region

Source: Department of Provincial Administration of Thailand; Government of Myanmar, Ministry of National Planning and Economic Development, Central Statistical Organization. 2010. *Statistical Yearbook 2009*. Nay Pyi Taw; Government of Viet Nam, Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi; Guangxi Bureau of Statistics. *Communique On the National Socio-economic Development of Nanning*; Macrodata Mining and Analyzing system of China; World Bank. World Development Indicators and Global Development Finance. http://databank.worldbank.org. (Accessed 20 July 2012); Yunnan Bureau of Statistics. *Statistical Communique On the National Socio-economic Development of Kunming*.

Table 4.8: Population Growth Rate in Largest City (%)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Bangkok	0.32	0.81	0.98	1.08	-3.6	0.44	0.65	0.36	-0.1	-0.14	-0.02
Ha Noi	–	–	–	–	–	12.1	–	11.6	12.3	13.1	12.7
Ho Chi Minh	–	–	–	–	–	11.9	–	11.3	10.9	9.7	9
Kunming	–	–	1.2	1.2	–	–	–	–	–	–	1.26
Nanning	1.94	1.07	1.06	1.1	1.12	1.65	1.87	1.73	1.2	0.9	1.36
Phnom Penh	3.09	3.08	3.09	3.07	3.03	2.98	2.92	2.87	2.81	2.78	2.76
Yangon	–	–	–	2.18	2.17	2.18	2.17	1.88	1.86	1.39	–

– Data not available.

Source: Department of Provincial Administration of Thailand; Government of Viet Nam, Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi; Government of Myanmar, Ministry of National Planning and Economic Development, Central Statistical Organization. 2010. *Statistical Yearbook 2009*. Nay Pyi Taw World Bank; World Development Indicators and Global Development Finance. http://databank.worldbank.org. (Accessed 20 July 2012); Yunnan Bureau of Statistics. *Statistical Communique On the National Socio-economic Development of Nanning*.

Table 4.9a: MDG Indicators–(Goal 4) Under-Five Mortality Rate, 2000–2010 (per 1,000 live births)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	103	96	90	84	78	73	68	63	59	55	51
PRC, Guangxi	32	29	27	25	21	19	16	16	13	11	11
PRC, Yunnan	42	39	35	33	30	28	25	23	19	16	15
Lao PDR	88	84	80	77	73	69	66	63	60	57	54
Myanmar	87	85	82	80	78	76	74	72	70	69	66
Thailand	18	17	17	16	16	15	15	14	14	14	13
Viet Nam	35	34	32	31	30	29	27	26	25	24	24

Source: Monitoring Report on Development Plan of Children in Guangxi 2000-2010; UN Millennium Development Goals Indicators. http://unstats.un.org/unsd/mdg/Data.aspx (Accessed 19 July 2012); UNDP Myanmar. 2011. *Integrated Household Living Conditions Survey in Myanmar (2009-2010): MDG Data Report;* Viet Nam Government Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi; Yunnan Health Department.

Table 4.9b: MDG Indicators–Infant Mortality Rate, 2005–2010 (per 1,000 live births)

Country	2005	2006	2007	2008	2009	2010
Cambodia	58	55	52	49	46	43
PRC, Guangxi	15	13	13	10	9	8
PRC, Yunnan	22	19	18	15	13	12
Lao PDR	52	50	48	46	44	42
Myanmar	57	55	54	53	52	50
Thailand	13	13	12	12	12	11
Viet Nam	23	22	21	20	19	16

Source: Guangxi Bureau of Statistics; UN Millennium Development Goals Indicators. http://unstats.un.org/unsd/mdg/Data.aspx (Accessed 19 July 2012); Viet Nam Central Statistics Office. 2011. *Statistical Yearbook of Viet Nam.* Ha Noi; Yunnan Health Department.

Table 4.9c: MDG Indicators–Proportion of 1-Year-Old Children Immunized against Measles, 2000,2005,2010 (%)

Country	2000	2005	2010
Cambodia	65	79	93
PRC, Guangxi	97.2	97.2	98.7
PRC, Yunnan	96.1	98.1	99.1
Lao PDR	42	41	64
Myanmar	84	72	88
Thailand	94	96	98
Viet Nam	97	95	98

– Data not available.

Source: Guangxi Bureau of Statistics; Guangxi Public Health Department; UN Millennium Development Goals Indicators. http://unstats.un.org/unsd/mdg/Data.aspx (Accessed 19 July 2012); Yunnan Health Department. *Report on 11th Five-year Plan of Health Development in Yunnan*. Kunming.

Table 4.9d: MDG Indicators–(Goal 5) Proportion of Births Attended by Skilled Health Staff, 2007–2010 (%)

Country	2007	2008	2009	2010
Cambodia	–	–	–	71.0
PRC, Guangxi	93.8	96.27	98.17	98.99
PRC, Yunnan	–	–	–	98.4
Lao PDR	–	–	–	37.0
Myanmar	–	–	–	77.9
Thailand	–	–	99.5	–
Viet Nam	–	–	–	–

– Data not available.
Source: Chinese Health Statistical Yearbook 2004 and 2011; Monitoring Report on Developmental Plan of Women in Guangxi 2001-2010; UN Millennium Development Goals Indicators. http://unstats.un.org/unsd/mdg/Data.aspx (Accessed 19 July 2012); World Bank. World Development Indicators and Global Development Finance. http://databank.worldbank.org (Accessed 20 July 2012); UNDP Myanmar.2011. Integrated Household Living Conditions Survey in Myanmar (2009-2010): MDG Data Report.

Table 4.9e: MDG Indicators–(Goal 6) Combat HIV/AIDS, Malaria, and Other Diseases

Country	HIV Prevalence Among 15-24 Year-Old Women (%)	Contraceptive Prevalence Rate (%)	Incidence of Tuberculosis (TB) per 100,000 People	Propotion of TB Cases Detected under DOTS (%)
Cambodia	0.1(2009)	50.5 (2010)	437.0 (2010)	65.0 (2010)
PRC, Guangxi	–	86.7 (2009)	97.0 (2010)	–
PRC, Yunnan	–	86.2 (2010)	593.0 (2009)	–
Lao PDR	0.2 (2009)	38.4 (2005)	90.0 (2010)	72.0 (2010)
Myanmar	0.3 (2009)	39.5 (2010)	384.0 (2010)	71.0 (2010)
Thailand	–	79.6 (2009)	137.0 (2010)	70.0 (2010)
Viet Nam	0.1 (2009)	79.5 (2008)	199.0 (2010)	54.0 (2010)

– Data not available.
Source: Cambodia National Institute of Statistics, Directorate General for Health, and ICF Macro, 2011. *Cambodia Demographic and Health Survey 2010.* Phnom Penh; Guangxi Bureau of Statistics, 2010. *Monitoring Report on Developmental Plan of Woman in 2009*; and Guangxi Public Health Department; Yunnan Bureau of Statistics . 2011. *Monitoring Report on Development Plan of Woman and Children in Yunnan 2001-2010*. Kunming; UNDP Myanmar. 2011. Integrated Household Living Conditions Survey in Myanmar (2009-2010): MDG Data Report; UN Millennium Development Goals Indicators. http://unstats.un.org/unsd/mdg/Data.aspx (Accessed 19 July 2012); World Bank; World Development Indicators and Global Development Finance. http://databank.worldbank.org. (Accessed 20 July 2012).

Table 4.9f: MDG Indicators-Incidence of Tuberculosis (TB) per 100,000 People, 2000–2010

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	492	485	478	472	467	461	456	451	446	442	437
PRC, Guangxi	70	71	74	92	120	146	127	130	131	103	97
PRC, Yunnan	497	–	–	–	–	–	–	–	–	593	–
Lao PDR	85	86	86	86	86	87	87	88	88	89	90
Myanmar	412	411	410	408	406	403	400	396	393	388	384
Thailand	137	137	137	137	137	137	137	137	137	137	137
Viet Nam	205	205	205	205	205	204	203	202	201	200	199

– Data not available.
Source: *Chinese Health Statistic Year Book 2010*; Guangxi Public Health Department; UN Millennium Development Goals Indicators. http://unstats.un.org/unsd/mdg/Data.aspx (Accessed 19 July 2012); Yunnan Tuberculosis Prevention and Control Plan (2002-2010),

Table 4.9g: MDG Indicators-Proportion of TB Cases Detected under DOTS, 2000–2010 (%)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	31	31	40	46	50	58	56	58	63	64	65
Lao PDR	49	52	56	57	65	74	78	75	76	71	72
Myanmar	17	23	30	40	52	57	66	69	67	69	71
Thailand	40	57	56	61	61	64	61	59	59	68	70
Viet Nam	56	56	58	56	58	56	57	57	56	55	54

DOTS = Directly–Observed Treatment Short (course).
Source: UN Millennium Development Goals Indicators. http://unstats.un.org/unsd/mdg/Data.aspx (Accessed 19 July 2012).

Table 4.9h: MDG Indicators-GDP Per Unit of Energy Used, 2000–2009 (PPP $ per kg of oil equivalent)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Cambodia	2.9	3.0	3.2	3.4	3.7	4.2	4.7	5.1	5.5	5.6
Thailand	4.3	4.2	4.2	4.3	4.4	4.6	4.9	5.1	5.1	5.2
Viet Nam	3.0	3.1	3.1	3.3	3.2	3.5	3.8	4.0	4.1	4.0

PPP = purchasing power parity.
Source: World Bank. World Development Indicators and Global Development Finance. http://databank.worldbank.org. (Accessed 20 July 2012).

Table 4.9i: MDG Indicators-Proportion of Population with Sustainable Access to an Improved Water Source, 2000–2010 (%)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	44.0	46.0	48.0	50.0	52.0	54.0	56.0	58.0	60.0	62.0	64.0
PRC, Guangxi	–	–	–	–	–	88.8	–	65.1	–	87.9	–
Lao PDR	45.0	48.0	50.0	53.0	55.0	57.0	59.0	61.0	63.0	64.0	67.0
Myanmar	67.0	69.0	70.0	72.0	74.0	75.0	77.0	78.0	80.0	81.0	83.0
Thailand	92.0	92.0	93.0	94.0	94.0	94.0	95.0	96.0	96.0	96.0	96.0
Viet Nam	77.0	79.0	81.0	82.0	84.0	86.0	88.0	90.0	92.0	93.0	95.0

– Data not available.
Source: *Monitoring Report on Development Planning of Children in Guangxi 2007 & 2009;* UN Millennium Development Goals Indicators. http://unstats.un.org/unsd/mdg/Data.aspx (Accessed 19 July 2012).

Table 4.9j: MDG Indicators-Proportion of Population with Access to Improved Sanitation, 2000–2010 (%)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	17.0	18.0	20.0	21.0	23.0	24.0	25.0	26.0	28.0	29.0	31.0
PRC, Guangxi	–	–	–	–	–	–	43.8	46.5	49.2	53.2	60.0
Lao PDR	26.0	30.0	33.0	37.0	41.0	45.0	48.0	52.0	56.0	60.0	63.0
Myanmar	62.0	63.0	65.0	67.0	68.0	70.0	71.0	72.0	74.0	76.0	76.0
Thailand	94.0	94.0	96.0	96.0	96.0	96.0	96.0	96.0	96.0	96.0	96.0
Viet Nam	56.0	58.0	60.0	62.0	64.0	66.0	69.0	70.0	72.0	74.0	76.0

– Data not available.
Source: Addressing Climate Change in Guangxi; UN Millennium Development Goals Indicators. http://unstats.un.org/unsd/mdg/Data.aspx (Accessed 19 July 2012).

Table 4.9k: MDG Indicators-(Goal 8) Net Official Development Assistance Received, 2000–2010 (% of Gross National Income)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	11.2	11.0	11.8	11.6	9.5	8.9	7.6	8.2	7.5	7.3	6.9
Lao PDR	16.9	14.4	16.4	15.8	11.9	11.3	11.1	9.7	9.6	7.4	6.2
Myanmar	–	–	–	–	–	–	–	–	–	–	–
Thailand	0.6	0.2	0.2	-0.7	0.0	-0.1	-0.1	-0.1	-0.2	0.0	0.0
Viet Nam	5.5	4.4	3.7	4.6	4.1	3.7	3.1	3.6	2.9	4.0	2.9

– Data not available.
Source: World Bank. World Development Indicators and Global Development Finance. http://databank.worldbank.org. (Accessed 20 July 2012).

Table 4.9l: MDG Indicators-Other Indicators

Country	Unemployment Rate of 15-24 Year-Olds (%)	Number of Telephone Lines per 100 People	Mobile cellular subscriptions per 100 people	Nuber of Personal Computers per 100 People
Cambodia	3.3 (2008)	2.5 (2010)	57.7 (2010)	0.4 (2007)
PRC, Guangxi	–	57.4 (2010)	45.6 (2010)	25.2 (2010)
PRC, Yunnan	–	–	49.1 (2010)	22.3 (2010)
Lao PDR	0.5 (1995)	1.64 (2010)	64.6 (2010)	1.7 (2005)
Myanmar	4.7 (2010)	1.3 (2010)	1.2 (2010)	0.9 (2006)
Thailand	4.3 (2009)	10.1 (2010)	100.8 (2010)	6.7 (2005)
Viet Nam	4.6 (2004)	18.7 (2010)	175.3 (2010)	9.5 (2006)

– Data not available.

Source: Cambodia Census 2008. Report 8: Economic Activity and Employment. Phnom Penh; *Guangxi Statistical Yearbook 2011* and *China Statistical Yearbook 2011*; Census Report 8. Economic Activity and Employment.; *Yunnan Statistical Yearbook 2010*. Statistical Communique on National Socio-economic Development of Yunnan 2001,2002,2003. Guangxi National Economy. Statistical Analysis.http://www.gxtj.gov.cn/show.asp?typid=81&id=9483,2005 data:http://www.eai.nus.edu.sgCWP74.pdf. East Asia Institute, National University of Singapore. http://www.eai.nus.edu.sgCWP74.pdf; Yunnan Health Report (1949-2009), http://health.yunnan.cn/html/2009-09/29/content_927345.htm. Lao PDR statistical yearbook 2010. UNDP Myanmar.2011.Integrated Household Living Conditions Survey in Myanmar (2009-2010):Poverty Profile. GSO. 2011. *Statistical Yearbook of Viet Nam*. Ha Noi (15 years old and older); UN Millennium Development Goals Indicators. http://unstats.un.org/unsd/mdg/Data.aspx (Accessed 19 July 2012); World Bank. World Development Indicators and Global Development Finance. http://databank.worldbank.org. (Accessed 20 July 2012).

Table 4.9m: MDG Indicators-Life Expectancy at Birth, 2000–2010 (years)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	57.5	57.9	58.4	58.9	59.4	60.0	60.5	61.1	61.6	62.1	62.5
PRC, Guangxi	–	–	–	–	–	–	–	–	–	–	76.3
PRC, Yunnan	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	65.5	68.0
Lao PDR	61.4	62.0	62.6	63.2	63.8	64.5	65.1	65.7	66.2	66.7	67.1
	–	–	–	–	–	61.0	61.7	–	63.2	63.9	64.7
Myanmar	61.9	62.1	62.3	62.5	62.7	62.9	63.1	63.4	63.8	64.2	64.7
Thailand	72.5	72.6	72.8	72.9	73.1	73.2	73.3	73.5	73.6	73.8	73.9
Viet Nam	71.9	72.4	72.8	73.1	73.4	73.7	73.9	74.2	74.4	74.6	74.8

– Data not available.

Source: Guangxi National Economy. Statistical Analysis.http://www.gxtj.gov.cn/show.asp?typid=81&id=9483,2005 data:http://www.eai.nus.edu.sgCWP74.pdf; East Asia Institute, National University of Singapore. http://www.eai.nus.edu.sgCWP74.pdf; UNDP2011. Human Development Report 2011. New York; World Bank. World Development Indicators and Global Development Finance. http://databank.worldbank.org. (Accessed 20 July 2012); Yunnan Statistical Year Book 2011. *Lao PDR statistical yearbook 2010.*

Table 4.9n: MDG Indicators-People Living with HIV, 15-49 Years Old, 2000–2009 (%)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Cambodia	1.30	1.20	1.10	0.90	0.80	0.80	0.70	0.60	0.60	0.50
Lao PDR	0.00	0.00	0.00	0.10	0.10	0.10	0.10	0.20	0.20	0.20
Myanmar	0.80	0.80	0.70	0.70	0.70	0.70	0.70	0.60	0.60	0.60
Thailand	1.80	1.70	1.60	1.50	1.50	1.50	1.40	1.40	1.30	1.30
Viet Nam	0.20	0.30	0.30	0.30	0.40	0.40	0.40	0.40	0.40	0.40

Source: UN Millennium Development Goals Indicators. http://unstats.un.org/unsd/mdg/Data.aspx (Accessed 19 July 2012).

Chapter 5: Geology

Table 5.1: Mining Sector Share of GDP, 2000–2010 (%)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	0.24	0.26	0.28	0.31	0.34	0.38	0.38	0.38	0.39	0.45	0.62
Lao PDR	0.20	0.22	0.26	2.64	2.02	5.79	12.63	10.98	10.07	7.66	7.42
Myanmar	0.59	0.49	0.45	0.45	0.63	0.73	0.72	0.88	0.87	0.98	0.91
Thailand	2.37	2.46	2.49	2.61	2.70	3.14	3.28	3.27	3.47	3.39	3.42
Viet Nam	9.65	9.21	8.61	9.34	10.13	10.59	10.23	9.77	9.87	9.97	10.86

Source: ADB. 2011. *Key Indicators for Asia and the Pacific 2011.* Manila.

Table 5.2: Mineral Production in GMS Countries, 2010 (ton, unless otherwise specified)

Mineral	Cambodia	Lao PDR	Myanmar	Thailand	Viet Nam
Barytes	–	29,000	14,346	33,465	90,000
Bauxite	–	–	–	–	80,000
Bentonite	–	–	1,000	–	20,000
Coal	–	500,000	240,527	17,906,894	44,010,700
Copper (metal content)	–	132,047	12,000	–	11,300
Diamond (carat)	–	–	–	–	–
Diatomite	–	–	–	7,100	10,000
Feldspar	–	–	–	641,900	200,000
Ferro alloys	–	–	–	–	8,000
Fluorspar	–	–	–	30,487	4,000
Fuller's earth	–	–	–	130	20,000
Gold (kilogram)	–	5,138	100	5,300	3,000
Gypsum	–	760,000	77,617	10,662,629	5,000
Iron ore	–	–	–	976,937	1,900,000
Iron and steel	–	–	40,000	–	500,000
Kaolin	–	–	–	250,000	650,000
Lead (metal content)	–	–	6,000	–	3,700
Manganese	–	–	–	50,450	–
Natural gas (million cubic meter)	–	–	12,509	29,565	9,240
Perlite	–	–	–	14,700	–
Petroleum	–	–	–	13,000,000	14,967,000
Phosphates	–	–	–	35,783	2,267,600
Salt	170,000	35,000	79,187	1,300,000	718,000
Silver (kilogram, metal content)	–	17,234	–	15,500	–
Talc	–		–	672	–
Tin	–	800	400	291	5,400
Titanium	–	–	–	–	881,602
Tungsten (metal content)	–	–	60	326	–
Zinc (metal content)	–	3,000	8,600	21,971	36,000

– Data not available.

Source: British Geological Survey. 2012. *World Mineral Production 2006-10*. Keyworth, Nottingham.

Chapter 6: River Basins and Wetlands

Table 6.1: Contribution of Discharges by Country to Mekong River Basin

	Country/Province					
Description	Cambodia	PRC, Yunnan	Lao PDR	Myanmar	Thailand	Viet Nam
Catchment						
Area (square kilometer)	155,000	165,000	202,000	24,000	184,000	65,000
Contribution to Mekong River (%)	20	21	25	3	23	8
% of total area of country/province	86	38	97	4	36	20
Average discharge (million cubic meter)						
In rainy season	90,193	76,128	166,195	9,416	80,732	52,350
In dry season	13,529	19,032	24,929	1,419	12,110	7,852
Average discharge as % of total Mekong River Basin						
In rainy season	19	16	35	2	17	11
In dry season	17	24	32	2	15	10

Source: UNEP http://www.unep.org/dewa/giwa/areas/reports/r55/regional_definition_giwa_r55.pdf

Table 6.2: Major Rivers of Guangxi, PRC

River	Drainage Area (square kilometer)	Annual Flow (million square meter)	Hydropower Resource (kilowatt)	Proportion of Total Drainage Area of Guangxi (%)
Total	236,700	182,200	21,330,000	100
Hongshuihe River	38,600	27,009	6,900,000	16.3
Yujiang River	68,100	30,633	3,558,600	28.8
Lower Reaches of Xijiang River	21,400	22,973	258,200	9
Guijiang River	18,200	22,495	1,462,000	7.7
Nanliujiang River	9,200	6,972	490,600	3.9
Liujiang River	42,000	39,642	3,418,200	17.7
Hejiang River	8,400	7,305	–	3.5

– Data not available.
Source: *Guangxi Statistical Yearbook 2011.*

Table 6.3: Area of Wetlands of Guangxi, PRC, 2010

	Area of Natural Wetlands(ha)						
Area of Wetlands (ha)	Coasts and Seashores (hectare)	River	Lakes	Marshland	Area of natural wetlands (hectare)	Area of Human-made Wetlands (hectare)	Proportion of Wetlands in Total Area (%)
6,561,000	3,484,000	2,191,000	–	–	5,675,000	886,000	2.76

– Data not available.
Source: National Bureau of Statistics of China. 2011. *China Statistical Yearbook 2011.* Beijing.

Table 6.4: Major Lakes in Yunnan, PRC

Lake	River system	Lake Area (square kilometer)	Maximum Depth (meter)	Average Depth (meter)	Average Water Level (meter)	Water Volume (billion cubic meter)
Dian Lake	Jinsha River	309	10.4	5.3	1,887	1.56
Er hai Lake	Mekong River	251	21.3	10.6	1,974	2.74
Fuxian Lake	Nanpan River	212.6	158.9	95.2	1,722	20.62
Chenhai Lake	Jinsha River	74.6	35	25.7	1,501	1.98
Lugu Lake	Jinsha River	57.7	105.3	38.4	2,691	2.22
Xingyun Lake	Nanpan River	34.3	10.81	6.01	1,723	1.96
Qilu Lake	Nanpan River	37.3	6.8	4	1,797	0.17
Yangzonghai Lake	Nanpan River	31.1	30	20	1,770	0.65
Yilong Lake	Lu River	31	5.7	3.9	1,414	0.12

Source: Yunnan Environmental Protection Department, 2012

Table 6.5: Major Rivers in Yunnan, PRC

	Internal Length (kilometer)	Catchments Area (square kilometer)
River	1,560	105,614
Jinsha (Yangtze) River	1,227	88,574
Lancang (Mekong) River	680	37,455
Yuan (Red) River	677	43,342
Nanpan River	618	33,366
Nu River	370	9,743
Daying River	196	5,859

Source: *Yunnan Statistical Yearbook 2011.*

Table 6.6: Area of Wetlands of Yunnan, PRC, 2010

	Area of Natural Wetlands (hectare)						
Area of Wetlands (ha)	Coasts and Seashores	Rivers	Lakes	Marshland	Natural Wetlands, Total	Human-made Wetlands	Proportion of Wetlands in Total Area of Territory (%)
2,353,000	–	1,198,000	965,000	4,000	2,203,000	15,000	0.61

– Data not available.
Source: National Bureau of Statistics of China. 2011. *China Statistical Yearbook 2011.* Beijing.

Table 6.7: Main Rivers in Lao PDR

Name	Flowing by	Length (kilometer)
Mekong	Whole country	1,898
Nam Ou	Phongsaly - Luangphabang	448
Nam Ngum	Xienkhuang - Vientiane	354
Nam Xebanghieng	Savannakhet	338
Nam Tha	Luangnamtha - Bokeo	325
Nam Xekong	Saravane - Sekong - Attapeu	320
Nam Beng	Oudomxay	215
Nam Xedone	Saravane - Champasack	192
Nam Xekhanong	Saravannakhet	115
Nam Kading	Borikhamxay	103
Nam Khan	Huaphanh - Luangphabang	90

Source: Ministry of Planning and Investment. *Statistical Yearbook 2010.* Vientiane.

Table 6.8: River Basins and Annual Discharge, Lao PDR

River Basin	Watershed area (hectare)	Annual discharge (cubic meter)	Length (kilometer)
Nam Ou	19,700	12,276,964,800	390
Nam Suang	5,800	3,654,076,320	150
Nam Khan	6,100	29,454,624,000	250
Nam Ngum	16,500	23,021,280,000	1,403
Nam Nhiep	4,270	5,885,248,320	156
Nam San	2,230	4,271,235,840	120
Nam Theun/Kading	3,370	7,027,166,880	138
Nam Sebangfai	8,560	13,623,552,000	190
Nam Sebanghieng	19,400	15,673,392,000	370
Nam Sedone	6,170	5,064,681,600	1,574
Nam Sekong	10,500	16,146,432,000	170

Source: http://www.wepa-db.net/policies/state/laos/river.htm

Chapter 8: Biodiversity

Table 8.1: Total Forest Area, 1990–2010 ('000 hectare)

	1990	2000	2005	2010	Annual Change (2000–2010)	Annual change (2000–2005)	Annual Change (2005–2010)
Cambodia	12,944	11,546	10,731	10,094	-1.3	-1.41	-1.19
PRC, Guangxi	–	9,819	12,525	13,427	3.7	5.51	1.44
PRC, Yunnan	–	12,873	15,600	18,177	4.1	4.24	3.30
Lao PDR	17,314	16,532	16,142	15,751	-0.5	-0.47	-0.48
Myanmar	39,218	34,868	33,321	31,773	-0.9	-0.89	-0.93
Thailand	19,549	19,004	18,898	18,972	0.0	-0.11	0.08
Viet Nam	9,363	11,725	13,077	13,797	1.8	2.31	1.10
Greater Mekong Subregion	98,388	116,367	120,294	121,991	0.5	0.7	0.3

– Data not available
Source: Yunnan Institute of Science. 2002. *Atlas of Remote Sensing Investigation on Eco- Environment in Western PRC*; FAO 2010. *Global Forest Resources Assessment 2010*. Rome; Guangxi Forestry Department; National Bureau of Statistics of China. 2006. *China Statistical Yearbook 2006*. Beijing; Report on the State of the Environment in Yunnan Province 2010.

Table 8.2: Primary Forest Area, 2000, 2005, 2010 ('000 hectare)

	2000	2005	2010
Cambodia	456	–	322
PRC, Guangxi	–	–	–
PRC, Yunnan	–	–	–
Lao PDR	1,490	1,490	1,490
Myanmar	3,192	3,192	3,192
Thailand	6,726	6,726	6,726
Viet Nam	187	85	80

– Data not available
Source: FAO 2010. *Global Forest Resources Assessment 2010*. Rome.

Table 8.3: Other Naturally Regenerated Forest, 2000, 2005, 2010 ('000 hectare)

	2000	2005	2010
Cambodia	11,011	10,335	9,703
PRC, Guangxi	–	–	–
PRC, Yunnan	–	–	–
Lao PDR	14,943	14,428	14,037
Myanmar	30,980	29,280	27,593
Thailand	9,167	8,728	8,261
Viet Nam	9,488	10,198	10,205

– Data not available
Source: FAO 2010. *Global Forest Resources Assessment 2010*. Rome.

Table 8.4: Other Wooded Land Area, 2000, 2005, 2010 ('000 hectare)

	2000	2005	2010
Cambodia	300	133	133
PRC, Guangxi	187	87	53
PRC, Yunnan	–	–	–
Lao PDR	4,153	4,493	4,834
Myanmar	19,703	19,908	20,113
Thailand	–	–	–
Viet Nam	1,816	1,791	1,124

– Data not available
Source: FAO 2010. *Global Forest Resources Assessment 2010*. Rome; Guangxi Forestry Department

Table 8.5: Planted Forest, 2000, 2005, 2010 ('000 hectare)

	2000	2005	2010
Cambodia	79	74	69
PRC, Guangxi	–	–	–
PRC, Yunnan	–	2,515	3,268
Lao PDR	99	224	224
Myanmar	696	849	988
Thailand	3,111	3,444	3,986
Viet Nam	2,050	2,794	3,512
	–	2,334	3,083

– Data not available
Source: FAO 2010. *Global Forest Resources Assessment 2010*. Rome; Government of Viet Nam, Ministry of Agriculture and Rural Denvelopment, Department of Forest Protection.

Table 8.6: Annual Reforestation/Plantation, 2000–2010 ('000 hectare)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	1	1	1	2	1	12	5	9	–	–	–
PRC, Guangxi	243	217	272	345	234	191	190	191	192	240	257
PRC, Yunnan	431	335	402	495	259	211	159	319	566	713	662
Lao PDR	–	–	–	–	–	–	35	32	40	35	35
Myanmar	31	31	31	30	32	33	28	24	24	–	–
Thailand	21	23	26	12	14	12	12	4	17	17	15
Viet Nam	–	–	–	170	116	128	130	90	217	149	164

– Data not available
Source: FAO 2010. *Global Forest Resources Assessment 2010*. Rome; Guangxi Forestry Department; Government of Lao PDR, Ministry of Agriculture and Forestry. 2010. *Agriculture Statistics Yearbook 2010;* Government of Myanmar, Ministry of National Planning and Economic development, Central Statistical Organization. 2010. *Statistical Yearbook 2009*. Nay Pyi Taw; Government of Viet Nam, Ministry of Agriculture and Rural Denvelopment, Department of Forest Protection Kingdom of Thailand, Ministry of Natural Resources and Environment, Royal Forest Department. Forest Statistics; *Yunnan Statistical Yearbook 2011.*

Table 8.7: Annual Timber Harvest, 2000–2010 ('000 cubic meter)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	187	127	1	0	4	10	3	–	–	–	–
Lao PDR	567	570	392	409	280	194	194	194	–	–	–
Myanmar	–	–	–	2,684	2,612	2,696	2,811	2,881	3,208	3,264	–
Thailand	46	41	34	20	2	9	13	285	–	–	–
Viet Nam	2,376	2,397	2,504	2,436	2,628	2,996	3,129	3,462	3,610	3,767	4,043

– Data not available
Source: FAO 2010. *Global Forest Resources Assessment 2010*. Rome; Government of Myanmar, Ministry of Environmental Conservation and Forestry. 2011; Forestry in Myanmar. Nay Pyi Taw; Government of Viet Nam, Ministry of Planning and Investment, General Statistics Office. http://www.gso.gov.vn/default_en.aspx?tabid=494 (Indicator: Gross output of wood).

Table 8.8: Industrial Roundwood Production, 2000–2010 ('000 cubic meter)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	179	123	125	125	125	113	113	118	118	118	83
Lao PDR	567	570	392	409	280	194	194	194	223	218	218
Myanmar	3,612	3,962	3,939	4,238	4,196	4,262	4,262	4,262	4,262	4,262	4,262
Thailand	6,262	7,101	7,800	8,700	8,700	8,700	8,700	8,700	8,700	8,700	8,700
Viet Nam	4,183	4,183	4,183	4,937	5,237	4,754	4,871	5,450	5,850	5,850	5,850

Source: FAO. FAOSTAT. http://faostat.fao.org/site/626/default.aspx#ancor (Accessed 31 July 2012).

Table 8.9: Fuelwood Production, 2000–2010 ('000 cubic meter)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	10,119	9,924	9,737	9,558	9,386	9,221	9,053	8,891	8,735	8,586	8,442
Lao PDR	5,872	5,885	5,899	5,913	5,928	5,944	5,944	5,944	5,945	5,946	5,948
Myanmar	34,471	35,403	34,939	37,954	37,560	38,286	38,286	38,286	38,286	38,286	38,286
Thailand	20,553	20,396	20,250	20,113	19,985	19,866	19,736	19,615	19,503	19,398	19,301
Viet Nam	26,686	26,615	26,547	21,500	21,250	21,250	21,250	22,000	22,000	22,000	22,000

Source: FAO. FAOSTAT. http://faostat.fao.org/site/626/default.aspx#ancor (Accessed 31 July 2012).

Table 8.10: Annual Timber Exports, 2000–2010 ('000 cubic meter)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Myanmar	951	888	879	1,065	1,332	1,596	1,674	1,753	1,251	1,525	–
Thailand	379	403	1,562	1,106	1,791	1,370	1,316	1,740	1,019	–	–

– Data not available
Source: Government of Myanmar, Ministry of Environmental Conservation and Forestry. 2011; Forestry in Myanmar. Nay Pyi Taw; Kingdom of Thailand, Ministry of Natural Resources and Environment, Royal Forest Department.

Table 8.11: Total Export Value of Forest Products, 2000–2010 ($'000)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	28,185	14,155	12,877	18,356	14,526	11,944	74,295	108,447	71,414	56,832	34,331
Lao PDR	13,542	62,697	62,697	62,697	62,697	62,697	88,102	137,477	168,333	123,737	192,092
Myanmar	246,698	292,667	320,984	421,551	360,008	723,304	713,745	783,854	934,301	672,093	788,797
Thailand	682,144	720,444	868,260	857,675	1,303,432	1,207,630	1,520,640	1,666,157	1,810,119	1,739,820	2,306,962
Viet Nam	47,277	55,331	63,596	63,599	134,823	151,902	199,727	256,719	392,941	343,553	745,901

Source: FAO. FAOSTAT. http://faostat.fao.org/site/626/default.aspx#ancor (Accessed 31 July 2012).

Table 8.12: Number of Species and Threatened Species, by Country

Country	Higher Plant Species	Threatened Higher Plant Species	Mammal Species	Threatened Mammal Species	Bird Species	Threatened Bird Species
Cambodia	2,308	30	123	37	545	24
PRC, Guangxi	8562	–	131	–	543	–
PRC, Yunnan	17,000	151	259	–	793	–
Lao PDR	412	23	282	45	700	23
Myanmar	7,000	44	251	45	1,056	43
Thailand	12,000	96	302	57	928	46
Viet Nam	11,494	147	310	54	840	43

– Data not available
Source: Guangxi Forestry Department .2011. Nanning (Unpublished); Government of Lao PDR. 2010. Assessing Progress Towards the 2010 Biodiverstiy Target: The 4th National Report to the Convention on Biological Diversity. Viantiane Capital; Government of Myanmar, Ministry of Forestry, National Commission for Environmental Affairs. 2009. Fourth National Report to the UNCBD. Nay Pyi Taw; Government of Viet Nam, MONRE. 2008. 4th Country Report: Viet Nam's Implementation of the Biodiversity Convention (draft). Ha Noi; IUCN Red List of Threatened Species, version 2011.2: Table 5; Kingdom of Thailand, Ministry of Natural Resources and Environment, Office of Natural Resources and Environment Policy and Planning. 2009; National Report on the Implementation of the Convention on Biological Diversity. Bangkok; Royal Government of Cambodia. MOE.2010. Fouth National Report to the Convention on Biological Diversity. Phnom Penh; Yunnan Bureau of Statistics. 2011. Overview of Agriculture in Yunnan. Kunming.

Table 8.13: Terrestrial Protected Areas 2000–2010 (square kilometer)

Cambodia	41,770.31	41,770.31	41,770.31	41,770.31	46,003.79	46,003.79	46,003.79	46,087.43	46,087.43	47,033.93	47,033.93
PRC, Guangxi	–	–	–	–	–	–	–	–	–	–	–
PRC, Yunnan	24,000	27,360	29,900	34,900	32,680	35,495	35,495	28,833	28,502	28,410	29,556
Lao PDR	38,433.44	38,433.44	38,433.44	38,433.44	38,433.44	38,433.44	38,433.44	38,433.44	38,433.44	38,433.44	38,433.44
Myanmar	30,081.89	35,688.93	42,638.91	42,638.91	42,638.91	42,638.91	42,638.91	42,638.91	42,638.91	42,638.91	42,638.91
Thailand	103,154.97	104,006.8	104,023.59	104,023.59	104,023.59	104,023.59	104,023.59	104,023.59	104,023.59	104,023.59	104,023.59
Viet Nam	19,897.7	19,897.7	20,567.6	20,567.6	20,568.32	20,568.32	20,568.32	20,568.32	20,568.32	20,568.33	20,568.33

– Data not available
Source: People's Government of Guangxi Zhuang Autonomous Region. Statistical Communique on National Socio-Economic Development of Guangxi; United Nations. United Nations Millennium Development Goals Indicators. http://unstats.un.org/unsd/mdg/Data.aspx (Accessed 16 January 2012); Yunnan Bureau of Statistics. 2011. Statistical Communique on National Socio-Economic Development of Yunnan.

Table 8.14: Terrestrial Protected Area, Share of Total Area 2000–2010 (%)

Cambodia	22.89	22.89	22.89	22.89	25.21	25.21	25.21	25.25	25.25	25.77	25.77
PRC, Guangxi	6.78	6.78	6.68	6.19	6.33	6.38	6.04	5.97	6.03	6.11	6.11
PRC, Yunnan	6.09	6.94	7.59	8.86	8.29	9.01	9.01	7.32	7.23	7.21	7.50
Lao PDR	16.621	16.621	16.621	16.621	16.621	16.621	16.621	16.621	16.621	16.621	16.62
Myanmar	4.47	5.3	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33	6.33
Thailand	19.92	20.09	20.09	20.09	20.09	20.09	20.09	20.09	20.09	20.09	20.09
Viet Nam	6.03	6.03	6.24	6.24	6.24	6.24	6.24	6.24	6.24	6.24	6.24

Source: People's Government of Guangxi Zhuang Autonomous Region. Statistical Communique on National Socio-Economic Development of Guangxi; United Nations. United Nations Millennium Development Goals Indicators. http://unstats.un.org/unsd/mdg/Data.aspx (Accessed 16 January 2012); Yunnan Bureau of Statistics. 2011. Statistical Communique on National Socio-Economic Development of Yunnan;

Table 8.15: Summary Values of Ecosystem Services in Biodiversity Corridors (in $ '000)

Ecosystem Services	Cambodia (1,560,236 ha)	Lao PDR (417,660 ha)	Viet Nam (360,748 ha)	Total Value (2,338,644 ha)	Unit Value ($/hectare)
Non-timber forest products	4,200	2,958	1,694	8,852	3.79
Carbon storage	2,720,110	770,815	751,714	4,242,639	1,814.14
Watershed protection	1,016,843	284,222	510,934	1,811,998	774.81
Water quality regulation	1,588,817	299,765	407,725	2,296,307	981.90
Soil erosion control	622,730	158,673	143,984	925,386	395.69
Total Value	**5,952,700**	**1,516,433**	**1,816,050**	**9,285,183**	**3,970**

Source: GMS Biodiversity Conservation Corridors (ADB R-PPTA 7459), Aug 2010.

Chapter 9: Agriculture, Fisheries, and Food Security

Table 9.1: Fisheries-Total Aquaculture Production (inland and marine), 2000–2010 ('000 ton)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	14	18	18	26	21	16	34	35	40	50	60
PRC, Guangxi	1,419	1,488	1,587	1,690	1,779	1,882	1,599	1,690	1,729	1,842	1,971
Lao PDR	42	50	60	65	65	60	60	63	64	75	82
Myanmar	116	190	252	400	485	575	616	675	762	858	816
Thailand	738	814	955	1,064	1,260	1,304	1,354	1,370	1,331	1,417	1,286
Viet Nam	590	710	845	1,004	1,203	1,479	1,695	2,125	2,466	2,590	2,707
GMS (excluding Yunnan)	2,919	3,270	3,716	4,249	4,813	5,316	5,359	5,958	6,392	6,832	6,922

Source: Fisheries and Aquaculture Information and Statistics Service. http://www.fao.org/fishery/topic/16140/en (Accessed 7 August 2012); National Bureau of Statistics of China. 2010. *China Statistical Yearbook 2010*. Beijing; Guangxi Bureau of Aquatic Products and Animal Husbandry. Nanning; Government of Myanmar, Ministry of Agriculture and Irrigation, Department of Agricultural Planning. 2011. Myanmar Agriculture at a Glance 2011. Nay Pyi Taw; Kingdom of Thailand, Ministry of Agriculture and Coorperatives, Department of Fisheries. 2009. Fisheries Statistics of Thailand 2008. Bangkok; and Government of Viet Nam, Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi.Royal Government of Cambodia, Ministry of Agriculture, Forestry and Fisheries for Food Security and Sustainable Development. http://www.stats.maff.gov.kh/en/index.php?option=com_content&view=article&id=20&Itemid=93 (Accessed 1 December 2011).

Table 9.2: Fisheries-Total Capture Fisheries Production (inland and marine), 2000–2010 ('000 ton)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	122	177	406	363	300	339	483	459	431	465	490
PRC, Guangxi	980	995	965	956	909	957	765	771	762	776	780
Lao PDR	29	31	33	30	30	27	27	28	29	30	31
Myanmar	1,167	1,284	1,343	1,586	1,731	2,006	2,244	2,494	2,754	3,060	3,320
Thailand	2,997	2,834	2,842	2,850	2,840	2,699	2,305	1,873	1,871	1,871	1,827
Viet Nam	1,661	1,725	1,803	1,856	1,940	1,988	2,027	2,075	2,136	2,281	2,421
GMS (excluding Yunnan)	6,956	7,046	7,392	7,641	7,750	8,015	7,849	7,700	7,983	8,482	8,869

Source: FAO. Fisheries and Aquaculture Information and Statistics Service. http://www.fao.org/fishery/topic/16140/en (Accessed 7 August 2012); Government of Myanmar, Ministry of Agriculture and Irrigation, Department of Agricultural Planning. 2011. Myanmar Agriculture at a Glance 2011. Nay Pyi Taw; Government of Viet Nam, Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi; People's Government of Guangxi Zhuang Autonomous Region. Guangxi Bureau of Aquatic Products and Animal Husbandry. Nanning; and Royal Government of Cambodia, Ministry of Agriculture, Forestry and Fisheries for Food Security and Sustainable Development. http://www.stats.maff.gov.kh/en/index.php?option=com_content&view=article&id=20&Itemid=93 (Accessed 1 December 2011).

Table 9.3: Fisheries-Total Production from All Sources, 2000–2010 ('000 ton)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	136	195	424	390	321	355	517	494	471	515	550
PRC, Guangxi	2,399	2,484	2,551	2,646	2,689	2,839	2,364	2,461	2,491	2,618	2,751
Lao PDR	71	81	93	95	95	87	87	92	94	105	113
Myanmar	1,283	1,474	1,595	1,986	2,216	2,580	2,860	3,169	3,516	3,918	4,136
Thailand	3,735	3,648	3,797	3,914	4,100	4,003	3,659	3,244	3,202	3,287	3,113
Viet Nam	2,251	2,435	2,648	2,860	3,143	3,467	3,722	4,199	4,602	4,870	5,128
GMS (excluding Yunnan)	9,875	10,316	11,109	11,890	12,563	13,331	13,208	13,658	14,375	15,314	15,791

Chapter 10: Water Availability, Demand, and Use

Table 10.1: Annual Availability of Water Resources Per Capita, 2002,2007, 2009, 2010 (cubic meter)

	2002	2007	2009	2010
Cambodia	37,065	34,828	34,061	33,675
PRC, Guangxi	4,942	2891	–	3,771
PRC, Yunnan	5,328	4,996	3,450	–
Lao PDR	60,669	56,230	54,565	53,782
Myanmar	21,991	21,379	–	20,912
Thailand	6,785	6,469	6,384	6,345
Viet Nam	10,982	10,400	10,174	10,064

– Data not available.
Source: FAO. Aquastat online database. http://www.fao.org/nr/water/aquastat/data/query/results.html (Accessed 23 Dec 2011 and 10 Aug 2012); Guangxi and Yunnan Statistical Yearbook 2003,2008,2010; Yunnan Water Resources Report 2002, 2007, 2009.

Table 10.3: Water Resources: Total Internal Renewable per Capita, 2002, 2007, 2009, 2010 (surface + ground) (cubic meter/person/year)

	2002	2007	2009	2010
Cambodia	9,389	8,822	8,628	8,530
Lao PDR	34,637	32,103	31,152	30,705
Myanmar	21,991	21,379	21,071	20,912
Thailand	3,473	3,311	3,268	3,248
Viet Nam	4,465	4,228	4,136	4,091

Source: FAO. Aquastat online database. http://www.fao.org/nr/water/aquastat/data/query/results.html (Accessed 23 Dec 2011 and 10 Aug 2012).

Table 10.2: Water Resources-Total Internal Renewable, 2002, 2007, 2009, 2010 (surface+ground) (10^9 cubic meter per year)

	2002	2007	2009	2010
Cambodia	120.6	120.6	120.6	120.6
Lao PDR	190.4	190.4	190.4	190.4
Myanmar	1,003	1,003	1,003	1,003
Thailand	224.5	224.5	224.5	224.5
Viet Nam	359.4	359.4	359.4	359.4

Source: FAO. Aquastat online database. http://www.fao.org/nr/water/aquastat/data/query/results.html (Accessed 23 Dec 2011 and 10 Aug 2012).

Table 10.4: Surface Water Produced Internally, 2002, 2007, 2009, 2010 (10^9 cubic meter)

	2002	2007	2009	2010
Cambodia	116.0	116.0	116.0	116.0
PRC, Guangxi	237.2	137.7	–	182.2
PRC, Yunnan	230.5	225.6	157.7	–
Lao PDR	190.4	190.4	190.4	190.4
Myanmar	992.1	992.1	992.1	992.1
Thailand	213.3	213.3	213.3	213.3
Viet Nam	323.0	323.0	323.0	323.0

– Data not available.
Source: FAO. Aquastat online database. http://www.fao.org/nr/water/aquastat/data/query/results.html (Accessed 23 Dec 2011 and 10 Aug 2012); People's Government of Guangxi Zhuang Autonomous Region, Guangxi Bureau of Statistics. 2011. *Guangxi Statistical Yearbook 2011.* Beijing; Yunnan Water Resources Report 2002, 2007, 2009.

Table 10.5: Groundwater Produced internally, 2002, 2007, 2009, 2010 (10^9 cubic meter)

	2002	2007	2009	2010
Cambodia	17.6	17.6	17.6	17.6
PRC, Guangxi	51.4	34.1	–	31.6
PRC, Yunnan	76.4	79.5	58.3	–
Lao PDR	37.9	37.9	37.9	37.9
Myanmar	453.7	453.7	453.7	453.7
Thailand	41.9	41.9	41.9	41.9
Viet Nam	71.42	71.42	71.42	71.42

– Data not available.
Source: FAO. Aquastat online database. http://www.fao.org/nr/water/aquastat/data/query/results.html (Accessed 23 Dec 2011 and 10 Aug 2012); *Guangxi and China Statistical Yearbook;* unnan Water Resources Report 2002, 2007, 2009.

Table 10.6: Water Flows from Other Countries, 2002, 2007, 2009, 2010 (billion cubic meter)

	2002	2007	2009	2010
Cambodia	355.5	355.5	355.5	355.5
PRC, Guangxi	–	–	–	5.87
PRC, Yunnan	8.96	2.58	1.85	–
Lao PDR	143.1	143.1	143.1	143.1
Myanmar	165	165	165	165
Thailand	214.1	214.1	214.1	214.1
Viet Nam	524.7	524.7	524.7	524.7

– Data not available.
Source: FAO. Aquastat online database. http://www.fao.org/nr/water/aquastat/data/query/results.html (Accessed 23 Dec 2011 and 10 Aug 2012); Guangxi Water Resource Department; Yunnan Water Resources Report 2002, 2007, 2009.

Table 10.7: Annual Freshwater Withdrawals, 2000, 2007, 2009 (billion cubic meter)

	2002	2007	2009
Cambodia	4.08	2.184	2.184
PRC, Guangxi	–	31.04	–
PRC, Yunnan	9.19	8.68	8.89
Lao PDR	3	4.26	4.26
Myanmar	47.12	47.12	47.12
Thailand	–	57.31	57.31
Viet Nam	82.03	82.03	82.03

– Data not available.
Source: Government of Myanmar, Ministry of Agriculture and Irrigation. 2009. Water Resources Management in Myanmar; World Bank; http://databank.worldbank.org/ddp/home.do?Step=3&id=4; Yunnan Water Resources Report 2002, 2007, 2009.

Table 10.8: Water and Sanitation Coverage, 2004 and Projected to 2015

		Water Supply		Sanitation	
		Coverage (%)	People Served (%)	Coverage (%)	People Served (%)
Cambodia	2004	<30	0.7	<10	<0.2
	2015	68	2.9	59	2.5
PRC, Yunnan	2004	70	7.5	70	7.5
	2015	90	19.4	90	19.4
Lao PDR	2004	40	0.57	55	0.77
	2015	80	1.7	70	1.6
Viet Nam	2004	60	11.5	30	9.5
	2015	80	25	60	18.5
Myanmar	2004	–	–	–	–
	2015	–	–	–	–

Note: Estimates based on data from government sources, ADB and UNDP reports.
– Data not available.
Source: UN-HABITAT. Supporting Secondary Urban Centres in the Mekong Region to Achieve the Millennium Development Goals on Water and Sanitation. http://www.un-habitat.org/pmss/listItemDetails.aspx?publicationID=2401.

Chapter 11: Energy

Table 11.1: Total Final Energy Consumption, 2010 and 2025 (thousand ton of oil equivalent)

Country / Region	Coal		Gas		Oil		Electricity		Fuelwood and Renewable Energy		Total	
	2010	2025	2010	2025	2010	2025	2010	2025	2010	2025	2010	2025
Cambodia	93	24	19	490	607	3,191	103	406	3,377	2,408	4,199	6,518
PRC, Guangxi	17,171	41,354	1,720	6,888	11,503	43,745	6,927	19,370	9,305	11,885	46,625	123,242
PRC, Yunnan	16,667	34,155	375	3,998	4,966	17,873	4,849	12,133	10,024	11,445	36,880	79,605
Lao PDR	227	681	256	380	642	1,722	153	566	1,013	762	2,291	4,111
Myanmar	564	2,455	265	638	1,963	3,466	542	1,975	12,210	19,831	15,544	28,365
Thailand	9,700	18,400	4,200	9,850	47,000	85,950	15,000	35,300	10,600	15,250	86,500	164,750
Viet Nam	6,800	13,900	1,400	3,650	15,000	36,100	5,700	16,500	22,500	22,500	51,400	92,650

Source: Gadde, B., K. Ganesan, and PJ. Tharakan. 2012. Status of Energy Use, Power Sector Expansion Plans and Related Policies in the GMS: Challenges and Opportunities; In H. Moinuddin and J. Maclean, eds. 2012. International Conference on GMS 2020: Balancing Economic Growth and Environmental Sustainability. Focusing on Food - Water - Energy Nexus. Manila: ADB.

Table 11.2: Total Primary Energy Production, 2010 and 2025 (thousand ton of oil equivalent)

Country / Region	Coal		Gas		Oil		Electricity		Fuelwood and Renewable Energy		Total	
	2010	2025	2010	2025	2010	2025	2010	2025	2010	2025	2010	2025
Cambodia	136	5	–	–	812	5,278	33	33	3,420	2,737	4,402	8,054
PRC, Guangxi	37,957	88,929	–	–	12,874	57,801	1,564	2,049	10,502	16,619	62,898	165,398
PRC, Yunnan	29,185	66,230	208	490	5,302	17,484	2,491	8,149	11,603	15,267	48,789	107,619
Lao PDR	1,433	5,895	1,039	533	908	1,003	5,209	6,518	1,027	1,650	9,616	15,599
Myanmar	583	5,950	750	597	2,341	2,914	609	3,360	12,305	21,049	16,588	34,470
Thailand	15,500	48,800	35,100	61,100	51,500	90,850	1,000	850	11,000	18,150	114,100	219,750
Viet Nam	11,300	27,100	6,800	13,750	15,000	37,650	2,800	5,350	23,200	25,550	59,100	109,400

– Data not available.
Source: Gadde, B., K. Ganesan, and PJ. Tharakan. 2012. Status of Energy Use, Power Sector Expansion Plans and Related Policies in the GMS: Challenges and Opportunities; In H. Moinuddin and J. Maclean, eds. 2012. International Conference on GMS 2020: Balancing Economic Growth and Environmental Sustainability. Focusing on Food - Water - Energy Nexus. Manila: ADB.

Table 11.3: Assumptions for Main Stem Mekong River Dam Construction

Main Stem Dam	Location	Earliest commission date	Design status	Installed capacity (megawatt)	Mean annual energy (gigawatt hour)	Live storage (million cubic meter)	Reservoir area (square kilometer)	Length of dam (meter)	Height (meter)
Pak Beng	Lao PDR	2016	MOU, feasibility	1,230	5,517	442	87	943	76
Luangprabang	Lao PDR	2016	MOU, feasibility	1,410	5,437	734	90	1,106	68
Xayaburi	Lao PDR	2016	MOU, feasibility	1,260	6,035	225	49	810	32
Pak Lay	Lao PDR	2016	MOU, feasibility	1,320	6,460	384	108	630	35
Sanakham	Lao PDR	2016	MOU, feasibility	700	5,015	106	81	1,144	38
Pakchom	Lao PDR / Thailand	2017	Master Plan	1,079	5,318	12	74	1,200	55
Ban Koum	Lao PDR / Thailand	2017	MOU, feasibility	1,872	8,434	–	133	780	53
Lat Sua	Lao PDR	2018	MOU, Pre-feasibility	686	2,668	–	13	1,300	27
Don Sahong	Lao PDR	2016	PDA, detailed planing	240	2,375	115	290 (ha)	1,820-720-2,730	10.6-8.2-8.3
Thakho diversion	Lao PDR	2016	MOU, pre-feasibility	50	360	–	–	Channel 1,800 m	–
Stung Treng	Cambodia	n/a	MOU, pre-feasibility	980	5	70	211	10,884	22
Sambor	Cambodia	2020	MOU, pre-feasibility	2,600	11,740	465	620	18,002	56

MOU = memorandum of understanding, PDA = pilot and demonstration activities.
– Data not available.
Source: Ward, J., T. Foran, A. Smajgl, L. Bouapao, S. Pech, and L Xing. 2012. Mekong Energy Metabolism: Connecting Energy Demand into the Nexus of Food-Water-Energy Security; In H. Moinuddin and J. Maclean, eds. 2012. International Conference on GMS 2020: Balancing Economic Growth and Environmental Sustainability. Focusing on Food - Water - Energy Nexus. Manila: ADB.

Table 11.4: Electricity Sources–Cambodia, 2000–2009 (% of total)

Source	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Hydropower	0	0	5.12	6.46	3.66	5	4.69	3.71	3.15	3.9
Coal	0	0	0	0	0	0	0	0	0	0
Oil	100	100	94.88	93.54	96.34	95	95.13	95.92	96.51	96.61
Gas	0	0	0	0	0	0	0	0	0	0
Nuclear power	0	0	0	0	0	0	0	0	0	0
Wood/Biomass (renewable sources)	0	0	0	0	0	0	0.18	0.37	0.34	0.5

Source: World Bank. World Development Indicators and Global Development Finance. http://databank.worldbank.org/ddp/home.do?Step=1&id=4 (Accessed 16 August 2012).

Table 11.5: Electricity Production–Cambodia, 1990–2009 (gigawatt hour)

Year	Consumption	Production
1990	199	199
1995	194	198
2000	331	435
2002	402	548
2003	462	632
2004	538	760
2005	641	906
2006	787	1,071
2007	1,349	1,349
2008	1,664	1,484
2009	1,853	1,235

Source: ADB. 2008. Energy Sector in the Greater Mekong Subregion. Manila. *Electricity Authority of Cambodia. 2008, 2009.Power Sector of the Kingdom of Cambodia. Annual Report. Phnom Penh.*

Table 11.6: Energy Generated by Type of Generation, Cambodia, 2010

Type of Generation	Unit (gigawatt hour)	%
Hydropwer	47.425	3.84
Coal	28.003	2.27
Diesel/HFO	1,152.65	93.36
Wood/biomass	6.486	0.53
Total	**1,234.564**	**100**

Source: EDC.2010. Report on Power Sector of the Kingdom of Cambodia 2010 Edition.

Table 11.7: Hydropower Potential–Cambodia (greater than 10 megawatts)

No.	Project	Location (province)	Effective Head (meter)	Installed capacity (megawatt)	Annual Energy (gigawatt)	Full Supply Level (meter)
1	Sambo	Kratie	20	467 or 3,300	2,800 or 14,870	20/30
2	Prek Chhlong	Kratie	15	12	51	64
3	Prek Ter 3	Kratie	18	15	92	70
4	Prek Ter 2	Kratie	17	11	55	90
5	Lower Sre Pok 4	Mondul Kiri	16	68	255	190
6	Prek Por 1	Mondul Kiri	124	5	32	520
7	Lower Sre Pok 2	Stung Treng	18	228	990	75
8	Lower Se San 2	Stung Treng	23	169	710	80
7&8	Lower Srepok2+ Lower Se San 2	Stung Treng	22	431	1,724	75
	Se San1 (Se San 4)	Rattanak Kiri	25	90	480	141
	Lower Sre Pok 4	Rattanak Kiri	53	235	1,233	190
9	Stung Treng	Stung Treng	43	6,624	24,590	55
10	Se Kong	Stung Treng	10	148	551	–
11	Lower Se San 3	Rattanak Kiri	26	161	692	120
12	Prek Liang 1	Rattanak Kiri	116	51	220	330
13	Prek Liang 1A	Rattanak Kiri	52	23	106	–
14	Prek Liang 2	Rattanak Kiri	163	48	260	510
15	Lower Sre Pok 3	Rattanak Kiri	29	235	988	–
16	Middle St. Russey Chrum	Koh Kong	194	56	345	400
17	Stung Chhay Areng	Koh Kong	179	109	668	210
18	Stung Tatay	Koh Kong	168	38	230	420
19	Stung Metoek 1	Pursat	123	11	66	400
20	Stung Metoek 2	Pursat	110	29	174	240
21	Stung Metoek 3	Koh Kong	57	23	103	120
22	Stung Kep 2	Koh Kong	170	114	458	200
23	Upper St. Russey Chrum	Pursat	368	38	231	800
24	Stung Pursat 1	Pursat	116	18	108	200
25	Stung Pursat 2	Pursat	32	10	62	70
26	Stung Sen	Preah Vihar	27	58	356	50
27	Stung Battambang 2	Battambang	347	17	104	560
28	Stung Battambang 1	Battambang	28	24	149	75
29	Bokor Plateao	Battambang	912	22	133	945

Source. Takeshi Washizawi. JICA Expert to Ministry of Industry, Mines and Energy Cambodia. (Overview on Power Sector in Cambodia. 2009).

Table 11.8: Current Installed Energy Capacity–Cambodia, 2000–2010 and to 2025 (megawatt)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Up to 2025
Thermal	122.50	137.50	142.70	144.00	157.78	202.20	300.25	330.77	398.30	472.34	538.77	3,716.00
Hydro	1.00	1.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	14.00	1,885.00
Solar	0.5	0.5	0.5	0.5	0.8	0.8	2.00	2.00	2.00	2.00	2.00	25.00
Coal	–	–	–	–	–	–	–	–	–	10.00	10.00	1,300.00
Coal/Gas	–	–	–	–	–	–	–	0	0	0	0	900 (2020)
HFO/DO	122.50	137.50	126.70	127.86	141.78	186.23	283.25	314.27	308.90	283.73	292.76	210.60

– Data not available.
Source: Ministry of Industry, Mines and Energy, Cambodia.

Table 11.9: Electricity Production–Guangxi and Yunnan, PRC, 1995–2010 (billion kilowatt hour)

Country	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
PRC, Guangxi	21.729	28.909	–	–	–	37.849	44.604	52.334	68.281	86.853	94.445	–
PRC, Yunnan	22.842	29.784	–	–	–	54.805	62.42	75.363	90.45	107.852	117.086	136.485

– Data not available.
Source:National Bureau of Statistics of China,and *China Statistical Yearbook* for Regional Economy 2010 & *China Statistical Yearbook*.

Table 11.10: Electricity Consumption–Guangxi and Yunnan, PRC, 1995–2010 (billion kwh)

Country	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
PRC, Guangxi	22.077	33.202	33.192	35.695	41.583	45.686	51.015	57.946	68.115	76.079	85.629	99.324
PRC, Yunnan	22.371	31.725	32.075	35.32	37.031	45.451	55.725	64.562	74.552	82.944	89.119	100.407

Source: *China Statistical Yearbook* for Regional Economy 2010 & *Yunnan Statistical Yearbook 2010* data from National Bureau of Statistics of China. 2011. *China Statistical Yearbook 2011*. Beijing.

Table 11.11: Sources of Energy Production and Consumption–Guangxi, PRC, 1990–2010 ('0,000 SCE)

Year	Total Production	Coal (%)	Crude oil (%)	Hydropower (%)	Total Consumption	Coal (%)	Oil (%)	Hydropower (%)
1990	704.63	59.1	2.4	38.5	1,308.21	62.7	11.6	20.7
1995	1,103.39	50.9	1.3	47.8	2,256.52	55.9	10.1	23.4
2000	833.28	36.6	0.6	63.4	2,669.34	49.3	15.2	20.5
2001	838.35	31.1	0.6	68.3	2,898.53	50.8	17.1	20.8
2002	770.23	24.1	0.7	75.2	2,981.82	47.6	19.3	20.6
2003	729.67	25.8	0.6	73.6	3,420.82	51.2	21.3	17.3
2004	908.43	32.3	0.8	66.9	4,308.20	49.1	21.5	14.4
2005	1,220.99	29.4	0.4	70.2	4,868.57	56	17.6	17.6
2006	1,359.27	21.2	0.4	78.4	5,390.35	53.7	17.2	19.8
2007	1,467.60	20.8	0.3	78.9	5,997.38	59	16.6	19.3
2008	1,926.42	9.9	0.2	89.9	6,497.05	56.1	16.1	26.6
2009	1,820.23	14.3	0.2	85.5	7,074.96	58.8	16.2	22
2010	1,951.85	22	2	77.9	7,918.97	53.9	16.6	19.2

SCE = standard coal equivalent.
Source: Guangxi Bureau of Statistics. 2011. *Guangxi Statistical Yearbook 2011*. Beijing.

Table 11.12: Sources of Energy Production and Consumption–Yunnan, PRC, 1990–2010 ('0,000 SCE)

Year	Total production of energy	Coal (%)	Hydropower (%)	Total consumption of energy	Coal (%)	Petroleum (%)	Natural gas (%)	Hydropower (%)
1990	1,594.50	79.8	20.2	1,954.18	71.7	7.2	2.8	18.3
1995	2,313.65	69.2	30.8	2,640.55	66.1	6.9	2.2	24.8
2000	2,471.77	64.03	32.11	3,468.33	62.61	7.46	1.81	25.39
2001	2,611.54	65.48	30.53	3,741.03	62.33	10.62	1.72	22.57
2002	3,259.95	67.19	29.41	4,131.31	61.04	11.12	1.51	23.7
2003	3,608.45	64.24	30.78	4,449.97	60.85	11.64	1.53	22.01
2004	4,455.68	68.13	27.04	5,209.81	63.3	11.13	1.34	20.16
2005	5,353.36	68.93	26.61	6,023.97	62.48	11.14	1.35	21.11
2006	6,075.09	75.29	22.42	6,620.57	67.7	11.52	1.09	17.62
2007	6,546.65	73.82	23.7	7,132.63	66.47	12.37	1.02	17.93
2008	7,595.31	68.87	29.48	7,510.82	60.83	12.81	0.93	23.79
2009	7,851.21	68.65	28.59	8,032.06	62.62	12.74	0.75	21.22
2010	8,822.03	66.6	32.05	8,674.17	56.73	15.11	0.56	23.98

SCE = standard coal equivalent.
Source: Yunnan Bureau of Statistics. 2011. *Yunnan Statistical Yearbook 2011*. Beijing.

Table 11.13: Hydropower Development–Lao PDR

	Project status				
	In operation	Under construction	Under licence	Planned	Total
Projects	10	8	22	60	100
Capacity (megawatt)	662	2,558	4,126	13,561	20,907
Annual energy (gigawatt hour)	3,356	11,390	20,308	59,502	94,556
Investment ($ million, 2008)	1,020	3,256	8,560	26,997	39,832

Source: Mekong River Commission. 2010. *Strategic Environmental Assessment*. Vientiane.

Table 11.14: Electricity Consumption–Lao PDR, 2001–2010 (gigawatt hour)

Regions	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Northern	33.9	43.2	49.0	65.3	85.6	106.8	136.1	162.1	193.1	246.9
Central	504.5	537.0	558.5	597.8	561.9	698.3	814.7	1,030.9	1,267.7	1,458.2
Southern	189.6	204.3	211.2	239.6	363.6	595.5	692.3	722.7	797.0	856.2
Total	728.0	784.6	818.7	902.8	1,011.1	1,400.6	1,643.1	1,915.7	2,257.8	2,561.3
Growth rate (%)	–	8.0	4.0	10.0	12.0	39.0	17.0	17.0	18.0	13.0

– Data not available.
Source: Electricite du Laos (EDL). 2011. *Power Development Plan PDP2010-2020*. Vientiane Capital, Lao PDR.

Table 11.15: Electricity Production, Import, and Export–Lao PDR, 2001–2010

Year	Production		Import		Export	
	Gigawatt hour	Growth rate (%)	Gigawatt hour	Growth rate (%)	Gigawatt hour	Growth rate (%)
2001	1,553.6		182.5		796.4	
2002	1,570.2	1	200.8	10	77.1	3
2003	1,316.9	16	229.3	14	434.7	44
2004	1,416.5	8	277.6	21	507.1	17
2005	1,715.1	21	325.6	17	727.8	44
2006	1,639.3	4	334.6	3	547	25
2007	1,398.4	15	475.9	42	268	51
2008	1,777.6	27	510	7	391.8	46
2009	1,655.9	7	818.6	61	229.5	41
2010	1,552.7	6	997.3	22	334.1	50

Source: Electricite du Laos (EDL). 2011. *Power Development Plan PDP2010-2020*. Vientiane Capital, Lao PDR.

Table 11.16: Sources of Electricity–Myanmar, 2000–2009 (% of total)

Source	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Hydropower	36.97	38.86	44.04	41.47	42.94	49.83	53.94	56.56	61.48	71.47
Coal	0	0	0	0	0	0	0	0	0	0
Oil	13.5	11.35	10.83	9.05	7.79	10.34	13.21	13.88	9.88	8.94
Gas	49.53	49.8	45.13	49.48	49.27	39.83	32.85	29.56	28.65	19.59
Nuclear power	0	0	0	0	0	0	0	0	0	0
Wood/Biomass (renewable sources)	0	0	0	0	0	0	0	0	0	0

Source: World Bank. World Development Indicators and Global Development Finance. http://databank.worldbank.org/ddp/home.do?Step=1&id=4 (Accessed 16 August 2012).

Table 11.17: Energy Generated by Type of Generation–Myanmar, 1990–2010 (million kilowatt hour)

Fiscal year	Thermal	Diesel	Hydropower	Gas	Total
1990–1991	28.11	73.89	1,248.45	1,292.60	2,643.05
1995–1996	62.49	43.21	1,595.46	2,061.17	3,762.33
2000–2001	661.59	36.20	1,891.93	2,527.92	5,117.64
2002–2003	641.48	28.50	2,111.02	2,286.95	5,067.95
2003–2004	634.31	31.45	2,074.81	2,685.31	5,425.88
2004–2005	183.91	33.23	2,407.75	2,983.35	5,608.24
2005–2006	631.91	33.37	3,000.80	2,398.08	6,064.16
2006–2007	786.42	28.08	3,324.63	2,025.02	6,164.15
2007–2008	854.70	33.59	3,618.51	1,891.22	6,398.02
2008–2009	614.23	39.95	4,071.08	1,896.50	6,621.76
2009–2010	473.36	29.57	5,256.36	1,204.98	6,964.27
2010–2011(p)	670.80	32.65	5,105.43	1,734.18	7,543.06

p = provisional.
Sources : Hydropower Generation Enterprise. Statistical Yearbook 2009; http://www.myanmararchives.com/statistical-data/200.html. http://www.csostat.gov.mm/sIndicators.asp; Myanmar Electric Power Enterprise; Electricity Supply Enterprise.

Table 11.18: Existing Hydropower Installations–Myanmar

No.	Name of Project	Location	Installed Capacity (megawatt)	Annual Energy (gigawatt hour)	Commissioned
1	Baluchaung.1	Loikaw, Kayah State	28	200	1992
2	Baluchaung.2	Loikaw, Kayah State	168	1,190	1974
3	Kinda	Myittha, Mandalay	56	165	1985
4	Sedawgyi	Mandalay	25	134	1989
5	Zawgyi.1	Yatsauk, Shan	18	35	1995
6	Zawgyi.2	Yatsauk, Shan	12	30	2000
7	Zaungtu	N-W of Bago	20	76.3	2000
8	Thaphanzeik	Kyunhla, Sagaing	30	117.2	2002
9	Mone	Sidoktaya, Magwe	75	330	2004
10	Paunglaung	N-E of Pyinmana	280	911	2005
11	Yenwe	Kyauktaka, Bago	25	123	2007
12	Kabaung	Oaktwin, Bago	30	120	2008
13	Kengtawng	Moene, Shan	54	377.6	2009
14	Shweli 1	Namkham, Shan	600	4,022	2009
15	Yeywa	Mandalay	592	2,662.5	2010
	Total		**2,013.5**	**10,493.6**	

Table 11.19: Existing Coal-Fired Power Station–Myanmar

Name of Project	Location	Installed Capacity (megawatt)	Annual Energy (gigawatt)	Commissioned	Annual Required Coal (ton)
Tigyit	Pinlaung, Shan	120	600	2005	640,000

Table 11.20: Existing Gas Turbine and Thermal Power Stations–Myanmar

No.	Name of Project	Installed Capacity (megawatt)	Annual Energy (gigawatt hour)	Commissioned
1	Kyunchaung	54.3	300	1974
2	Mann	36.9	238	1980
3	Mawlamyaing	12	60	1980
4	Shwedaung	55.35	300	1984
5	Myanaung	18.45	200	1984
		16.25		1975
6	Thahtone	18.45	300	1985
		32.5		2001
7	Hlawga	99.9	640	1996
		54.3	350	1999
8	Yawma	36.9	238	1980
		24	140	2004
		9.4	60	2004
9	Ahlone	99.9	640	1995
		54.3	350	1999
10	Thaketa	57	368	1990
		35	200	1997
	Total		**714.9**	

– Data not available.

Table 11.21: Hydropower Projects Under Construction–Myanmar

No.	Name of Project	Installed Capacity (megawatt)
1	Kun	60
2	Phyu	40
3	Shwekyin	75
4	Tha-htay	111
5	Upper Paunglaung	140
6	Nancho	40
7	Thaukyegat (2)	120
8	Ann	10
9	Manipur	380
10	Upper Keng Tawng	51
11	Upper Yeywa	280
12	Shweli (3)	1,050
13	Upper Bu	150
14	Bawgata	160
15	Beluchaung (3)	52
16	Upper Beluchaung	29
17	Htarcha	6
18	Saingdin	77
19	Anyaphya	9
20	Upper Sedawgyi	64
21	Thakyat	20
	Total	**2,924**

– Data not available.
Source: Country Report: http://nrec.mn/data/uploads/Nom%20setguul%20xicheel/Water/badrakh%20china/Myanmar.pdf; MS-RPTTC-8 meeting, Myanmar ppt:http://www.adb.org/Documents/Events/Mekong/Proceedings/PWG-FG-RPTCCAnnex5-MYA.pdf; Training Workshop on Small Hydropower Technology for Developing Countries Hangzhou-People's Republic of China, May 26-July 6 2011.

Table 11.22: Future Hydropower Projects to be Implemented by Foreign Investment–Myanmar

No.	Name of Project	Installed Capacity (megawatt)
1	Myitsone	6,000
2	Yenam	1,200
3	Kawanglangphu	2,700
4	Pisa	2,000
5	Wutsok	1,800
6	Chipwi	2,800
7	Laza	1,900
8	Chipwinge	99
9	Tapain 1	240
10	Tapain 2	168
11	Gawlan (Nawchankha)	100
12	Wuxhongze (Nawchankha)	60
13	Hkankan (Nawchankha)	140
14	Tongxinqiao (Nawchankha)	320
15	Lawndin (Nawchankha)	435
16	Konlon (Upper Thanlwin)	1,400
17	Naungpha	1,000
18	Mantaung	200
19	Tarsang	7,110
20	Hutgyi	1,360
21	Ywathit	600
22	Keng Tong (Namlwai)	96
23	Wantapeng (Namlwai)	25
24	Solu (Namlwai)	165
25	Mongwa (Namlwai)	50
26	Kengyan (Namlwai)	28
27	Heku (Namlwai)	88
28	Htamanthi	1,200
29	Shwesarye	660
30	Laymyo	500
31	Tanintharyi	600
32	Mawleik	520
33	Nampon	130
34	Namtabat	110
35	Namkha	200
36	Shweli 2	520
	Total	**36,524**

– Data not available.

Table 11.23: Future Coal-Fired Thermal Power Stations–Myanmar

Name of Project	Location	Installed Capacity (megawatt)	Annual Energy (gigawatt hour)
Htantapin	Yangon	270	2,160
Kalewa		600	
Total		870	

Table 11.24: Energy Consumption–Thailand, 2000–2010 (thousand ton of oil equivalent)

Year	Solid Fossil Fuel			Petroleum Products								Electricity	Industrial Use			Grand Total
	Coal	Lignite	Total	Liquefied Petroleum Gas	Premium	Regular	Jet Fuel	Kerosene	Diesel	Fuel Oil	Total		Energy	National Petrochemical Co.	Total	
2000	1,282	1,776	3,058	2,127	2,553	2,484	2,856	40	12,882	3,774	26,716	7,704	1,629	189	1,818	39,296
2001	1,625	1,791	3,416	2,349	2,236	2,873	3,039	46	13,060	3,687	27,290	8,183	1,690	269	1,959	40,848
2002	1,995	2,148	4,143	2,446	2,224	3,235	3,088	51	13,822	4,032	28,898	8,741	1,872	261	2,133	43,915
2003	3,049	1,313	4,362	2,505	2,298	3,390	3,074	29	15,109	4,128	30,533	9,345	2,033	270	2,303	46,543
2004	3,343	1,911	5,254	2,543	2,257	3,451	3,467	19	16,868	4,488	33,093	10,095	2,427	286	2,713	51,155
2005	4,054	2,135	6,189	2,750	2,150	3,250	3,509	17	16,847	4,098	32,621	10,664	2,451	312	2,763	52,237
2006	4,535	1,449	5,984	3,198	1,979	3,397	3,693	16	15,817	3,723	31,823	11,145	2,649	310	2,959	51,911
2007	5,409	1,030	6,439	3,663	1,956	3,510	4,031	15	16,120	3,239	32,534	11,649	3,320	363	3,683	54,305
2008	6,270	1,013	7,283	4,303	2,093	3,212	3,790	13	15,201	2,859	31,471	11,833	3,993	368	4,361	54,948
2009	6,529	974	7,503	4,344	2,409	3,198	3,622	14	15,906	2,466	31,959	11,836	4,853	414	5,267	56,565
2010	6,882	949	7,831	4,781	2,166	3,360	3,851	12	15,919	2,330	32,419	13,062	5,764	388	6,152	59,464

* Including Power Generation from small power producers

Table 11.25: Sources of Electricity–Thailand, 2000–2009 (% of total)

Source	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Hydropower	6.28	6.15	6.85	6.24	4.8	4.39	5.86	5.66	4.82	4.82
Coal	18.54	19.46	17.24	16.29	16.13	15.31	17.84	21.3	21.27	19.94
Oil	10.44	2.86	2.59	2.7	6.16	6.59	6.14	2.68	1.13	0.48
Gas	62.95	70	71.4	72.06	70.14	70.66	67.43	66.96	69.11	70.72
Nuclear power	0	0	0	0	0	0	0	0	0	0
Wood/Biomass (renewable sources)	1.79	1.54	1.92	2.71	2.77	3.06	2073	3.4	3.66	4.04

Source: World Bank. World Development Indicators and Global Development Finance. http://databank.worldbank.org/ddp/home.do?Step=1&id=4 (Accessed 16 August 2012).

Table 11.26: Sources of Electricity–Viet Nam, 2000–2009 (% of total)

Source	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Hydropower	54.8	59.5	50.8	46.4	38.4	39.4	33.7	33.7	35.6	36.0
Coal	11.8	10.5	13.6	17.7	15.3	16.2	23.7	22.2	20.8	18.0
Oil	17	15.5	12.3	6.5	3.7	3.5	2.2	5.4	3.7	2.5
Gas	16.4	14.5	23.3	29.4	42.7	40.9	40.5	38.7	39.9	43.4
Nuclear Power	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	–
Wood/Biomass (renewable sources)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

– Data not available.
Source: World Bank. World Development Indicators and Global Development Finance. http://databank.worldbank.org/ddp/home.do?Step=1&id=4 (Accessed 16 August 2012).

Table 11.27: Electricity Production and Consumption–Viet Nam, 1990–2010 (gigawatt hour)

Year	Electricity production (gigawatt-hour)	Electricity consumption, (gigawatt-hour)
1990	8,681	6,476
1995	14,648	11,469
2000	26,561	22,904
2001	30,608	26,365
2002	35,796	30,784
2003	40,925	35,653
2004	46,029	41,200
2005	53,462	47,593
2006	60,493	54,596
2007	66,857	61,970
2008	73,049	68,907
2009	79,721	74,816.41
2010	91,602	85,700.59

Source: ADB, SAP-REG 2008; ADB. 2011. *Key Indicators for Asia and the Pacific 2011*. Manila; World Bank. Viet Nam Ministry of Industry and Tarade. 2011. Report on the Implementation of the 2010 plan for Industry and Trade Development.

Chapter 12: Urbanization

Table 12.1: Particulate Matter (PM10) in Ambient Air by Country, 2000–2009 (microgram per cubic meter)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Cambodia	48	50	49	48	50	47	46	44	42	37
PRC, Yunnan	–	–	0.11	0.10	0.09	0.08	0.09	0.08	0.07	0.067
Lao PDR	55	53	54	53	53	50	47	47	45	45
Myanmar	75	72	69	69	63	58	53	49	44	41
Thailand	70	70	68	69	70	67	61	56	54	53
Viet Nam	67	66	64	63	63	59	55	55	52	50

Note: Yunnan data refer only for Kunming
– Data not available.
Source: World Bank. http://data.worldbank.org/indicator (Accessed 24 April 2012)

Table 12.2: Ambient Air Concentrations–Phnom Penh, Cambodia, 2000–2010

Indicator	2000	2001	2002	2005	2009	2010
Carbon monoxide (parts per million)	–	–	–	–	9.11	11.26
Sulfur dioxide (migrogram/cubic meter)	–	5.2	10.4	–	–	–
Nitrogen dioxide (microgram/cubic meter)	–	–	–	–	–	0.05
Lead (microgram/cubic meter)	–	–	–	–	–	–

Note: Yunnan data refer only for Kunming
– Data not available.
Source: Ministry of Environment. Annual Report 2009, 2010. ADB.2006. Country Synthesis Report on Urban Air Quality Management: Cambodia. Manila.

Table 12.3: Phnom Penh Waste Generation, 2003–2007

	2003	2004	2005	2006	2007
Daily Waste Generation (ton/day)	927.80	985.50	1,043.30	1,101.00	1,158.70
Annual Waste Generation (ton/year)	338,647.00	359,716.60	380,786.30	401,855.90	422,925.50
Solid Waste Collected (ton/year)	240,859.00	227,909.70	266,781.10	324,159.00	343,657.00
Solid Waste Uncollected (ton/year)	97,788.00	131,806.90	114,005.20	77,696.87	79,268.50
% uncollected	29	37	30	19	19

Note: Yunnan data refer only for Kunming
– Data not available.
Source: JICA, 2007; Waste transported to Steung Meanchey Dumping Site (Ministry of Environment, 2008). EOC/ADB. 2011. Cambodia_Draft EPA Report.

Table 12.4: Discharge and Disposal of City Sewage–Yunnan 2011

Item	Total Volume of City Sewage Discharged ('000 cubic meter)	Total Volume of Sewage Disposal ('000 cubic meter)	Volume of Utilized by Sewage regenerated ('000 cubic meter)	Ratio of City Sewage Disposal (%)	Ratio of Centralized Disposal by Sewage Disposal Plants (%)
All Cities	798,600	596,440	13,550	74.70	70.10

Source: *Yunnan Statistical Yearbook 2011.*

Table 12.5: Average per Capita Waste Production in Five Large Cities, Lao PDR, 2004

City	Per Capita Waste Production (kilogram)
Vientiane	0.8
Luangprabang	1
Thakhek	0.8
Savannakhet	1
Pakse	1.4

Source: MPWT/UNDP/NORAD LAO/96/006: Solid waste Management in *Secondary Urban Centres of Lao PDR*. Quoted in EPA report 2012.

Table 12.6: Waste Collection in Five Large Cities, Lao PDR, 2008

City	Population	Urban Area (number of households)	Waste Collection (number of households)	Waste Volume Collection and Landfill (ton/day)
Vientiane	321,984	49,672	19,723	250-300
Luangprabang	73,883	N/A	N/A	42-45
Thakhek	82,476	6,873	2,818	16-19
Savannakhet	113,915	9,977	4,290	18-20
Pakse	75,890	8,000	3,899	18-21

Source: MCTPC/UNDP/NORAD Lao 96/006, 2002. S*olid Waste Management in Secondary Urban Centres of Lao*. Quoted in EPA Report 2012.

Table 12.7: Ambient Air Concentrations–Yangon, Myanmar 2007–2008

Site		Total Suspended Particulates (microgram/cubic meter)	Particulate Matter (PM10) (microgram/cubic meter)	Sulfur Dioxide (microgram/cubic meter)	Nitrogen Dioxide (microgram/cubic meter)
1 Commercial area	April, 2007	342.58	177.69	–	–
	Jan, 2008	143.21	71.75	–	–
2 Residential area	April, 2007	168.61	68.59	1.14	23.22
	Jan, 2008	118.7	65.3	1.24	22.28
3 Industrial area	April, 2007	127.37	66.95	0.37	28.36
	Jan, 2008	188.66	136.92	0.25	25.42
	Average (1,2,3), April 2007	**212.85**	**104.41**	**0.755**	**25.79**
	Average (1,2,3), Jan 2008	**150.19**	**91.32**	**0.745**	**23.85**

– Data not available.
Source: Environment Division, Planning and Statistics Department, Ministry of Environmental Conservation and Forestry.

Table 12.8: Solid Waste Generation and Collection–Yangon, Myanmar, 2010

District	Households (HH)			Population			Total Solid waste generation (kilogram/day)	Solid waste generation/HH (kilogram/day)	Solid waste generation/ person (kilogram/ capita/day)
	Listed HH	Surveyed HH	%	Listed	Surveyed	%			
Eastern	243,032	8,021	3	1,170,501	37,665	3	10,547	1.315	0.280
Western	92,779	4,585	5	478,885	20,746	4	12,156	2.651	0.586
Southern	165,892	6,002	4	809,016	28,511	4	10,286	1.714	0.361
Northern	288,446	9,752	3	1,603,342	44,413	3	19,551	2.005	0.440
Total	**79,0149**	**28,360**	**3.6**	**4,061,744**	**131335**	**3.2**	**52,539.54**	**1.853**	**0.400 (0.267)**

Source: Yangon City Development Committee.

Table 12.9: Air Pollutant Emissions-Mass Loadings–Thailand, 2000–2009 (ton)

Indicator	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Sulfur Dioxide	487,000	350,000	359,000	335,000	377,000	382,000	462,000	520,000	663,000	–
Nitrogen Dioxide	656,000	703,000	752,000	800,000	865,000	891,000	895,000	902,000	923,000	–
Carbon Dioxide	–	154,535,000	163,039,000	171,370,000	186,716,000	191,158,000	191,281,000	195,847,000	198,145,000	196,022,000
Methane	55,000	55,000	57,000	59,000	61,000	64,000	65,000	72,000	85,000	–

Excluding emissions from renewable energy and international bunker oil, diesel, and jet fuel.
– Data not available.
Source: Kingdom of Thailand, Ministry of Energy, Department of Alternative Energy Development and Efficiency.

Table 12.10: Solid Waste Generation and Collection–Thailand, 2006–2008 (ton/day)

Region	Solid Waste Quantity			Solid Waste Collected by Sanitary Disposal System			Proportion of Sanitary Disposal in Total Waste (%)		
	2006	2007	2008	2006	2007	2008	2006	2007	2008
Whole Kingdom	40,012	40,332	41,064	14,303	14,432	15,540	36	36	38
Bangkok	8,403	8,532	8,780	8,403	8,532	8,780	100	100	100
Municipality and Pattaya	12,912	13,600	14,915	4,780	4,810	5,370	37	35	36
Subdistrict Administrative Organization	18,697	18,200	17,369	1,120	1,090	1,390	6	6	8

Source: National Statistical Office Ministry of Information and Communication Technology.

Table 12.11: Hazardous Waste Generation–Thailand, 2000–2008

Item	2000	2001	2002	2003	2004	2005	2006	2007	2008
Total hazardous waste	1,649	1,650	1,791	1,800	1,808	1,813	1,834	1,850	3,135
Industrial hazardous waste	1,290	1,305	1,405	1,400	1,405	1,409	1,424	1,440	2,454
Bangkok and vicinities	926	923	924	921	930	950	926	346	491
Central and East region	104	115	196	219	216	210	256	749	1,870
Northeast	24	27	43	43	48	56	64	115	46
North	134	136	137	116	115	107	100	158	35
South	102	104	105	101	96	86	78	72	12
Domestic hazardous waste	359	373	386	400	403	405	409	409	681
Bangkok and vicinities	133	149	151	138	136	137	266	264	262
Central and East region	58	58	62	88	94	95	74	71	144
Northeast	78	76	77	79	81	82	18	25	122
North	50	49	44	51	49	48	29	27	64
South	40	41	52	44	43	42	23	23	89

Note: In 2008 Adjusted database by Department of Industral Works.
Source: Pollution Control Department, Ministry of Natural resources and Environment.

Table 12.12: Radioactive Waste Generation–Thailand, 2002–2008

Radioactive Waste Category	2002		2005		2006		2007		2008	
	kilogram	cubic meter	kilogram	cubic meter	kilogram	cubic meter	kilogram	cubic meter	kilogram	cubic meter
Low radioactive waste										
Burnable solid waste	2,321.9	60.2	1,265.0	10.4	626.0	5.9	434.0	4.3	528.5	4.0
Compressible solid waste	367.9	5.5	1,035.0	7.0		4.3	347.0	2.5	405.4	3.1
Non-burnable and non-compressible solid waste	133.7	2.5	62.0	0.5	966.0	0.5	553.0	1.2	5,526.0	11.1
Special solid waste	–	–	80.0	1.4	–	–	469.0	0.5	141.0	0.3
Aqueous liquid waste	–	21.8	–	18.1	–	80.7	–	0.3	–	0.1
Organic liquid waste	–	1.0	–	0.6	–	0.4	–	0.2	–	0.2
Biological liquid waste	–	–	–	0.1	–	0.1	–	–	–	0.2
Spent sealed radioactive source	1,338.6	8.7	1,144.0	4.3	2,741.0	6.5	908.0	0.8	4,833.7	4.9
Effluent release (after treatment)	–	380.0	–	288.8	–	1.5	–	180.0	–	150.0
Effluent release (after treatment)	–	1.5	–	0.2	–	0.8	–	–	–	–

– Data not available.
Source : Thailand Institute of Nuclear Techrology, Ministry of Science and Technology.

Table 12.13: Air Pollutant Emissions–Viet Nam, 1995, 2000, 2005 ('000 ton carbon dioxide equivalent)

	1995	2000	2005
Nitrous Oxide	15,415	19,736	23,030
Methane	65,683	72,238	82,978

Source: ADB. 2011. *Key Indicators for Asia and the Pacific 2011*. Manila

Table 12.14: Solid Waste Generation–Viet Nam, 2003 and 2008 (ton)

Type of Solid waste	2003	2008
Urban	6,400,000	12,802,000
Industrial	2,638,400	4,786,000
Medical	21,500	179,000
Rural	6,400,000	9,078,000
Craft village	774,000	1,023,000
Total	16,233,900	27,868,000
Average domestic solid waste generation in urban areas kilogram/person/day	0.8	1.45
Average domestic solid watse generation in rural areas kilogram/person/day	0.3	0.4

Source: Government of Viet Nam, Ministry of Natural Resources and Environment. 2010. *National State of Environment 2010.* Ha Noi.

Chapter 13: Transport

Table 13.1a: Total Length of Road Network by Country, 2000–2010 (kilometer)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	–	–	–	–	–	–	–	–	–	30,704	44,919
PRC, Guangxi	52,910	54,752	56,297	58,451	59,704	62,003	90,318	94,202	99,273	100,491	101,782
PRC, Yunnan	163,604	163,953	164,852	166,133	167,050	194,495	198,496	200,333	203,753	206,028	209,231
Lao PDR	25,090	–	32,620	31,210	–	33,861	35,260	36,831	34,994	39,568	39,585 (2011)
Myanmar	28,765	–	29,148	29,670	29,998	30,611	30,891	31,083	32,185	34,377	–
Thailand	60,788	62,195	64,095	63,983	63,287	63,062	63,773	64,745	66,266	66,495	–
Viet Nam	–	–	–	–	–	–	–	160,089	171,392	180,549	–

– Data not available.
Source: Cambodia MPWT.2011.Anual Report 2010 and Target in 2011.P1. Guangxi Bureau of Statistics. 2011. *Guangxi Statistical Yearbook 2011* Beijing. *Yunnan Statistical Yearbook 2011.* Lao PDR National Statistic Center; http://www.nsc.gov.la/index2.php?option=com_content&view=article&id=42&Itemid=44. Myanmar Central Statistics Office. Statistical Yearbook 2009. Thailand Transport Statistics 2009, Ministry of Transportation, Source: http://www.news.mot.go.th/motc/portal/graph/transtat09.pdf. Viet Nam General Statistics Office

Table 13.1b: Length of Paved Road by Country, 2000–2010 (kilometer)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	–	–	–	–	–	–	–	–	–	–	4362
PRC, Guangxi	18,001	19,037	20,319	21,876	23,211	26842	27839	33652	40945	46676	52,229
PRC, Yunnan	156,594	106,396	107,616	109,300	110,876	138,778	99,834	104,771	124,526	138,150	158,120
Lao PDR	–	–	4,590	4,497	–	4,537	4,549	4,810	4,738	5,413	–
Myanmar	–	–	–	–	–	–	–	–	–	–	–
Thailand	56,559	58,967	61,125	61,559	61,238	61,468	62,177	62,988	64,977	65,366	–
Viet Nam	–	–	–	–	–	–	–	76,241	88,433	96,839	–

– Data not available.
Source: Cambodia MPWT.2011.Anual Report 2010 and Target in 2011.P1. Guangxi Communications Department. Yunnan Statistical Yearbook 2000-2011. World Bank. http://databank.worldbank.org/ddp/home.do?Step=1&id=4 (Accessed 21 June 2012) Thailand Transport Statistics 2009, Ministry of Transportation, Source: http://www.news.mot.go.th/motc/portal/graph/transtat09.pdf Viet Nam General Statistics Office

Table 13.2: Number of Registered Road Motor Vehicles by Country, 2000–2010 (thousand)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	–	–	–	–	38	89	140	154	215	307	260
PRC, Guangxi	2,204	2,564	3,039	3,845	4,409	4,984	5,452	6,028	6,493	7,411	8,237
PRC, Yunnan	–	–	–	–	–	–	–	–	–	–	–
Lao PDR	198	219	249	261	368	430	568	641	769	886	1,009
Myanmar	442	–	467	483	964	979	997	1033	1999	2147	2309
Thailand	20,030	21,760	23,674	25,549	19,815	21,729	23,958	24,738	25,512	26,258	–
Viet Nam	–	–	–	–	–	–	–	–	947	1,138	1,274

– Data not available.
Source: Cambodia MPWT.2011.Anual Report 2010 and Target in 2011.P1. Traffic Police Headquarters of Guangxi. Department of Transport, Ministry of Communications, Transport, Post and Construction. Myanmar Central Statistics Office. Statistical Yearbook 2009. Ministry of Transport, Thailand, Source: http://www.news.mot.go.th/motc/portal/graph/excel/index3.asp. Ministry of Transport, Viet Nam

Table 13.3: Road Passengers by Country, 2000–2010 (million persons)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	–	–	–	–	–	–	–	–	–	–	–
PRC, Guangxi	393.21	410.20	424.59	405.24	455.78	487.40	526.09	572.13	606.45	650.45	722.08
PRC, Yunnan	315.86	379.09	367.26	330.39	365.02	385.09	408.61	429.13	311.57	327.75	362.30
Lao PDR	16.43	–	–	–	–	34.89	–	38.31	37.62	39.16	45.00
Myanmar	37.06	–	37.45	36.34	35.47	37.63	37.67	38.11	37.89	37.89	–
Thailand	–	–	–	–	–	–	–	–	–	427.00	–
Viet Nam	620.70	677.30	727.70	931.30	1,041.90	1,173.40	1,131.60	1,473.00	1,629.00	1,761.00	2,011.10

– Data not available.

Source: *Guangxi Bureau of Statistics. 2011. Guangxi Statistical Yearbook 2011 Beijing;* Government of Viet Nam, Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi; Lao PDR National Statistic Center; http://www.nsc.gov.la/index2.php?option=com_content&view=article&id=42&Itemid=44; Myanmar Central Statistics Office. *Statistical Yearbook 2009*; *Yunnan Statistical Yearbook2011*.

Table 13.4: Road Freight, 2000–2010 ('000 ton)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	–	–	–	–	–	–	–	–	–	–	–
PRC, Guangxi	235,140	237,470	243,250	241,640	258,220	278,610	305,250	329,200	648,840	757,660	935,520
PRC, Yunnan	487,890	491,890	505,490	538,640	543,260	567,020	606,140	655,370	391,190	407,650	456,650
Lao PDR	1,635	–	–	–	–	2,592	–	3,322	3,659	3,707	4,730
Myanmar	1,485	–	2,041	2,081	2,108	2,349	2,380	2,399	2,416	2,411	–
Thailand	–	–	–	–	–	–	–	–	–	423,677	–
Viet Nam	144,572	164,014	192,322	225,297	264,762	298,051	338,623	403,362	455,898	513,630	585,025

– Data not available.

Source: *Guangxi Statistical Yearbook 2011*; Lao PDR National Statistic Center; http://www.nsc.gov.la/index2.php?option=com_content&view=article&id=42&Itemid=44; Myanmar Central Statistics Office. *Statistical Yearbook 2009;* Government of Viet Nam, Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi; *Yunnan Statistical Yearbook 2011.*

Table 13.5a: Number of Traffic Accidents by Country, 2000–2010

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	2,951	2,699	3,335	3,760	4,255	3,957	9,338	9,449	10.015	11.040	5.518
PRC, Guangxi	–	–	–	–	–	–	8,895	7,652	6,121	5,196	4,351
PRC, Yunnan	–	–	–	–	–	–	6,420	5,425	5,038	5,075	4,739
Lao PDR	–	2,540	2,205	3,080	1,643	1,838	2,091	–	–	–	5,802
Myanmar	4,920	–	4,831	5,369	5,905	5,755	6,643	6,939	7,204	–	–
Thailand	–	–	–	–	–	122,040	110,686	101,752	88,689	84,806	–
Viet Nam	–	–	–	–	–	–	–	–	–	–	14,442

– Data not available.

Source: Cambodia Statistical Yearbook 2008. P269; Cambodia MOPWT.2011. Annual Report; Statistical Communique on National Socioeconomic Development of Guangxi 2006-2010. Statistical Communique on National Socioeconomic Development of Yunnan 2006-2010; Lao PDR National Statistic Center; http://www.nsc.gov.la/index2.php?option=com_content&view=article&id=42&Itemid=44. (2001-2006) Sector assistanc program evaluation for the thransport sector; Myanmar Central Statistics Office. *Statistical Yearbook 2009*; Ministry of Transport, Thailand, Source: http://www.news.mot.go.th/motc/portal/graph/excel/index3.asp. National Traffic Safety Committee, MoT.

Table 13.5b: Number of Traffic Accident Casualties by Country, 2000–2010 (death, injury)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	4,790	4,643	5,836	7,153	7,967	7,922	26,146	19,200	25796	21227	11189
PRC, Guangxi	–	–	–	–	–	–	14,352	12,747	10,087	8,941	7,531
PRC, Yunnan	–	–	–	–	–	–	10,587	8,571	7,120	8,437	7,786
Lao PDR	–	4,025	2,871	3,375	2,967	3,298	3,691	–	–	–	10,767
Myanmar	8,240	–	8,806	9,253	10,859	10,903	12,656	14,254	14,479	16,873	–
Thailand	–	–	–	–	–	94,364	83,290	79,029	71,059	61,996	–
Viet Nam	–	–	–	–	–	–	–	–	–	–	22,082

– Data not available.

Source: ADB. 2010. *Transport Sector in the Lao People's Democratic Republic. Manila.* Statistical Yearbook 2008. P269; MOPWT.2011. Annual Report; Statistical Communique on National Socioeconomic Development of Guangxi 2006-2010; Statistical Communique on National Socioeconomic Development of Yunnan 2006-2010; Lao PDR National Statistic Center; http://www.nsc.gov.la/index2.php?option=com_content&view=article&id=42&Itemid=44 (2001-2006); Myanmar Central Statistics Office. *Statistical Yearbook 2009;* Ministry of Transport, Thailand, Source: http://www.news.mot.go.th/motc/portal/graph/excel/index3.asp. National Traffic Safety Committee, MoT.

Table 13.6: Railway Route Length, 2000–2010 (kilometer)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	650	650	650	650	650	650	650	650	650	650	650
PRC, Guangxi	2,012	2,711	2,745	2,738	2,738	2,729	2,735	2,734	2,731	3,126	3,205
PRC, Yunnan	1,873	1,946	2,371	2,340	2,328	2,328	2,310	2,308	2,309	2,475	2,473
Lao PDR	–	–	–	–	–	–	–	–	–	–	–
Myanmar	4,786	–	4,810	4,847	4,896	4,949	5,020	5,129	5,211	5,488	–
Thailand	4,103	4,044	4,044	4,044	4,044	–	–	–	4,429	4,429	–
Viet Nam	3142	–	2545	2652	2600	2671	3147	3147	3147	2347	2347

– Data not available.

Source: Cambodia MOP2008.Statiscal Yearbook.P260; Cambodia MPWT.2011. Achievement Report for 2010 and Target in 2011. Phnom Penh; National Bureau of Statistics of China. 2000-2010. *China Statistical Yearbook* 2000-2010. Beijing; Myanmar Central Statistics Office. *Statistical Yearbook 2009;* World Data Bank. World Bank. World Development Indicators and Global Development Finance. http://databank.worldbank.org/ddp/home.do?Step=1&id=4 (Accessed 20 June 2012). World Data Bank.

Table 13.7: Number of Railway Passengers, 2000–2010 (million persons)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	0.34	0.23	0.09	0.09	0.08	0.05	0.01	0.01	0.00	0.00	0.00
PRC, Guangxi	25.08	22.70	21.48	19.36	19.38	20.37	23.47	25.78	29.37	29.56	31.63
PRC, Yunnan	15.32	14.24	13.92	13.61	15.24	15.74	18.40	21.06	24.32	24.36	27.08
Lao PDR	–	–	–	–	–	–	–	–	–	–	–
Myanmar	60.49		61.76	56.67	58.22	69.28	72.71	75.96	73.56	71.60	–
Thailand	55.46	56.33	55.75	54.13	50.87	49.67	48.49	45.05	47.83	47.94	–
Viet Nam	9.80	10.60	10.80	11.60	12.90	12.80	11.60	11.60	11.30	11.10	11.60

– Data not available.

Source: *Asean Statistical Year Book 2006* and *Thailand Transportation Statistics* 2009; Cambodia MPWT.2011.Anual Report 2010 and Target in 2011.P1; Government of Viet Nam, Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi; *Guangxi Bureau of Statistics. 2011. Guangxi Statistical Yearbook 2011 Beijing;* Myanmar Central Statistics Office. *Statistical Yearbook 2009*; *Yunnan Statistical Yearbook 2011.*

Table 13.8: Railway Freight, 2000–2010 ('000 ton)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	332	405	389	433	297	269	317	315	233	151	3
PRC, Guangxi	58,430	63,160	66,360	65,160	78,600	85,170	93,740	105,030	98,610	95,640	70,520
PRC, Yunnan	35,210	38,590	43,120	46,340	50,820	53,000	55,420	60,210	61,040	59,450	62,680
Lao PDR	–	–	–	–	–	–	–	–	–	–	–
Myanmar	3,551	–	3,442	2,877	2,878	2,879	2,822	2,929	2,952	3,327	–
Thailand	–	–	–	–	11,760	11,579	11,055	12,807	11,133	11,517	–
Viet Nam	6,258	6,457	7,052	8,385	8,874	8,787	9,153	9,050	8,481	8,248	7,980

– Data not available.
Source: Cambodia MPWT.2011.Anual Report 2010 and Target in 2011.P1. *Guangxi Statistical Yearbook 2011*. *Yunnan Statistical Yearbook 2011.* Myanmar Central Statistics Office. Statistical Yearbook 2009. http://www.news.mot.go.th/motc/portal/graph/excel/index9.asp. Government of Viet Nam, Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi.

Table 13.9a: Number of Inland Waterway Passengers, 2000–2010 (million)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	–	–	–	–	–	–	–	–	–	–	–
PRC, Guangxi	–	–	–	–	–	–	–	–	–	–	3.90
PRC, Yunnan	2.41	2.71	3.69	3.82	4.12	5.01	5.44	5.99	6.39	6.58	7.31
Lao PDR	1.84	–	–	–	–	1.57	–	1.95	1.81	1.81	–
Myanmar	23.27	–	24.20	24.26	24.72	25.35	26.33	26.89	27.42	27.11	–
Thailand	–	–	–	–	–	–	–	–	–	–	–
Viet Nam	130.3	130.0	135.6	128.6	142.6	156.9	143.2	144.5	143.0	151.3	157.5

– Data not available.
Source: Government of Viet Nam, Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi; Lao PDR National Statistic Center; http://www.nsc.gov.la/index2.php?option=com_content&view=article&id=42&Itemid=44; Myanmar Central Statistics Office. *Statistical Yearbook 2009*; *Yunnan Statistical Yearbook 2011.*

Table 13.9b: Inland Waterway Passengers Carried, 2000–2010 (million passenger-kilometers)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	–	–	–	–	–	–	–	–	–	–	–
PRC, Guangxi	–	–	–	–	–	–	–	–	–	–	–
PRC, Yunnan	78	82	90	88	91	105	117	121	154	155	178
Lao PDR	73	–	–	–	–	40	–	51	49	49	–
Myanmar	736	–	774	774	831	948	1,054	1,160	1,261	1,320	1,452
Thailand	–	–	–	–	–	–	–	–	–	–	–
Viet Nam	2,510	2,693	2,957	2,739	3,158	3,407	3,189	3,151	3,246	3,048	3,185

– Data not available.
Source: Government of Viet Nam, Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi; Lao PDR National Statistic Center; http://www.nsc.gov.la/index2.php?option=com_content&view=article&id=42&Itemid=44; Myanmar Central Statistics Office. *Statistical Yearbook 2009*. *Yunnan Statistical Yearbook 2011.*

Table 13.9c: Freight Carried on Inland Waterways, 2000–2010 ('000 ton)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	468	503	427	534	602	743	956	1,107	–	1,198	–
PRC, Guangxi	–	–	–	–	–	–	–	–	–	–	128,320
PRC, Yunnan	1,340	1,420	1,460	1,600	2,210	2,360	2,470	2,620	3,390	3,450	4,020
Lao PDR	672	–	–	–	–	621	–	767	883	961	–
Myanmar	3,863	–	4,171	4,192	4,307	4,262	4,284	4,478	4,658	4,685	–
Thailand	–	–	–	–	–	–	–	–	–	–	–
Viet Nam	57,395	64,794	74,932	86,013	97,937	111,146	122,984	135,283	133,028	137,715	144,325

– Data not available.
Source: Cambodia MPWT.2011. Anual Report 2010 and Target in 2011.P1; Government of Viet Nam, Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi; Lao PDR National Statistic Center; http://www.nsc.gov.la/index2.php?option=com_content&view=article&id=42&Itemid=44; Myanmar Central Statistics Office. *Statistical Yearbook 2009*. *Yunnan Statistical Yearbook 2011.*

Table 13.10a: Airline Passengers Carried (domestic + overseas), 2000–2010 (thousand persons)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	–	–	125	165	162	169	256	308	211	184	312
PRC, Guangxi	3,570	3,730	4,100	3,500	4,390	5,360	6,560	8,060	8,230	10,770	12,010
PRC, Yunnan	3,450	3,800	3,930	3,770	4,640	4,950	5,991	6,723	5,994	7,214	7,538
Lao PDR	211	211	220	219	272	293	327	328	323	303	645
Myanmar	438	398	1,186	1,117	1,392	1,504	1,621	1,663	1,638	1,527	396
Thailand	17,392	17,662	18,112	16,623	20,343	18,903	20,102	21,192	19,993	19,619	20,303
Viet Nam	2,806	3,853	4,445	4,519	5,531	6,495	7,446	8,898	10,200	10,965	14,100

– Data not available.
Source: *Guangxi Statistical Yearbook 2011*; Government of Viet Nam, Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi; World Bank. http://databank.worldbank.org/ddp/home.do?Step=1&id=4 (Accessed 21 June 2012); *Yunnan Statistical Yearbook 2011.*

Table 13.10b: Air Freight Transported (domestic + overseas), 2000–2010 (million ton-kilometers)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	–	–	4.1	3.3	3.1	1.2	1.1	2.0	0.7	1.0	18.3
PRC, Guangxi	–	–	–	–	–	–	–	–	–	–	–
PRC, Yunnan	113.0	125.0	100.0	90.0	118.0	123.0	132.0	131.0	116.0	116.0	129.0
Lao PDR	1.7	1.6	1.8	1.9	2.3	2.5	2.5	2.6	2.6	2.4	0.4
Myanmar	0.8	0.9	2.0	2.1	2.5	2.7	2.8	2.9	2.8	2.6	1.6
Thailand	1,712.9	1,669.2	1,823.6	1,764.1	1,868.6	2,002.4	2,106.9	2,454.6	2,289.0	2,132.6	3,132.8
Viet Nam	114.1	158.3	171.8	210.6	235.8	239.3	269.4	279.9	295.6	316.6	429.2

– Data not available.

Source: Government of Viet Nam, Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi; World Bank. http://databank.worldbank.org/ddp/home.do?Step=1&id=4 (Accessed 21 June 2012). *Yunnan Statistical Yearbook 2011.*

Table 13.11: Transport Share of GDP, 2000–2010 (%)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	–	7.0	6.9	6.7	7.1	7.4	7.1	6.9	7.4	7.5	7.5
PRC, Guangxi	6.0	6.4	6.9	6.5	6.1	5.4	5.0	4.6	4.8	4.9	4.8
PRC, Yunnan	6.1	6.7	–	7.0	7.2	4.7	4.4	4.1	3.9	2.9	3
Lao PDR	–	–	–	–	–	–	3.0	7.4	8.1	5.5	7
Myanmar	5.7	5.1	6.0	9.4	9.4	10.4	11.0	10.9	11.9	–	–
Thailand	8.0	8.3	8.2	7.7	7.6	7.3	7.3	7.3	7.1	7.2	6.8
Viet Nam	–	–	–	–	–	3.3	–	3.4	3.4	3.3	3.3

– Data not available.

Source: ADB. Thailand Economic Key Indicators 2010; Cambodia MOE. 2010. Cambodia Macroeconomic Framework 2000-2011; CSO-Myanmar, *Statistical Yearbook 2006 and 2009* (National Account at Current Price); *Guangxi Statistical Yearbook 2011*; Government of Viet Nam, Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi; National Bureau of Statistics of China. 2001-2011. *China Statistical Yearbook 2001-2011;* Lao PDR National Statistic, 2011. http://www.nsc.gov.la/index2.php?option=com_content&view=article&id=31&Itemid=32.

Table 13.12a: Pump Price for Diesel Fuel by Country, 2000–2010 ($ per liter)

	2000	2002	2004	2006	2008	2010
Cambodia	0.44	0.44	0.61	0.78	0.89	0.98
PRC	0.45	0.37	0.43	0.61	1.01	1.04
Lao PDR	0.32	0.30	0.48	0.73	0.76	0.97
Myanmar	0.12	0.28	0.10	0.75	0.52	0.80
Thailand	0.35	0.32	0.37	0.65	0.64	0.95
Viet Nam	0.27	0.27	0.32	0.53	0.77	0.77

Source: Federal Ministry for Economic Cooperation and Development, German Technical Cooperation. 2009. International Fuel Prices 2009. Eschborn; Federal Ministry for Economic Cooperation and Development, German Technical Cooperation. 2010. International Fuel Prices 2010-2011: Data Review. http://www.gtz.de/de/dokumente/giz2011-international-fuel-prices-2010-2011-data-preview.pdf .

Table 13.12b: Pump Price for Gasoline by Country, 2000–2010 ($ per liter)

	2000	2002	2004	2006	2008	2010
Cambodia	0.61	0.63	0.79	1.01	0.94	1.15
PRC	0.40	0.42	0.48	0.69	0.99	1.11
Lao PDR	0.41	0.36	0.54	0.86	0.92	1.26
Myanmar	0.33	0.36	0.12	0.66	0.43	0.80
Thailand	0.39	0.36	0.54	0.70	0.87	1.41
Viet Nam	0.38	0.34	0.48	0.67	0.80	0.88

Source: Ministry of Germany, Federal Ministry for Economic Cooperation and Development, German Technical Cooperation. 2009. International Fuel Prices 2009. Eschborn; Ministry of Germany, Federal Ministry for Economic Cooperation and Development, German Technical Cooperation. 2010. International Fuel Prices 2010-2011: Data Review. http://www.gtz.de/de/dokumente/giz2011-international-fuel-prices-2010-2011-data-preview.pdf .

Table 13.13: Motor vehicles per 1,000 Persons, 2003–2009

	2003	2004	2005	2006	2007	2008	2009
Cambodia	–	20	21	–	–	–	–
PRC	15	20	24	28	32	37	47
Lao PDR	–	–	–	–	20	–	–
Myanmar	5	–	6	6	–	7	7
Thailand	–	–	146	134	–	–	–
Viet Nam	–	–	–	–	13	–	–

Source: World Bank. http://databank.worldbank.org/ddp/home.do?Step=3&id=4 (AAccessed 21 June 2012).

Chapter 14: Tourism

Table 14.1: Top 10 GMS Tourist Destinations

Name	Location	Reason to Visit
Cambodia		
Angkor	Siem Reap	One of the most spectacular ancient sites on earth. A vast temple complex featuring the remains of several capitals of the Khmer Empire.
Banteay Srei	Siem Reap	A largely red sandstone temple with elaborate decorative wall carvings.
Koh Ker Temple	Preah Vihear	The capital of the Khmer empire for a very brief period, 928 to 944 AD.
Kratie	Kratie	There are old French colonial buildings and the rare Irrawaddy dolphins.
Bokor Hill Station	Kampot	Built by the French in the 1920s; abandoned in the 1940s. The abandoned buildings have an eerie, ghost-town feel, and now are under reconstruction.
Silver Pagoda	Phnom Penh	The pagoda houses many national treasures, such as gold and jeweled Buddha statues and the richly colored and detailed mural of the Ramayana myth, painted in 1903–04.
Tonle Sap	Kampong Chhnang, Pursat, Battambang, Kampong Thom, Siem Reap and Banteay Meanchey	The largest freshwater lake in Southeast Asia and an ecological hot spot that was designated as a UNESCO biosphere. Home to many ethnic Vietnamese and numerous Cham communities, living in floating villages around the lake
Sihanoukvill	Preah Sihanouk	Port city and beach resort, white-sand beaches and several undeveloped tropical islands.
Phrea Vihear	Preah Vihear	Khmer temple situated atop a 525 meter (1,722 ft) cliff in the Dângrêk Mountains.
Siem Reap	Siem Reap	Fast growing city, wide range of hotels; large selection of restaurants offering many kinds of food.
PRC, Guangxi		
Lijiang River	Guilin city	Beautiful waters, natural landscape.
Yangsuo	Yangsuo county of Guilin city	Green mountains, beautiful waters, strange hills and mysterious caverns
Huangyao Ancient Town	Zhaoping county of Hezhou city	Famous for its culture, which is over 1 thousand years old.
Silver Beach	Beihai city	Beautiful beaches, marine tourism.
Weizhou Island	Beihai city	The largest and youngest volcanic island in the PRC.
Tongling Grand Canyon	Jingxi county of Baise city	Fantastic waterfalls, spacious water and outstanding scenic spots of quiet beauty, natural scenic views.
Detian Waterfall	Daxin county of Chongzuo city	The biggest cross-border waterfall in Asia, always changing, enticing, and entrancing.
Sanniang Bay	Qinzhou city	Moving legends, beautiful beach, and occasional dolphins.
Dragon Ridge Terrace Scenic Spot	Longsheng county of Guilin city	Honored as "the best terrace in the world".
Bama longevity town	Bama county of Hechi city	Original forest, rural scenery, and folk customs.
Damingshan Mountain Scenic Spot	Nanning city	Exhibits different seasons simultaneously and has special attractions, such as haze in spring, waterfall in summer, cloud in fall, and snow in winter, renowned as the “miraculous mountain in Lingnan area and fairyland of the world”.
PRC, Yunnan		
Lijiang Ancient city	Lijiang city	A Naxi minority city, which has been a UNESCO World Heritage Site since 1997, a well-preserved old city of ethnic minorities with brilliant culture.
Stone Forest	Kunming city	A series of karst outcrops, known since the Ming Dynasty as the “First Wonder of the World.”
Xishuangbanna Tropical Botanical Garden	Xishuangbanna state	National scenic resort, famous for its natural and cultural attractions, with tropical rainforests and the immense number of plant and animal species.
Jade Dragon Snow Mountain	Lijiang city	Widespread legends and myths of the Naxi ethnic minority and the unclimbed Shanzidou.
Shangri-La	Diqing city	An ethnic Tibetan township and county set high in Yunnan's northwestern mountains.
Lugu Lake	Ninglang county of Lijiang city	Minority ethnic groups and unique social culture termed the “Women’s World.”
Yuanyang Hani Rice Terraced	Yuanyang county of Honghe city	Renowned for its rice terraces, claimed to be the world's largest and most spectacular. Also famous for the Hani ethnic group customs.
Three Pagodas	Dali city	Unique ancient Buddhist architecture with a long history.
Erhai Lake and Cangshan Mountain	Dali city	A large lake with clear water that reflects land and sky; the entire region is unusually beautiful and Cangshan Moutain is noted for its very rich, diverse flora.
Jiuxiang	Yiliang county of Kunming city	National scenic resort, with ethnic culture and outstanding natural scenic views.

Table 14.1: continued

Name	Location	Reason to Visit
Lao PDR		
Luangprabang	Luangprabang Province	UNESCO World Heritage City, Buddhist temples (wats), French-era houses, and many opportunities for active travel.
Wat Phou	Champasack Province	UNESCO World Heritage site, impressive hillside ruin of a temple that predates Angor Wat.
Vientiane Capital	Vientiane Capital	Quiet city, beautiful temples, French colonial buildings.
Vang Vieng	Vientiane Province	Beatiful river and karst topography.
Plain of Jars	Xienkhuang Province	Vast green plateau where several hundred huge jars are scattered around.
Nam Ha National Biodiversity Conservation Area	Luangnamtha Province	Ecotourism.
Si Phan Don region	Champasack Province	Spectacular scenery, waterfall, peaceful Lao way of life, and Irrawaddy dolphins.
Konglor cave	Khammuan Province	Limestone cave.
Bolaven Plateau	Saravan Province	Center for the Mon-Khmer culture, beautiful area of waterfalls and forests.
Myanmar		
Shwedagon Pagoda	Yangon	Yangon, the cosmopolitan capital city, still maintains its colonial charm with wide tree-lined avenues, tranquil lakes, and gracious turn-of-the-century architecture, including the Shwedagon Pagoda.
Mandalay	Mandalay	The cultural heart of Myanmar. The well-known places are the palace, the Great Mahamuni Image, Kuthodaw pagoda, Kyauktawgyi pagoda, Mandalay Hill, U Bein Bridge, and some famous ancient monasteries, such as Shwenanadaw and Atumashi.
Bagan	about 145 km southwest of Mandalay	There are as many as 4,400 pagodas and temples in Bagan. Most of the buildings were constructed during the height of first kingdom (11th and 13th centuries).
Inle Lake	Southern Shan state	The lake sits at 900 meters above sea level and is famous for its leg rowers, floating markets and prolific birdlife.
Mrauk U	Rakhine State	Not far from Sittwe on the Arakan Coast, the 15th century ruins of Mrauk-U were once the capital of a flourishing Rhakine Kingdom.
Golden Rock (Kyaikhtiyo Pagoda)	Mon state	A large natural rock, covered in gold, situated on the edge of a natural rock pillar. A small pagoda was built on top of the rock.
Myeik Archipelago	Myeik, Tanintharyi Region	Myeik Archipelago, located in the southernmost part of Myanmar, comprises over 800 beautiful islands.
Two Treasures of Kachin State	Kachin state	Ice-capped mountains, white-water rivers, and protected wild life sanctuaries as well as precious minerals and gems.
Ngapali Beach	Rakhine State	Miles of empty, white-sand beaches, brilliant turquoise seas, all backed by towering coconut palms.
Pidaya Cave, Kalaw	Southern Shan state	Pindaya is famous for its limestone caves as well as temples, Danu Village and pagodas.
Thailand		
Grand Palace of Bangkok	Bangkok	The Grand Palace is a large compound built in 1782, consisting of more than one hundred buildings, with beautiful gilded architecture, intricate carved decorations and fantastic statues depicting both mythical and the divine.
Wat Arun	Bangkok	A first-class royal temple and well known landmark of Bangkok.
Ancient City of Ayutthaya	Ayutthaya	The ancient city of Ayutthaya or Phra Nakhon Si Ayutthaya was built by King U-Thong in 1350 and was the Thai capital for 417 years, ruled by 33 successive kings, before it was destroyed by war in 1767.
Sukhothai Historic Park	Sukhothai	Sukhothai ancient city was built in 1238 and is considered to be the first capital of Thailand; it thrived between the 13th and 14th centuries. This ancient city is surrounded by walls that form a rectangle shape and houses numerous Buddhist shrines, Buddha statues, former palaces and temples.
Doi Suthep-Doi Pui National Park	Chiang Mai	Doi Suthep-Dui Pui National Park, one of the most visited national parks in Thailand.
Chiang Mai Night Bazaar	Chiang Mai	Chiang Mai Night Bazaar, a huge market located in the heart of the city. The night market is famous for its handicrafts and portrait paintings.
Railay Beach	Krabi	A beach accessible only by boat, cut off from the mainland by a huge limestone rock formation. The area has lush green tropical forests, mountains, beautiful beaches, crystal clear water, smooth golden sand, and fascinating limestone rock formations.
Phi Phi Island	Krabi	The islands are part of a National Marine Park in Krabi Province which can be reached by speedboat from Krabi town or Phuket. Phi Phi island is surrounded by azure, deep, crystal-clear water, countless marine creatures, and beautiful beaches and coral reefs.
Phang Nga Bay National Park	Phang Nga	This bay is popular for its unique characteristics of limestone cliffs that rise vertically from the water. The Koh Pannyi and the James Bond Island are the major tourist highlights of this bay.
The Bridge on the River Kwai	Kanchanaburi	First built in 1942 as a part of the railway between Thailand and Myanmar by British and Asian prisoners for the Japanese army.

Table 14.1: continued

Name	Location	Reason to Visit
Viet Nam		
Ha Long Bay	Quang Ninh Province	World Heritage Site, thousands of islands, each topped with thick jungle vegetation, forming a spectacular seascape of limestone pillars.
Complex of Hue Monuments	Hue city, Thua Thien Hue Province	World Heritage Site, established as the capital of unified Viet Nam in 1802, Hué was not only the political but also the cultural and religious centre under the Nguyen dynasty until 1945.
Ha Noi	Ha Noi	Ha Noi preserves many ancient architectural works, including the Old Quarter and over 600 pagodas and temples.
Hoi An ancient town	Quang Nam Province	World Heritage Site and called the "Venice of Viet Nam" because of the narrow canals that cut through part of the town. Its buildings and its street plan reflect the influences, both indigenous and foreign, that have combined to produce this unique heritage site. -
Sapa townlet	Lao Cai Province	Sapa has many natural sights, such as Ham Rong Mountain, Silver Waterfall, Rattan Bridge, Bamboo Forest, rice terraces, and Ta Phin Cave.
Phu Quoc island	Kien Giang Province	The island features pristine tropical forests, undamaged coral reefs and great beaches.
Cu Chi Tunnel		The Cu Chi Tunnels are an immense network of connecting war-torn underground tunnels located about 40 km northwest of Ho Chi Minh City.
My Son Sanctuary		World Heritage Site, a unique culture which owed its spiritual origins to Indian Hinduism developed on the coast of contemporary Viet Nam, with remains of a series of impressive tower-temples.
Mui Ne	Phan Thiet city, Binh Thuan Province	A popular destination in Viet Nam for kite- and windsurfing, famous sand dunes located a short distance north of the town.
Nha Trang beach	Khanh Hoa Province	Nha Trang is Viet Nam's most popular seaside resort town located along the second most beautiful bay in the country.

Source: China Discovery. http://www.chinadiscover.net/china-tour/guilinguide/attractions-guangxi.htm; China Scenic Spot Net. http://www.fjms.net/Masterpiece/?ID=4; GOBAGAN.COM. http://www.gobagan.com/go/famous_locations; Go Travel. http://theplacesmusttravel.blogspot.com/2011/05/10-most-favourite-tourist-destinations.html (Accessed 7 December 2011); Mystical Myanmar. Destination Myanmar. http://www.myanmar-tourism.com; Qunar.com. http://place.qunar.com/list/sight/27095_2_0. html . http://www.ilvping.com/gx/find-area-104105-cp-1.html; Touropia: The Travel List Website. http://www.touropia.com/category/asia/; Travel China Guide. http://www.travelchinaguide.com/attraction/yunnan/kunming/stone_forest.htm; UNESCO World Heritage Center. The List. http://whc.unesco.org/en/list/; Viet Nam Tourism. Destination. http://www.vietnamtourism.com/e_pages/tourist/travel.asp; Visit Mekong. Myanmar. Myanmar Area Guides. http://www.visit-mekong.com/myanmar/pindaya.htm.

Table 14.2a: International Tourist Arrivals, 2000–2010

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	466,365	604,919	786,524	701,014	1,055,202	1,421,615	1,700,041	2,015,128	2,125,465	2,161,577	2,508,289
PRC, Guangxi	1240265	1,245,100	1,302,200	645,300	1,125,300	1,461,605	1,676,403	2,051,779	2,010,200	2,098,516	2,502,363
PRC, Yunnan	1,001,141	1,100,000	1,303,550	1,000,100	1,100,994	1,502,817	1,810,017	2,219,030	2,502,170	2,844,902	3,291,532
Lao PDR	737,208	673,823	735,662	636,361	894,806	1,095,315	1,215,106	1,623,943	1,736,787	2,008,363	2,513,028
Myanmar	–	–	217,212	205610	241,938	232,218	263,514	248,076	193,319	227,400	310,688
Thailand	9,508,623	10,061,950	10,799,067	10,004,453	11,650,703	11,516,936	13,821,802	14,464,228	14,584,220	14,149,841	15,936,400
Viet Nam	2,140,100	2,330,800	2,628,200	2,429,600	2,927,876	3,467,757	3,583,486	4,171,564	4,253,740	3,772,359	5,049,855

– Data not available.

Source: 2000, 2005 to 2010 data from Yunnan Statistical Yearbook 2007 and 2011. 2001-2004 data from Statistical Communique on National Eco-social Development of Yunnan; Kingdom of Cambodia, Ministry of Tourism, Statistics and Tourism Information Department. 2010; Lao National Tourism Administration, Planning and Cooperation Department, Tourism Statistics Division. 2010 Statistical Report on Tourism in Laos; Ministry of Culture, Sports and Tourism, Viet Nam National Administration of Tourism. http://www.vietnamtourism.gov.vn/english/index.php?cat=012010&itemid=299; Ministry of Hotel and Tourism, Myanmar. Department of Tourism. www.tourism.go.th: data from Immigration Bureau, Police Department; Tourism Statistics: Annual Report 2010. 2000,2005,2009 and 2010 data from Guangxi *Statistical Yearbook 2008 and2011. 2001-2004,2006-2008* data from Statistical Communique on National Eco-social Development of Guangxi.

Table 14.2b: Growth in GMS International Tourist Arrivals, 2000–2010 (annual increase, %)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	26.82	29.71	30.02	-10.87	50.53	34.72	19.59	18.53	5.48	1.70	16.04
PRC, Guangxi	–	0.39	4.59	-50.45	74.38	29.89	14.70	22.39	-2.03	4.39	19.24
PRC, Yunnan	–	9.87	18.50	-23.28	10.09	36.50	20.44	22.60	12.76	13.70	15.70
Lao PDR	20	-8.60	9.18	-13.50	40.61	22.41	10.94	33.65	6.95	15.64	25.13
Myanamar	–	–	–	-5.34	17.67	-4.02	13.48	-5.86	-22.07	17.63	36.63
Thailand	10.82	5.82	7.33	-7.36	16.46	-1.15	20.01	4.65	0.83	-2.98	12.63
Viet Nam	20.1	8.91	12.76	-7.56	20.51	18.44	3.34	16.41	1.97	-11.32	33.86

– Data not available.

Note : calculated from arrival data (Table 14.3a)

Table 14.3: International Tourist Receipts, 2000–2010 ($ million)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	228	304	379	347	578	832	1,049	1,400	1,595	1,567	1,786
PRC, Guangxi	262	248	264	–	238	320	404	–	602	643	807
PRC, Yunnan	339	370	419	340	422	528	658	860	1,008	1,172	1,324
Lao PDR	114	104	113	87	119	147	173	233	276	268	382
Myanmar	–	–	–	–	–	–	164.0	182.0	165.0	196.0	254.0
Thailand	7,112	6,731	7,530	7,455	9,556	9,134	12,732	15,869	–	14,882	18,709
Viet Nam	–	–	–	–	–	–	–	–	–	–	–

– Data not available.

Source: 2010 Statistical Report on Tourism in Laos. Ministry of Hotel and Tourism, Myanmar. calculated based on Department of Tourism, converted Baht; into US$ by ADB exchange rate Ministry of Tourism.2010. Tourism Statistics. Annual Report 2010. Phnom Penh. Page.vi; Statistical Communique on National Socio economy l Development of Guangxi; Statistical Communique on National Eco-social Development of Yunnan; Lao National Tourism Administration, Planning and Cooperation Department, Tourism Statistics Division.

Table 14.4: Tourists' Average Length of Stay, 2000–2010 (day)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	5.50	5.50	5.80	5.50	6.30	6.30	6.50	6.50	6.65	6.45	6.45
PRC, Guangxi	–	–	–	–	–	–	–	–	–	–	–
PRC, Yunnan	–	–	–	–	–	–	–	–	–	–	–
Lao PDR	5.5	8	6.5	6	6.5	7	7	7	6.5	7	7
Myanmar	–	–	–	–	–	–	7	7.5	9	8.5	8
Thailand	7.77	7.93	7.98	8.19	8.13	8.2	8.62	9.19		8.99	9.12
Viet Nam	–	–	–	–	–	–	–	–	–	–	–

– Data not available.

Source: Kingdom of Cambodia, Ministry of Tourism, Statistics and Tourism Information Department. 2010; Ministry of Hotel and Tourism, Myanmar. Department of Tourism. www.tourism.go.th: data from Immigration Bureau, Police Department; Tourism Statistics: Annual Report 2010. Lao National Tourism Administration, Planning and Cooperation Department, Tourism Statistics Division. 2010 Statistical Report on Tourism in Laos.

Table 14.5: Average Expenditure per Tourist per day, 2000–2010 ($)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	89	91	83	90	87	93	95	107	113	112	110
PRC, Guangxi	212	–	–	–	–	216	235	268	–	306	323
PRC, Yunnan	–	–	–	–	–	–	–	–	–	–	–
Lao PDR	28	19	24	23	20	19	20	21	24	19	22
Myanmar	–	–	–	–	–	–	94	98	95	95	102
Thailand	96	84	87	91	101	97	107	119	–	117	129
Viet Nam	–	–	–	75	–	76	–	84	–	91	–

– Data not available.

Source: calculated based on above data tables; Guangxi Statistical Yearbook 2008 and 2011. calculated based on above data tables; Ministry of Hotel and Tourism, Myanmar. calculated based on Department of Tourism, converted Baht into US$ by ADB exchange rate; Ministry of Culture, Sports and Tourism, Viet Nam National Administration of Tourism. http://www.vietnamtourism.gov.vn/english/index.php?cat=012010&itemid=299.

Chapter 15: Human Resource Development

Table 15.1a: Primary Education, Number of Pupils, 2000–2010

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	2,248,109	2,431,142	2,728,698	2,772,113	2,762,882	2,695,372	2,582,250	2,479,644	2,340,606	2,289,759	2,272,527
PRC, Guangxi	4,527,900	–	5,100,400	4,918,500	4,705,600	4,527,900	4,601,200	4,524,800	4,448,100	4,367,800	4,300,600
PRC, Yunnan	4,720,600	4,605,000	4,509,300	4,418,800	4,406,500	4,412,300	4,522,600	4,533,100	4,510,400	4,441,400	4,352,100
Lao PDR	831,521	828,113	852,857	875,300	884,629	890,821	891,881	891,807	900,817	908,880	916,341
Myanmar	4,857,955	4,781,543	4,778,851	4,889,325	4,932,646	4,948,198	4,969,445	5,013,582	5,109,630	5,094,623	5,125,942
Thailand	6,100,647	6,023,714	6,056,420	5,997,390	6,054,517	5,974,615	5,843,512	5,703,756	5,564,622	5,370,546	–
Viet Nam	10,063,025	9,751,434	9,336,913	8,841,004	8,350,191	7,773,484	7,317,813	7,041,312	6,871,795	6,745,016	6,922,624

– Data not available.

Source: Guangxi Bureau of Statistics. *Guangxi Statistical Yearbook 2005,2008,2009, 2011*. Beijing; World Bank. Data by Indicators. http://data.worldbank.org/indicator (Accessed by 28th March 2012); Yunnan Bureau of Statistics. 2011. *Yunnan Statistical Yearbook 2011.* Beijing.

Table 15.1b: Secondary Education, Number of Pupils, 2000–2010

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	351,357	396,876	475,637	560,197	631,508	–	811,797	875,120	929,121	940,244	949,195
PRC, Guangxi	2,856,300	–	2,987,100	3,035,000	3,061,500	3,038,700	3,030,100	2,974,500	2,876,400	2,818,300	2,757,900
PRC, Yunnan	1,859,700	2,004,600	2,151,400	2,284,600	2,350,600	2,388,800	2,447,000	2,517,700	2,594,800	2,649,700	2,706,300
Lao PDR	264,586	288,389	320,275	353,362	379,579	393,856	395,382	403,833	412,375	421,899	433,427
Myanmar	2,268,402	2,301,919	2,372,593	2,382,608	2,544,437	2,589,312	2,696,307	2,686,198	2,828,868	2,812,866	2,852,447
Thailand	–	4,072,108	4,150,184	4,128,232	4,253,380	4,533,173	4,530,029	4,789,339	4,728,761	4,769,211	4,807,093
Viet Nam	7,926,126	8,318,192	8,783,340	9,265,801	9,588,698	9,939,319	9,975,113	9,845,407	9,543,007	–	–

– Data not available.

Source: Guangxi Bureau of Statistics. *Guangxi Statistical Yearbook 2005,2008,2009, 2011.* Beijing; World Bank. Data by Indicators. http://data.worldbank.org/indicator (Accessed by 28th March 2012); Yunnan Bureau of Statistics. 2011. *Yunnan Statistical Yearbook 2011.* Beijing.

Table 15.1c: Tertiary Education, Number of Students per 100,000 Inhabitants

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	182	205	255	339	352	435	576	692	908	–	–
PRC, Guangxi	460	–	750	900	910	993	1,153	1,260	1,352	1,385	1,569
PRC, Yunnan	2,013	–	–	–	–	–	–	–	–	–	5,778
Lao PDR	274	318	430	517	611	845	995	1,295	1,521	–	–
Myanmar	–	1,246	–	–	–	–	–	1,100	–	–	–
Thailand	3,052	3,326	3,382	3,422	3,457	3,587	3,524	3,742	3,606	3,562	3,553
Viet Nam	943	954	990	1,036	1,645	1,660	1,730	1,903	1,961	2,078	2,339

– Data not available.

Source: Guangxi Bureau of Statistics. *Guangxi Statistical Yearbook 2005,2008,2009, 2011.* Beijing; UNESCO Institute for Statistics. http://stats.uis.unesco.org (Accessed by 28th March 2012); Yunnan Bureau of Statistics. 2011. *Yunnan Statistical Yearbook 2011.* Beijing.

Table 15.2: Central Government Expenditure for Education, 2000–2010 (local currency, billion)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	183.20	209.20	289.70	300.50	325.90	350.80	445.60	491.40	606.50	708.20	824.90
PRC, Guangxi	4.88	–	–	–	9.88	11.47	14.60	18.94	25.12	29.66	36.68
PRC, Yunnan	6.23	7.63	10.43	11.74	11.18	12.23	15.04	19.05	21.20	30.82	37.48
Lao PDR	132.7	254.60	–	–	–	–	–	–	–	–	–
Myanmar	–	–	–	–	–	–	–	–	–	–	–
Thailand	198.4	199.80	226.50	235.30	263.00	265.80	276.50	332.00	364.50	397.20	423.40
Viet Nam	–	–	–	–	–	28,611.00	37,332.00	53,774.00	63,547.00	78,105.00	–

– Data not available.

Source: ADB Statistical Database System. https://sdbs.adb.org/sdbs/index.jsp. (Accessed by 28th March 2012); Government of Viet Nam, Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi; Guangxi Bureau of Statistics. *Guangxi Statistical Yearbook 2005,2008,2009, 2011*. Beijing; Yunnan Bureau of Statistics. *Yunnan Statistical Yearbook 2008, 2009, 2011.* Beijing.

Table 15.3a: Number of Primary Schools, 2000–2010

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	5,274	5,468	5,741	5,915	6,063	6,180	6,277	6,365	6,476	6,565	6767*
PRC, Guangxi	16,109	16,100	16,070	16,102	15,759	15,500	15,152	14,873	14,590	14,290	13,942
PRC, Yunnan	22,151	21,315	20,595	20,296	19,725	18,747	18,127	17,163	16,573	15,826	14,059
Lao PDR	8,161	8,184	–	–	–	8,573	8,654	–	–	8,871	8,968
Myanmar	–	–	–	36,095	35,267	36,213	36,206	36,205	36,144	36,159	–
Thailand	–	–	–	–	–	–	–	–	–	–	–
Viet Nam	–	–	–	–	–	14,688	–	14,933	15,051	15,172	15,242

– Data not available.

Source: Government of Lao PDR, Ministry of Planning and Investment, Department of Statistics. 2011. *Statistical Yearbook 2010*. Vientiane (Capital); Government of Myanmar, Ministry of National Planning and Economic development, Central Statistical Organization.*Statistical Yearbook 2006,2009*. Government of Viet Nam, Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010*. Ha Noi; Guangxi Bureau of Statistics. *Guangxi Statistical Yearbook 2005,2008,2009, 2011*. Beijing; People's Government of Yunnan Province, Yunnan Bureau of Statistics. 2011. *Yunnan Statistical Yearbook 2011.* Beijing; Royal Government of Cambodia, Ministry of Planning. 2008. *Statistical Yearbook 2008*. Phnom Penh;

Table 15.3b: Number of Secondary Schools, 2000–2010

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	503	518	542	594	698	810	922	1129	1321	1471	1596*
PRC, Guangxi	3,019	–	2,884	2,990	2,937	2,887	2,776	2,664	2,568	2,497	2,437
PRC, Yunnan	2,236	2,276	2,267	2,275	2,280	2,257	2,266	2,281	2,272	2,248	2,183
Lao PDR	811	831.0	–	–	–	672	670	–	–	757	865
Myanmar	–	–	–	3,095	3,138	3,231	3,241	3,245	3,254	3,242	–
Thailand	–	–	–	–	–	–	–	–	–	–	–
Viet Nam	–	–	–	–	–	12,539	–	12,965	13,063	13,236	13,351

– Data not available.

Source: Government of Lao PDR, Ministry of Planning and Investment, Department of Statistics. *Statistical Yearbook2001, 2006, 2010.* Vientiane (Capital); Government of Myanmar, Ministry of National Planning and Economic development, Central Statistical Organization. *Statistical Yearbook 2006,2009.* Government of Viet Nam, Ministry of Planning and Investment, General Statistics Office. 2011. *Statistical Yearbook of Viet Nam 2010.* Ha Noi; Guangxi Bureau of Statistics. *Guangxi Statistical Yearbook 2005,2008,2009, 2011.* Beijing; Royal Government of Cambodia, Ministry of Planning. 2008. Statistical Yearbook 2008. Phnom Penh; Yunnan Bureau of Statistics. 2011. *Yunnan Statistical Yearbook 2011.* Beijing;

Chapter 16: Climate Change and Natural Disasters

Table 16.1a: Carbon Dioxide Emissions, 2000–2009 ('000 ton CO_2)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Cambodia	2,255	2,644	2,860	3,128	3,498	3,722	4,074	4,437	4,954	4,613
Lao PDR	972	902	1,177	1,129	1,423	1,434	1,580	1,668	1,742	1,811
Myanmar	8,889	7,349	8,174	9,611	11,470	14,543	13,029	13,047	12,772	11,093
Thailand	201,549	217,086	230,636	245,674	267,761	275,164	283,987	275,634	283,723	271,721
Viet Nam	53,142	61,140	70,806	78,767	100,945	103,325	82,768	111,788	128,371	142,258

Source: UN Millennium Development Goals Indicators. http://unstats.un.org/unsd/mdg/Data.aspx (Accessed 19 July 2012).

Table 16.1b: Carbon Dioxide Emissions per Person, 2000–2009 (ton)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Cambodia	0.1812	0.209	0.2227	0.2402	0.2651	0.2786	0.3014	0.3246	0.3584	0.3300
Lao PDR	0.1828	0.1668	0.2141	0.2023	0.2511	0.2492	0.2705	0.2812	0.2893	0.2963
Myanmar	0.1977	0.1621	0.1792	0.2096	0.2490	0.3140	0.2796	0.2781	0.2703	0.2330
Thailand	3.1913	3.3973	3.5678	3.7582	4.0533	4.1255	4.2212	4.0656	4.1560	3.9548
Viet Nam	0.6748	0.7678	0.8796	0.9679	1.2271	1.2425	0.9844	1.3150	1.4935	1.6370

Source: Addressing Climate Change in Guangxi and http://gov.finance.sina.com.cn/chanquan/2010-08-17/89096.html.;UN Millennium Development Goals Indicators. http://unstats.un.org/unsd/mdg/Data.aspx (Accessed 19 July 2012),

Table 16.2a: Natural Hazards, 2000–2010–Cambodia

Indicator	unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Forest Fire	'000 hectare	0	0	0	0	0	0	0	0	0	0	1.0
	number	0	0	0	0	0	0	0	0	0	0	1
Landslides	'000 hectare	–	–	–	–	–	–	–	–	–	–	–
	number	–	–	–	–	–	–	–	–	–	–	–
Flash Flood	'000 hectare	668.0	256.6	45.0	0.0	0.0	1.3	1.1	18.8	18.2	0.0	100.5
	number	1	1	1	0	0	1	1	1	1	0	1
Earthquakes	'000 hectare	–	–	–	–	–	–	–	–	–	–	–
	number	–	–	–	–	–	–	–	–	–	–	–
Typhoon	'000 hectare	0	0	0	0	0	0	0	0	0	57.6	0
	number	0	0	0	0	0	0	0	0	0	1	0
Drought	'000 hectare	0	111.4	62.7	0.0	247.4	0.0	0.0	20.9	0.0	58.0	22.9
	number	0	1	1	0	1	0	0	1	0	1	1

– Data not available.

Source: National Committee for Disaster Management (NCDM). *Summary Annual Report Disaster Events in Cambodia, 2000-2010*. Phnom Penh.

Table 16.2b: Natural Hazards, 2000–2010–Guangxi, PRC

Indicator	unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Forest fires	'000 hectare	1.69	0.76	1.71	4.81	4.98	2.47	1.34	2.27	1.42	1.19	1.60
	number	311	224	468	1015	1217	688	549	737	659	560	715
Landslides	'000 hectare	–	–	–	–	–	–	–	–	–	–	–
	number	–	–	–	–	–	656	–	–	–	–	597
Flash floods	'000 ha	233.92	1,038.11	963.40	655.46	475.70	554.54	867.58	308.68	1,291.82	483.31	598.25
	number	–	8	10	10	5	3	8	5	15	6	10
Earthquakes	'000 hectare	–	–	–	–	–	–	–	–	–	–	–
	number	2	0	0	2	0	1	0	2	0	0	0
Typhoons	'000 hectare	–	–	–	–	–	–	–	–	–	19	–
	number	2	5	4	5	0	3	6	2	4	6	3
Drought	'000 hectare	0	111.4	62.7	0.0	247.4	0.0	0.0	20.9	0.0	58.0	22.9
	number	0	1	1	0	1	0	0	1	0	1	1

– Data not available.

Source: Guangxi Forestry Department. Guangxi Water resource Department, Guangxi Seismological Bureau, Guangxi Meteorological Bureau. 2005 data from:Report on the State of Environment In Guangxi 2005.

Table 16.2c: Natural Hazards, 2000–2010–Yunnan, PRC

Indicator	unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Forest fires	'000 hectare	0.20	2.30	–	2.17	1.26	2.35	2.86	1.80	0.94	2.22	3.23
	number	192	673	–	786	550	665	602	498	287	510	569
Landslides	'000 hectare	–	–	–	–	–	–	–	–	–	–	–
	number	233	11	1056		725	5	74	80	70	50	17
Flash floods	'000 ha of agricutural land	375.5	392	448.03	226.98	381.73	251.24	297.86	354.04	450.4	148.89	209
	number of counties/ districts	126	129	117	114	123	125	123	127	129	121	105
Earthquakes (>4.0)	'000 hectare	–	–	–	–	–	–	–	–	–	–	–
	number	26	42	11	21	24	16	17	23	36	30	9
Typhoons	'000 hectare	–	–	–	–	–	–	–	–	–	–	–
	number	–	–	–	–	–	–	–	–	–	–	–

– Data not available.
Source: Civil Affairs Department of Yunnan Province; National Bureau of Statistics of China. 2011. *China Statistical Yearbook 2011.*

Table 16.2d: Natural Hazards, 2000–2010–Myanmar

Indicator	unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Forest fires	'000 hectare	2,452.839	–	–	–	–	1,091.083	–	–	1,001.663	–	434.687
	number	0	–	–	–	–	–	–	–	–	–	–
Landslides	'000 hectare	–	–	–	–	–	–	–	–	–	–	–
	number	–	–	–	–	–	–	–	–	–	–	–
Flash floods	'000 ha	–	–	–	–	–	–	–	–	–	–	–
	number	13	–	37	10	18	9	25	12	7	–	–
Earthquakes	'000 hectare	–	–	–	–	–	–	–	–	–	–	–
	number	10	7	11	12	60	39	29	12	9	36	15
Typhoons	'000 hectare	–	–	–	–	–	–	–	–	–	–	–
	number	9	–	10	16	22	12	26	35	27	–	–

– Data not available.
Source: FAO 2010. *Global Forest Resources Assessment 2010*: Country Report. Rome; Government of Myanmar, Ministry of National Planning and Economic development, Central Statistical Organization. 2010. *Statistical Yearbook 2009*. Nay Pyi Taw; Northern California Earthquake Data Centre. Advanced National Seismic System (ANSS). http://www.ncedc.org/anss/catalog-search.html (Accessed 12 January 2012).

Table 16.2e: Natural Hazards, 2000–2009–Thailand

Indicator	unit	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Forest fires	'000 hectare	93.32	76.19	139.39	15.76	32.28	30.28	8.62	18.78	11.33	9.77
	number	–	–	–	–	–	–	–	–	–	–
Landslides	'000 hectare	–	–	–	–	–	–	–	–	–	–
	number	–	–	–	–	–	–	–	–	–	–
Flash floods	'000 ha	–	–	–	–	–	–	–	–	–	–
	number	12	14	5	17	12	12	6	13	6	8
Earthquakes	'000 hectare	–	–	–	–	–	–	–	–	–	–
	number	5	4	10	6	10	16	15	12	7	54
Typhoons	'000 hectare	–	–	–	–	–	–	–	–	–	–
	number	960	1061	594	3213	3834	1313	1883	2233	1995	918

– Data not available.
Source: Flood and Typhoon data from Department of Disaster Prevention and Mitigation, Ministry of Interior; Forest fire data from National Park, Wildlife and Plant Conservation Department, Ministry of Natural Resources and Environment; Storm and Earthquake data from The Meteorological Department, Ministry of Information and Communication Technology.

Table 16.3a: Natural Disasters, 2000–2010–Number of Events

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	1	2	2	0	1	3	3	2	0	2	1
Lao PDR	3	1	1	0	0	0	0	1	1	2	0
Myanmar	0	1	1	0	2	1	2	5	1	1	2
Thailand	6	7	6	6	8	6	3	5	6	1	3
Viet Nam	11	7	6	6	7	11	11	7	10	6	7

Source: UNESCAP Annual Core Indicators online database. http://www.unescap.org/stat/data/statdb/DataExplorer.aspx. (Accessed 25 June 2012).

Table 16.3b: Natural Disasters, 2000–2010–Number of Deaths

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	347	56	29	0	0	23	5	184	0	19	8
Lao PDR	59	0	2	0	0	0	0	2	6	26	0
Myanmar	0	51	21	0	307	17	59	35	138,366	24	113
Thailand	198	222	190	18	8,389	86	280	53	39	15	260
Viet Nam	592	392	147	148	231	324	579	353	411	356	221

Source: UNESCAP Annual Core Indicators online database. http://www.unescap.org/stat/data/statdb/DataExplorer.aspx. (Accessed 25 June 2012).

Table 16.3c: Natural Disasters, 2000–2010–Persons Affected (thousand)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	3,448	1,969	2,120	0	0	600	42	36	0	178	0
Lao PDR	460	453	150	0	0	0	0	0	204	129	0
Myanmar	0	0	50	0	13	0	70	162	2,400	1	405
Thailand	3,366	466	8,318	113	575	823	2,557	183	11,572	200	15,454
Viet Nam	5,028	1,786	2,734	403	536	852	2,995	1,600	776	3,608	1,523

Source: UNESCAP Annual Core Indicators online database. http://www.unescap.org/stat/data/statdb/DataExplorer.aspx. (Accessed 25 June 2012).

Table 16.3d: Natural Disasters, 2000–2010–Economic Damage ($ million)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cambodia	160	15	38	0	0	0	0	1	0	0	70
Lao PDR	1	0	0	0	0	0	0	0	0	100	0
Myanmar	0	0	0	0	501	0	0	0	4,000	0	57
Thailand	109	28	40	26	1,175	658	35	2	28	0	332
Viet Nam	291	172	284	105	38	346	1,099	981	674	1,065	705

Source: UNESCAP Annual Core Indicators online database. http://www.unescap.org/stat/data/statdb/DataExplorer.aspx. (Accessed 25 June 2012).

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Abbreviations and Acronyms

ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nations
CEETIA	Center for Environmental Engineering of Towns and Industrial Areas (Viet Nam)
c.i.f.	cost, insurance, and freight
CO_2	carbon dioxide
DWT	dead-weight ton
EOC	Environment Operations Center
ESA	European Space Agency
ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
ETM+	Enhanced Thematic Mapper Plus
FAO	Food and Agriculture Organization of the United Nations
f.o.b.	free on board
GDP	gross domestic product
GHG	greenhouse gas
GMS	Greater Mekong Subregion
GNI	gross national income
GW	gigawatt
ha	hectare
HRD	human resource development
IUCN	World Conservation Union
IRRI	International Rice Research Institute
kg	kilogram
km	kilometer
km^2	square kilometer
KW	kilowatt
m	meter
MDG	Millennium Development Goal
MOSTE	Ministry of Science, Technology and Environment (Thailand)
MRC	Mekong River Commission
MW	megawatt
NASA	National Aeronautic and Space Agency
NGO	nongovernment organization
NORAD	Norwegian Agency for Development Cooperation
NTFP	non-timber forest product
ODA	official development assistance
PDR	People's Democratic Republic (Lao)
PPP	purchasing power parity
PRC	People's Republic of China
PDR	People's Democratic Republic (Lao)
SRTM	Shuttle Radar Topographic Mission
STEA	Science, Technology and Environment Agency (Lao PDR)
UNCSD	United Nations Commission for Sustainable Development
UNDP	United Nations Development Programme
UNDP MIMU	United Nations Development Programme, Myanmar Information Management Unit
UNEP	United Nations Environment Programme
UNEP RRC.AP	UNEP Regional Resource Centre for Asia and the Pacific
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UN FAO DSMW	United Nations Food and Agriculture Organization, Digital Soil Map of the World
UN FAO GAUL	United Nations Food and Agriculture Organization, Global Administrative Unit Layer
USGS	United States Geological Survey
VMAP0	Vector Map Level 0
WHO	World Health Organization
WWF	World Wide Fund for Nature

NOTE: $ refers to US dollars throughout the Atlas

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Subject Index

See also Statistical Section, p. 262–288

Agenda 21 255
Agriculture 153
  land area 153
  productivity 164, 175
  slash-and-burn (swidden) 58, 67, 164
  types 154, 156
Agroecological zones 159
Agroecosystems 165
Anisoptera species 126, 127
Aquaculture production 169
Arable land, subregion 5, 8, 67, 174,
Asian Development Bank (ADB) 241, 256
Asian Elephant, Elephas maximus 89, 121, 139
Association of Southeast Asian Nations (ASEAN) 109, 202, 216, 23 8, 256
Avian flu 239, 254

Banteng,Bos javanicus 136, 139
Beans, coffee 156
Beef 159
Biodiversity 8, 14, 26, 35, 53, 121, 164,
  Conservation Corridors 257
  Landscapes 258
  Marine 144
Biofuel 190
Buffalo 156

Carbon sequestration 129, 165
Cassava 166, 190
Catchments, major 85
Catfish, giant Mekong 142, 174
Cement 80
Challenges, subregional 251
Chicken meat 156
Child mortality, reduction 72
Climate change 11, 78, 129, 183, 243
Coal deposits 188
Coastal zones 116
Coffee 156
Cooperation, subregional 238, 251
Coral bleaching 145
Corals 113, 145
Cows' milk 156
Crocodile, Siamese 109, 141
Cross-border issues 239, 260

Dams, GMS 186
  effects on fisheries 8, 143, 170
Deforestation, rate 126, 131
Deltas 85
Dendrobium 147
Development cooperation 250
  global partnerships (MDG) 76
  millennium goals 69
  sustainable 251, 256
Dipterocarpus species 126
Disasters, natural 67, 243
Diseases, combating (MDG) 74
Dolphin, Irrawaddy, Orcaella brevirostris 142
Douc langur, Pygathrix 140
Dugong 144

Earth Summit 255
Economic and Social Commission for Asia and the Pacific (ESCAP) 255
Economic corridor 257
Ecoregions 123, 130
Ecosystems 148, 165
Ecotourism 151, 236
Education 71, 237
  literacy rate (MDG) 71
  net enrolment ratio in primary 71
Eggs 156
Electricity 185, 195
Energy 185,
  Consumption 185
  cooperation 253
  cross-border trade 194, 253
  efficiency 198
  renewable 191
  resources 189
Environment
  and health 67
  and livelihood 67
  challenges, subregional responses 255
  strategic framework 194, 257
  sustainability 74, 251, 257
ESCAP 244
Ethnic minority groups, major 55, 69

FAO (Food and Agriculture Organization) 126
Fauna 138
  Asian Elephant, Elephas maximus 139
  Banteng, Bos javanicus, 139
  Douc langur, Pygathrix 140
  Giant barb, Catlocarpio siamensis 143
  Indochinese tiger, Panthera tigris corbetti 140
  Irrawaddy dolphin, Orcaella brevirostris 142
  Kouprey, Bos sauveli 140
  Mekong catfish, Pangasianodon gigas 142
  Saola, Pseudoryx nghetinhensis 140
  Siamese crocodile, Crocodylus siamensis 141
Fish fauna 142
Fisheries 4, 8, 168
  consumption 169
  threats 170
Flora 126, 146
  Canna lily 146
  Cordyline 147
  Dendrobium 147
  musa 135
  orchids 147
  Pometia 129
  Sapria 146
  Terminalia 126
Flowers, Yunnan 146
Food security 175
Forest area 124
Forest cover 130
  ecosystem services 129, 244
  species 127
  trends 131
Fish, freshwater 142
Fish, marine 144
Floods 156, 183, 245, 249
Fruits 151

Gas, natural 188
Gemstones 84
Geology 77
Gender equality (MDG) 72
Giant barb, Catlocarpio siamensis 143
Gibbon 122, 136
GMS
  Description 1
  programs 257
  Strategic Framework, 2012–2020 194, 257
  statistics 5
Greenhouse gases 186, 193, 243, 248
Gross domestic product (GDP) 2

Health, and environment 67
  infant mortality rate 73
  malaria cases 74
  maternal mortality ratio 73
HIV/AIDS 74
Hopea species 126
Horticulture 146
Human Development Index 3, 237
Human resource development 237
Human trafficking 239, 254
Hydropower 8, 87, 98, 171,189
  generation 189

Indochinese tiger, Panthera tigris corbetti 140
Industrialization 205
Irrawaddy dolphin 142
IUCN (World Conservation Union) 121, 149

Kouprey, Bos sauveli 140

Lancang Cascade, fisheries 171
Land degradation 156
Languages 5, 55
Langur, douc 140
Livelihood and environment 66
  Livestock 156

Maize 156, 190
Mangroves 107, 114, 247
Mekong River Commission (MRC) 98, 257
Migrant labor 254
Millennium Development Goals 69
Mineral resources 80
Mining, share of GDP 80

NGOs (nongovernment organizations) 59, 93, 152
Non-timber forest products 129

Oil, petroleum 188
Oil palm 159t
Orchids, Thailand 147
Oxygen, chemical oxygen demand 182

Peoples of the GMS 55
Phnom Penh Plan 239
Plantains
Pollution 9. 6 7, 174, 181, 208, 254
Population
  below minimum level of dietary energy intake 71
  density 6
  growth rate 5, 205
Poverty, and environment 65
  measures to combat 65
  national distribution 70
  undernourished children 70
Power trade 193
Protected Areas 134, 149, 150
  history of management 151
  IUCN categories 149
  legally designated 152
  Three Parallel Rivers 149
Pterocarpus 126

Religions 5
Rice 153, 155
  climate change 244
  price 178
  Ayeyarwady Delta 88
  Chao Phraya Delta 92
  Mekong Delta 96
  Red River Delta 100
Ricelands, distribution 155
Rio + 20 255
River basins, major 86
  Ayeyarwady 88
  Chao Phraya 92
  Mekong 96
  Red 100
  Pearl 102
  Thanlwin 90
Roherea 126
Rubber 156
Rubber plantations
  Xishuangbanna Prefecture, PRC 132
  Myanmar 176

Sanitation
  access to improved water source 52, 75
  access to sanitation facilities 76
Saola, Pseudoryx nghetinhensis,140
SARS 239, 254
School enrollment 71
Shorea species 127
Siamese crocodile, Crocodylus siamensis 141
Slash and burn, *See swidden*
Soils 78
Sorghum 155
Soybeans 155
Sugarcane 156
Swidden Agriculture 164
Syzygium 127

Teak 147
Terminalia tomentosa 126
Tetrameles nudiflora 127
Tiger 140
Tobacco 161
Tourism 227
Trafficking 239
Transboundary issues 253
Transport 209
  Air 225
  railways 218
  roads 213
  waterways 221
Turtles 144

United Nations Development Programme (UNDP) 255
United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) 255
United Nations Environment Programme (UNEP) 256
Urbanization 199

Ventilago calyculata 127

Water
  demand 179
  quality 181
  security 183
Watersheds
  major 85
  Mekong 96
Wetlands 106
  Ba Be Lake 112
  Beung Kiat Ngong 109
  Boeng Chhmar 106
  Can Gio 112
  Dat Mui 112
  Dian Chi Lake 30, 108
  Indawgyi Lake 109
  Inle Lake 109, 161
  Koh Kapic 106
  Er Hai Lake 108
  Ngong Xe Champhone 109
  Sam Roi Yod 111
  Shankou Mangrove Wetland 107
  Siphandon 109
  Songkhla Lake 110
  Tonle Sap 14, 78, 97, 105, 106, 159
Whales 144
Wildlife, cross-border trade 253
World Conservation Union (IUCN) 121, 149
World Summit on Sustainable Development 256
World Wide Fund for Nature 122, 135

Geographic Index

Andaman Islands 114, 118
Andaman Sea 113
Angkor Wat 231, 234
Annamite Range Rain Forest 123, 135
Aural, protected area 136
Ayeyarwady (Irrawaddy) River 8, 85, 88, 143, 182, 222
Ayeyarwady Delta 104, 159

Ba Be Lake 112
Bagan 231
Bai Boi 112
Bangkok 48, 92, 120, 204, 218, 226, 231
Battambang 13, 80

Beibu Gulf 19, 100, 116, 201
Beung Kiat Ngong 109
Boeng Chhmar 106
Bolaven Plateau 83

Cambodia 13
Can Gio Wetland 112
Cardamom Mountains Rain Forests 78, 123 136
Central Indochina Dry Forests, ecoregion 136
Chamkars, Cambodia, swidden agriculture 164
Champasak, Cambodia 231
Chao Phraya Delta, 10,157
Chao Phraya River 8, 43, 79, 85, 92 115
Chiang Mai, Thailand 147, 231

Coastal zones 116, 160

Dat Mui Wetlands 112
Dian Chi Lake

Er Hai Lake 30, 108

Guangxi Zhuang Autonomous Region 19
Guizhou 19, 25, 219
Gulf of Martaban 90, 114
Gulf of Thailand 115, 144, 221
Gulf of Tonkin (Beibu Gulf) 19, 100, 116, 201

Ha Long Bay 116, 231
Ha Noi 54
Hengduan Mountains 149
Ho Chi Minh City, Viet Nam 200, 204, 214, 247
Huai Kha Khaeng protected area138

Indawgyi Lake 109
Indochina Dry Forests, ecoregion 123, 136
Inle Lake 109
Irrawaddy, see Ayeyarwady
Isaan, Thailand 160

Kachin State, Myanmar 12, 40, 62, 88
Kayah-Karen Montane Rain Forests 123, 137
Khao Ang Ru Nai 136
Khorat Plateau 43, 77, 136, 160
Koh Kapic 106
Koh Kong 106, 116, 244
  mangroves 247
Koko Island, Myanmar
Kulen Promtep, protected area 136
Kunming, Yunnan 30, 108, 146, 206, 216

Lancang cascade 171, 253
Lao PDR 31
  shifting cultivation 166
Lijiang Prefecture, Yunnan 29, 231
Lomphat, protected area 136
Luangprabang, Lao PDR 96, 231

Mae Tuen, protected area 138
Mandalay, Myanmar 42, 63, 88, 231
Mekong Delta 78. 96, 111, 120, 159, 161, 181, 244
Mekong River 8, 78, 96, 123, 170, 171, 180, 222, 227, 253
Moattama 114
Mun Chi river basin, fisheries 174
Myanmar 37
  Plantation growth 176

Nam Ngum Hydropower Dam, Lao PDR 96, 193, 197
Nam Ou watershed 96
Nanning, Guangxi, PRC 24
Nay Pyi Taw 42, 201, 202
Ngong Xe Champhone 109
Nha Trang, Viet Nam 120, 173
Nong Khai, Lao PDR 252
Northern Annamites Rain Forests, ecoregion 135
  Northern Indochina Subtropical Forests, ecoregion 135

Omgoy, protected area 138

Pak Mun Dam, fisheries 174
Pearl River basin 102
Peninsular Malaysian Montane Rain Forests, ecoregion 123, 137
Peninsular Malaysian Rain Forests, ecoregion 137
Phnom Bokor, protected area 136
Phnom Penh, Cambodia 18
Phnom Prich, protected area 136
Phnom Samkos, protected area 136
Phu Kao-Phu Phan Kham, protected area 136
Pu Mat, protected area

Quang Ninh, Viet Nam 52

Rakhine Yoma, Myanmar, 37
Red (Song Hong) River 8, 100, 111
Red River Delta, rice bowl 87, 155, 159
Roniem Daun Sam, protected area 136

Salween, see Thanlwin
Sam Roi Yod wetlands 111
Sambor Dam, fisheries 171
Sesan, Sre Pok, and Sekong (3S) river basins 99
Shankou Mangrove Wetland 107
Si Phan Don 96
Siem Reap 13, 234
Song Hong, see Red River
Songkhla Lake 110
South China Sea 85, 115, 144
South China Karst Complex 83
Southeastern Indochina Dry Evergreen Forests, ecoregion 136

Southern Annamites Montane Rain Forests, ecoregion 135
Srinakarin Hydropower Dam, Kanchanaburi, Thailand 196

Tenasserim Mountain Range 137
Thanh Hoa, Viet Nam 52
Thanlwin (Salween) River 8, 37, 77, 85, 90
Three Parallel Rivers Protected Area
Thung Yai Naresuan, protected area
Tonle Sap 14, 78, 97, 105, 106, 159
  Freshwater Swamp Forests, ecoregion

Umphang, protected area

Vientiane, Lao PDR 36

Viet Nam Central Highlands, swidden agriculture 164

Xe Piane 136
Xishuangbanna, Yunnan Province, PRC 29, 59, 127, 132

Yangon, Myanmar 42, 201, 231
Yok Don 136
Yoma Range 32, 47, 148
Yunnan Province, PRC 25
Yunnan Plateau 108, 135

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