

PART I

OVERVIEW AND INTRODUCTION

1 OVERVIEW



Mekong Valley, taken from the cliffs of
Pha Taem National Park, Ubon Ratchathani, Thailand
Source: Matthew Markopoulos

The Greater Mekong Sub-region (GMS) is an area of great social, cultural, political and biological diversity. About 266 million people, representing more than 70 different ethnic and linguistic groups, occupy the five countries and one province of the GMS: Cambodia, Lao PDR, Myanmar, Thailand, Viet Nam, and Yunnan in southwest China¹. They share a common link in the Mekong River, the world's twelfth longest river at just under 4 200 km. The GMS extends well beyond the basin of the Mekong, but the river drains more than a third of the region. Moreover, about one-fifth of the region's population lives in Mekong basin itself.

In the past thirty years, the GMS has seen rapid social and economic change. Today, it is one of the world's fastest growing regions. Most of its countries have been able to channel the returns from growth into raising incomes and improving people's well-being. Thailand, Viet Nam and Yunnan in particular have made great strides towards reducing poverty.

Despite this progress, many social and economic challenges remain. A major challenge is achieving economic growth that improves people's livelihoods, especially those that depend heavily on natural resources. Agriculture, including forestry and fisheries, is still the mainstay of rural livelihoods and food security in the region. Some 40 million rural inhabitants are active in the lower Mekong basin fishery alone.

In recent years, the natural resource base has come under pressure from rapid economic and demographic change. Together with the

impact of infrastructure development, and the weakness of national protective and regulatory institutions, these forces have contributed to widespread pollution and natural resource depletion.

Every country in the GMS has made some progress towards setting national priorities and enacting plans and policies in line with global and regional targets for sustainable development and environmental protection. Much remains to be done, however, especially in terms of integrating social, economic and environmental concerns.

The Greater Mekong Environment Outlook provides an overview of the main environmental trends over the past two decades, and how social, economic and other factors have contributed to the changes that have occurred. It assesses the scope and effectiveness of national and regional policy responses, and identifies some of the main options for future action.

What follows is a synthesis of its main findings and recommendations.

1.1 STATE OF THE ENVIRONMENT AND POLICY RESPONSES

AIR

Air pollution in the GMS is a localized, though nonetheless serious, threat. The rapid growth of the industrial and agro-industrial sectors, particularly in Thailand and Yunnan, has caused severe air pollution in urban and peri-industrial areas. This has been exacerbated

¹ The autonomous region of Guangxi in China joined the GMS as the GMEO was being prepared and is not covered by this report.

local and regional sulphur dioxide and particulate matter pollution from coal-fired power plants. Air pollution is a major public health threat, and its associated treatment and cleanup costs are a serious drain on public finances.

As countries take measures to curb air pollution, particulate matter of 10 micrometres or less in diameter (PM₁₀) has emerged as one of the main airborne threats to health in urban areas. One of the main sources of PM₁₀ is vehicle traffic. Vehicle numbers are growing rapidly in such countries as Yunnan and Thailand, though remain relatively low elsewhere. The growing size of vehicle fleets, however, is only part of the problem. Low emissions standards, poor road networks and outdated technology also contribute to high levels of air pollution.

Besides the transport sector, the energy and industrial sectors are major sources of air pollution. The energy sector is also the main anthropogenic source of carbon dioxide (CO₂), a key greenhouse gas. Overall, the GMS is still not a major emitter of CO₂. Carbon intensity, however, is rising in most countries. This means that the growth in their CO₂ emissions is outstripping the growth in their economies.

The countries of the GMS are committed to action at all levels to reduce atmospheric pollution and maintain air quality. At the international level, all governments have signed treaties governing atmospheric pollution, including the United Nations Framework Convention on Climate Change, the Vienna Convention for the Protection of the Ozone Layer, the Montreal Protocol for Chlorofluorocarbon Control, and the Kyoto Protocol.

LAND

The demands of food production for a growing population are putting increasing pressure on land. In the GMS as a whole, the increase in cropped land has not kept pace with population growth, causing overall per capita allocation to fall by almost 11 per cent between 1990 and 2003.

POOR AGRICULTURAL PRACTICES, OFTEN AIMED AT INTENSIFYING PRODUCTION, CONTRIBUTE TO LAND PRESSURE. THE EXCESSIVE USE OF FERTILIZERS AND OTHER CHEMICALS HAS CONTRIBUTED TO SOIL DEGRADATION AND WATER POLLUTION.

Poor agricultural practices, often aimed at intensifying production, contribute to land pressure. The excessive use of fertilizers and other chemicals has contributed to soil degradation and water pollution. Irrigation is a key element of agricultural production in the GMS. Planned increases in irrigated areas have implications for land resources, as poorly designed or implemented irrigation schemes can cause waterlogging, salinization and alkalization of soils.

Land degradation is a major problem across the GMS. Historically, the main cause of degradation has been forest loss, followed by agriculture. Forest cover has declined in every country except Viet Nam and Yunnan, both of which have invested heavily in plantations. The annual rate of forest loss averaged 0.3 per cent for the GMS as a whole in 1990–2000.

A variety of approaches have been adopted to combat land degradation and associated processes such as desertification. Viet Nam, Thailand, Yunnan and other countries are rehabilitating millions of hectares of degraded cropland and instituting more appropriate land management policies and practices. Many countries have banned harvesting in natural forests, shifting the emphasis of forest production to plantations. In doing so, however, they may have cut off important sources of income and livelihoods for rural, forest-dependent people. It remains to be seen whether these people can find new livelihoods in forest protection or plantation tending.

WATER

The GMS as a whole does not suffer from a lack of water. The region has substantial,

though unevenly distributed, water resources. Per capita water availability in Lao PDR, for example, is an order of magnitude greater than in Thailand or Yunnan.

Aggregate measures of water availability can mask variations in the timing and seasonality of this supply. Most countries have a plentiful, often excessive, supply of fresh water during the wet season, but can experience severe, though temporary, water shortages during the dry season. Economic constraints and inadequate water supply systems can also restrict availability. Rapid urbanization and infrastructure development are putting pressure on existing water and sanitation systems, causing localized water shortages and pollution.

Agriculture is the largest consumer of water in the GMS, and will remain so for the foreseeable future. In the larger economies, however, future demand for water is expected to grow most rapidly in non-agricultural sectors such as tourism, industry and the residential sector.

Declining water quality is a growing concern for many different activities in the Mekong and other river basins of the GMS. Pollution of water sources, both surface and groundwater, with human and animal waste, and solid wastes, is common and increasing. The main sources of organic water pollution are domestic, industrial and agricultural discharges. The discharge of untreated domestic wastewater is a particular problem. In Viet Nam, well over 90 per cent of wastewater is still discharged without treatment.

Water resources management is the subject of numerous sub-regional initiatives and agreements. A framework for cooperation in Mekong river governance already exists in the form of the Mekong River Commission (MRC). This is complemented by other multilateral initiatives such as the Working Group on Water Resources Management of the Association of South-East Asian Nations (ASEAN), and the environmental aspects of the GMS Economic Cooperation Program (financed by the Asian Development Bank).

BIODIVERSITY

The GMS is rich in biodiversity. Across the region, however, this diversity faces serious threats from human activity and from natural changes caused in part by humans.

There are two main reservoirs of biodiversity in the GMS: forests, and wetlands and other aquatic ecosystems. In 2005, just over 44 per cent of the region was still classed as forest. The largest area of forest is in Myanmar, followed by Thailand, Yunnan and Lao PDR. The loss of forests over the past two decades from uncontrolled logging, land clearance, road building and other activities has had a substantial impact on populations of flora and fauna. The region is home to some of the world's most threatened species. Besides the threats from habitat loss, native species are also threatened by hunting and the wildlife trade, and by the spread of some invasive alien species.

Like forests, wetlands face threats from habitat degradation, pollution, uncontrolled exploitation and agricultural encroachment. The largest wetland in the GMS, and the largest lake in Southeast Asia, is Tonle Sap Lake in western Cambodia. In the wet season, Tonle Sap Lake covers 16 000 km², and, together with the Tonle Sap River, supplies almost two-thirds of the inland fisheries production of Cambodia. The threats to Tonle Sap Lake include the clearance of flooded forests on its margins for agriculture and settlements. Between 1992 and 1997, the area of flooded forest around Tonle Sap declined by almost a tenth.

Population growth is a key driver of biodiversity loss, through impacts such as land clearance, overfishing and illegal hunting for food and income. The links between population growth and biodiversity are crucial to the GMS, since the region's biological diversity—both natural and agricultural—supplies the main source of livelihood for much of its rural population.

The countries of the GMS have tackled biodiversity protection and conservation in two

main ways. The first is to use law, both national and international. All of the GMS countries, for example, are signatories to the Convention on Biological Diversity, and the Convention on International Trade in Endangered Species of Wild Fauna and Flora.

The second main response centres on protected areas. These vary widely in extent from one country to another. Across the region, however, protected areas face threats from illegal logging, hunting, encroachment and other human activities.

Governments are coming to realize that law enforcement and protected area management can both benefit from transboundary cooperation. This can take various forms, one of which is the creation of transboundary protected areas. These provide opportunities for promoting biodiversity conservation and sustainable use across ecosystems and landscapes divided by national borders, while at the same time encouraging collaboration and management in information sharing.

1.2 KEY ENVIRONMENTAL PRIORITIES

CONTROLLING LAND DEGRADATION

Forest loss is the main underlying cause of land degradation across the GMS. Forest clearance for agriculture, or uncontrolled logging and consequent deforestation, have caused widespread soil and water erosion. The loss of topsoil from surface water erosion is perhaps the most pervasive form of land degradation in the region. The problem of water erosion is acute in such countries as Cambodia, Lao PDR, Thailand and Viet Nam.

Attempts to reverse land degradation have met with mixed success. A consistent problem has been the inability to reorient economic planning systems or the dominant sectorial approaches to land management. The completing influences of fiscal and market

incentive programmes, and the underpricing of resources and subsidizing of agricultural inputs such as fertilizers, have also helped to maintain pressures on land.

Major policy failures leading to land degradation have included insecure land tenure and misjudged attempts to reform tenure patterns by encouraging fixed settlement and cultivation in upland areas.

In some areas, the means to control land degradation are already in place, but weak monitoring and enforcement have undermined their application. A case in point is China's 1991 Law on Soil and Water Conservation, which prohibits cultivation on slopes greater than 25 degrees. A failure to enforce the law rigorously in Yunnan and other provinces allowed steep-slope cultivation to spread and was a contributory factor in the soil and water erosion blamed for the Yangtze River floods in 1998.

Governments in the GMS are trying to address some of the underlying social and economic issues driving poverty and land degradation in upland areas. Lao PDR, for example, has introduced a land allocation policy aimed at increasing land tenure security and encouraging communities to protect forests by moving land from swidden cultivation to controlled reserves. Land reform has also been the focus of Viet Nam's efforts to stabilize and rehabilitate degraded agricultural and forest land. Since Viet Nam's Land Law was first revised in 1993, its land rehabilitation strategies have focused on allocating degraded land to farmers with long-term use rights. As many as eight million households have received land, although the process of allocation, particularly in poor and isolated upland areas, has been slow and problematic.

Besides these national responses, the countries of the GMS are also cooperating in regional and international initiatives aimed at controlling land degradation and desertification. One of the most prominent of these is the Convention to Combat Desertification (CCD). All of the GMS countries are signatories to



*Abundant arable land, Lao PDR
Source: Thailand Environment Institute*

the CCD, and every country except Cambodia (which is close to validating its programme) has adopted a national action programme for meeting its commitments under the Convention. In 2005, the countries of Southeast Asia launched a sub-regional action programme to tackle desertification. This includes every GMS country except China, which is cooperating with Mongolia in a separate plan for Northeast Asia.

BALANCING DEMANDS ON WATER RESOURCES

The water resources of the GMS are plentiful though unevenly distributed. In no country is overall water availability below the levels triggering water stress or scarcity. At the river basin level, the Chao Phraya basin in Thailand is the only major catchment to face severe water shortages. It is also the only major catchment with high levels of pollutants from human activities, although the Red River basin in Yunnan and Viet Nam is becoming increasingly polluted.

For the Mekong River itself, declining water quality is not a serious problem. Nor are water shortages, although the river and its tributaries are facing increasing pressure from efforts to develop water resources aimed at promoting economic growth.

Agriculture, and particularly irrigated agriculture, still accounts for most of the demand for water. Future demand for fresh water, however, will grow fastest in the residential, tourism and industrial sectors. Inevitably, as the demand from cities and industries grows, the water available for agriculture will decline. Effective management of the competition, and likely conflict, between multiple water uses and users is crucial. The need for integrated management also has a regional perspective, as GMS countries receive much of their freshwater from shared rivers.

Across the GMS, the response to the challenge of managing water resources has historically been fragmented. Recently, however, such countries as Thailand and Viet Nam have led a move towards catchment-based water

management. This promising approach has at times been hampered by weak links to local governments and communities, or to existing processes of planning and decision making. Such initiatives as MRC's Watershed Management Project and Basin Development Plan aim to strengthen these links, and to improve sub-regional growth through Integrated Water Resources Management (IWRM).

Although market mechanisms such as water pricing are increasingly being brought to bear in water resource management globally, their political and economic viability in the GMS is limited by the difficulty of charging small-scale, subsistence farmers for the water they consume.

PROTECTING AND MANAGING BIODIVERSITY

The GMS harbours globally important elements of biodiversity. Much of the region is still biologically unexplored, and surveys continue to reveal species new to science. Many species are endemic to the region and have extremely restricted ranges, so are vulnerable to habitat loss.

The natural biodiversity of the GMS is a crucial economic, social and cultural resource, yet faces many serious threats. The region could lose more than half of its remaining land and water habitats over the next century if countries fail to take any action.

The threats to biodiversity come from four main sources. First is depletion of natural resources and habitat loss or degradation. Some processes of degradation are linked to population growth. Second is over-exploitation for trade, both within countries and across borders. Large volumes of plant and animal species are shipped to markets outside the GMS, including countries in East Asia, Europe and North America. This trade is considered the single greatest threat to some species, more serious even than habitat loss. Third is the construction of transboundary roads and related economic activities. Last is limited awareness and understanding of, and

weak capacity for, biodiversity protection and management.

Besides these four threats, alien invasive species also pose a growing threat to the region's biodiversity. Many introduced plant, mollusc and fish species have established populations in the region, some at the expense of native populations.

As noted, the countries of the GMS have tackled biodiversity protection in two main ways: through the use of national and international law, and by establishing protected area systems. Both of these approaches are currently undergoing far-reaching changes caused by governance reforms in GMS countries, including decentralization, greater democratization, the development of new natural resource management institutions, and a renewed emphasis on the rule of law. The results include devolved management authority and structures; greater emphasis on outreach and involvement of local communities and local governments; and more clarity in management controls, procedures and rights under the law.

Across the GMS, a growing trend is for public participation in biodiversity protection. This has several drivers, including the growing recognition that communities which depend on biodiversity for their livelihoods can be partners and allies, rather than obstacles, in conservation efforts. Hence GMS countries are introducing measures for public participation and consultation, mostly as part of policies for environmental impact assessments of development projects. At the local level, a growing number of communities is involved in managing activities in the multi-use or buffer zones around and outside protected areas.



A community wildlife workshop in Tiliaba village, Thung Yai, Naresuan, Wildlife Sanctuary, Thailand.
Source: WWF-Thailand

Public participation is for many GMS countries a relatively new phenomenon, and faces many obstacles. Local communities in protected areas usually lack capacity and their roles and responsibilities are frequently unclear or poorly defined. Moreover, buffer zones around protected areas often lie outside official jurisdictions and lack integrated systems of planning. Across the region, top-down and proscriptive management procedures, complicated by a lack of clear demarcation between agencies and their responsibilities, continue to hamper participation.

1.3 SOCIAL AND ENVIRONMENTAL CHANGE AND ITS IMPLICATIONS

POVERTY, LIVELIHOODS AND THE ENVIRONMENT

Most GMS countries depend heavily on natural resources. Forests, fisheries and other resources make important contributions to economic growth and export earnings. The region as a whole has more than 180 million people living in rural areas, most of whom depend directly on the quality and quantity of natural resources such as soil and water, forests, rivers and wetlands.

Often, the poorer the people, the more closely their welfare is linked to the condition of the natural resources they rely on. The poorer GMS countries, and poor people in general, depend disproportionately on environmental assets and natural resources. The poorest are often most affected by the degradation of environmental resources, and are frequently most at risk from natural disasters. Environmental quality and poverty are closely correlated in such countries as Cambodia, Lao PDR, Viet Nam, and Yunnan.

These linkages imply that the welfare of the poor depends on the way natural resources are managed, and that efforts to reduce poverty could be enhanced by closely integrating environmental considerations into poverty

reduction strategies. The challenges for GMS countries, therefore, are to ensure natural resources are used in ways that generate sustainable growth from which the poor are able to benefit, and to sustain the natural resource base and its continued capacity for pro-poor growth.



The persistence of poverty despite the growing affluence of the GMS highlights the scale of the challenge facing governments. Poverty remains widespread in Cambodia, Lao PDR, Myanmar and Viet Nam, particularly among ethnic minority groups. Much of the economic growth has benefited urban areas more than rural areas, leading to growing inequality and a concentration of poverty in rural areas. Other causes include social and geographic isolation, high risks from disease and natural disasters, inadequate access to land and credit, a lack of environmental sustainability, and weak participation at the local level in formulating poverty alleviation initiatives. Despite some isolated and ad hoc attempts to redress this situation, what is still needed is a view of development aimed directly at eradicating poverty.

FOOD SECURITY

Environmental change and the poverty it can cause have many social and economic

impacts. One key group of impacts concerns food security, which is often related to a lack of access to food. This, in turn, is related to weak purchasing power, a result of poverty, and to transport and marketing constraints, which affect poor, isolated groups. Inadequate levels and quality of food intake cause undernourishment and malnutrition, and prevent people from playing an active role in the economy.

At the national level, most countries in the GMS can produce sufficient food to meet their needs. Indeed, Thailand and Viet Nam are major exporters of rice. A food surplus at the national level, however, does not necessarily translate into food security at the household level, even in the more advanced economies of the GMS. Recent structural changes in Thailand's economy, coupled with the effects of the 1997–98 financial crisis on employment and consumption, have caused localized household food insecurity in both rural and urban areas. A similar picture can be seen in Cambodia, which achieved a food surplus in 1999. Official statistics show that almost a third of the Cambodian population live below the food poverty line, and that a similar proportion of communes faces chronic food shortages.

Physical and environmental factors often account for regional variations in rice production that contribute to household food security. Variations in rainfall and low soil fertility (whether natural or human-induced) commonly affect the productivity of rain-fed rice systems. Extreme weather events such as floods and droughts can also have a major impact, particularly on poor, vulnerable rural populations.

Together with rice, inland capture fisheries production—particularly in the lower Mekong basin—forms the basis for the food security of much of the rural population. Fish is the single most important source of animal protein for rural people, and an important source of income as well.

In general, inland capture fisheries across the GMS are either stable or declining, and freshwater aquaculture production is

assuming greater importance. In Cambodia, capture fisheries still contribute the bulk of fish production, though yields have fallen sharply since 2001. Species composition is changing, too, as catches of large and medium-sized fish decline and smaller, faster growing species form a greater proportion of the catch by weight. Fishers now also need more time to catch the same amount of fish, and the number of fishery-related conflicts is growing.

The challenge of food security must be tackled as part of a poverty alleviation strategy that addresses agricultural growth and empowerment of the poor on one hand, and increased private sector involvement and investment on the other. Most of the national poverty reduction strategies developed by GMS countries recognise the importance of agriculture and rural development for broad-based growth and poverty alleviation. Local opportunities for livelihood diversification also need to be improved. This will mean addressing the issues of indebtedness and landlessness that affect many small farmers in the GMS.

1.4 OUTLOOK AND OPTIONS FOR ACTION

Across the GMS, the need and the opportunities for economic growth are high. The rapid economic growth of the past few decades is likely to continue, fuelled by industrialization, trade and investment. It should lift more people out of poverty, improving living standards, nutrition and livelihoods. However, the possible negative effects of this growth on the region's environment and vulnerable rural populations are cause for concern. Much of the economic growth to date has bypassed rural areas. It has also put pressure on the environment in the form of air and water pollution, land degradation and the depletion of natural resources and valuable biodiversity.

These changes may not only cause irreversible ecosystem damage with far-reaching implications for the economic activities

that depend on natural resources. They may also increase the vulnerability of poor, rural populations to health threats, natural disasters, food insecurity and community fragmentation, and in doing so lead to social conflict.

A need exists to reverse the trend of environmental degradation, and to secure the ability of natural resources to contribute to sustainable economic growth. This need can be met only by framing appropriate policy measures at local, national and regional levels, and by ensuring they are implemented equitably and efficiently. Political will is indispensable to this challenge, but so too are strong partnerships within and between governments, businesses and civil society. The watchword of this effort must be integration, since only an integrated development strategy that improves productivity while ensuring environmental sustainability will be able to absorb the inevitable trade-offs and compromises.

Despite increasing economic integration, a key weakness of the GMS is that it still lacks a genuinely regional body with the mandate to develop and implement a shared vision of sustainable development. Hence ensuring cooperation by all six GMS countries in a coordinated development programme presents an unavoidable, yet serious challenge. Establishing a strong, credible body to develop and coordinate the region's response to the challenges of environment and development must be a key future priority. ■

2 INTRODUCTION TO THE GMS

2.1 THE HUMAN CONTEXT

The Greater Mekong Sub-region comprises Cambodia, the Lao People's Democratic Republic (Lao PDR), Myanmar, Thailand, Viet Nam and the southwestern province of Yunnan in China (Figure 2.1)². It covers an area of almost 2.3 million km², and its total population in 2005, the latest year for which figures are available, was 266 million. Most of the region's people still depend on agriculture as their main source of income and livelihoods.

The GMS is a region of great human diversity, embracing more than 70 ethnic and linguistic groups. These share a common link in the Mekong River, the world's twelfth longest river (4 180 km), and its tenth largest in terms of flow volume (475 000 million m³ yearly). Although the GMS extends well beyond the catchment of the Mekong, the river drains more than a third of the region, particularly downstream of the Golden Triangle, the border area between Lao PDR, Myanmar and Thailand. Moreover, about one-fifth of the region's population lives in the basin itself, so any changes in the main artery of the Mekong or its tributaries (due to development or other causes such as climate change) can have a major impact on the region's environment and economy.

In the past thirty years the GMS has seen rapid social and economic change. Today, it is one of the world's fastest-growing regions. Except for Thailand, which was hit hardest by the Asian financial crisis of 1997–98, growth has averaged about 4 per cent or more in every economy over the past decade (ADB 2004a). Thailand is still the region's leading economy, with a per capita gross domestic product of US\$8 090 in 2004 (measured in purchasing power parity; see also Table 2.1 below) (UNDP 2006).

Despite this strong growth and an abundance of natural resources, some 55 million people in the GMS still lived in poverty in 2000 (ADB 2004b). Estimates of the incidence of poverty vary, but range between 30 and 40 per cent in Cambodia and Lao PDR, 20 and 30 per cent in Myanmar and Viet Nam, and below 20 per cent in Thailand and Yunnan (Table 10.1). In the past two decades, Thailand, Viet Nam and Yunnan—like the rest of China—have made great strides towards reducing poverty. Cambodia, which is still rebuilding its social and physical infrastructure after years of civil strife, has made less progress.

The record of the GMS countries in developing their economies and reducing poverty is reflected in their human development indicators (see Table 2.1 below). Life expectancies across the region are over 60 years, except in Cambodia and Lao PDR. Adult literacy rates are high in Myanmar, Thailand and Viet Nam, the most populous countries, but relatively low elsewhere. Overall enrolment ratios are still quite low, except in Thailand.

Despite this progress, several challenges still remain. The low life expectancies in Cambodia and Lao PDR, for example, can be traced to several causes, including high infant mortality rates (97 and 65 per 1 000 live births respectively in 2004). Maternal mortality rates are also high in Cambodia (450 per 100 000 live births in 2000) and Lao PDR (650 in 2000) (UNDP 2006)³. Overall, the health of infants and mothers has improved over the past decade, but better health and nutrition would reduce death rates even further.

Both children and adults in the region face severe threats from HIV/AIDS, malaria and other

² The autonomous region of Guangxi in China joined the GMS as the GMEO was being prepared and is not covered by this report.

³ The figures for maternal mortality are adjusted from the reported rate to account for under-reporting and misclassification (UNDP 2006).



Figure 2.1. Map of the Greater Mekong Sub-region. This shows the sub-region's newest member, the autonomous region of Guangxi in China, which is not covered by this report.

Table 2.1. Selected human development indicators, 2004.

	Population (millions) 2005	Human development index (HDI) value ^a	Life expectancy at birth (years)	Adult literacy rate (% ages 15 and above)	Gross enrolment ratio ^b (%)	GDP per capita (PPP US\$)
Cambodia	13.80	0.583	56.5	73.6	60.0	2 423
Lao PDR	5.62	0.553	55.1	68.7	61.0	1 954
Myanmar	54.15	0.581	60.5	93.3	53.4	1 027 ^c
Thailand	64.76	0.784	70.3	92.6	74.0	8 090
Viet Nam	83.12	0.709	70.8	90.3 ^d	63.0 ^e	2 745
Yunnan ^f	44.50	0.657	66.4 ^g	78.5	57.4	2 683
GMS	265.95	0.683	66.8	88.2	62.6	3 653

^a See Glossary for definition of HDI.

^b Combined primary, secondary and tertiary education.

^c Figure refers to 2002.

^d Figure refers to 1999.

^e Preliminary national or United Nations' estimate.

^f Except where otherwise noted, data refer to 2003.

^g Figure refers to 2000.

Sources: Asian Development Bank Key Indicators 2006 (http://www.adb.org/documents/books/key_indicators/2006/default.asp), China Statistical Yearbook 2006, GMS country submissions, UNDP (2004, 2005, 2006).

diseases. The prevalence of HIV in the 15–49 year old reference group ranges from 0.1 per cent in Lao PDR to 1.6 per cent in Cambodia (UNDP 2006). Thousands of people do not have access to treatment for malaria, tuberculosis or other serious diseases. In 2003, the region reported more than 3 500 deaths from malaria (WHO 2005a, Zhou, Tang and Sheng 2005). Almost 70 per cent of these were in Myanmar, where malaria is the leading cause of morbidity and a major cause of mortality (Country submission, WHO 2004a).

2.2 THE NATURAL RESOURCE AND ENVIRONMENTAL CONTEXT

The GMS is geographically, culturally, economically and politically diverse. Yet in many ways it is an integrated economic region, and is becoming more so, thanks to shared natural resources and growing social and economic interaction (ADB 2002a).

The region's rich natural resource base has historically supported economic development and sustained rural livelihoods. More than 44 per cent of the GMS is still classed as forest, and



River life in Vietnam
Source: Sansana Malaiaison, UNEP RRC.AP

another quarter or so is classed as agricultural land. Besides these resources, there are large mineral deposits (especially coal and petroleum reserves), and a high potential for hydroelectric power. Both riverine and coastal fishing provide food security as well as income for millions of the region's people. Some 40 million rural inhabitants are active in the lower Mekong basin fishery alone (MRC 2003).

In recent years, however, the natural resource base has come under pressure from

Table 2.2. Population size, annual change and distribution, 2000 and 2005.

	Total population (millions)		Annual change (%)		Urban population (% of total population)	
	2000	2005	2000	2005	2000	2005
Cambodia	12.60	13.80	1.8	1.9	...	18.0
Lao PDR	5.07	5.62	2.0	1.8	19.3	21.6
Myanmar	50.13	54.15	2.0	2.0	24.9	25.0
Thailand	62.24	64.76	0.7	0.9	19.0	32.5
Viet Nam	77.64	83.12	1.4	1.3	24.2	27.0
Yunnan	42.40	44.50	1.1	0.8	23.4	29.5
GMS	250.08	265.95	...	...	...	27.8

Sources: Asian Development Bank Key Indicators 2006 (http://www.adb.org/documents/books/key_indicators/2006/default.asp), China Statistical Yearbook (various years), GMS country submissions, Yunnan 2005 Economic and Social Development Statistics Abstract (http://www.stats.gov.cn/tjgb/ndtjgb/dfndtjgb/t20060308_402310284.htm), Yunnan Fifth Census Bulletin (http://www.stats.gov.cn/tjgb/rkpcgb/dfkpcgb/t20020331_15405.htm).

several sides. One is the combined effects of rapid demographic and economic change. The region's population is growing steadily (see Table 2.2). The annual rate of population growth is expected to slow in the coming decades, from about 1.7 per cent in 2000 to less than 1 per cent in 2015 (ADB 2004b). The total population, currently almost 266 million, is expected to reach 290 million by 2015 (ADB 2004b). Most of this growth will occur in Myanmar and Viet Nam, countries with large population bases. Population growth is a key driver of natural resource exploitation and environmental degradation. Coupled with the impact of infrastructure development, and the relative weakness of protective and regulatory institutions in the GMS, it has contributed to widespread pollution and natural resource depletion (ADB 2002a).

Some of the main environmental problems facing the region are common or transboundary issues that would benefit from a coordinated approach. Of these, the protection and management of shared water resources such as the Mekong perhaps ranks highest.

The countries of the GMS are defined by their relation to the Mekong River. As one writer has noted, "the history of the Mekong is the history of relationships among these countries"

(Than 1997). The Mekong serves as a natural boundary, a trade and navigation route, a source of livelihoods in farming and fisheries, and, in recent years, a source of hydroelectric power. Furthermore, the riverine system is rich in flora and fauna, many of which are endemic to it (Sunchindah 2005). Around 700 fish species from more than 50 families have been recorded from the Mekong basin (MRC 2003), though more than 1 000 species are believed to occur there.

Besides the Mekong, the GMS is also home to at least four other major river systems: the Ayeyarwady, the Red River, the Thanlwin (Salween), and the Chao Phraya (see Figure 2.1). The flow volume of the Ayeyarwady is closest to that of the Mekong (ADB 2002a). The smallest of these systems, and also the system under the greatest pressure from development, is the Chao Phraya in Thailand.

In general, the Mekong basin is still under relatively little pressure from development. Acute water shortages are less of a concern for the basin than they are for such basins as the Chao Phraya. Overall water quality for the Mekong is still good (Hien 2003). Nevertheless, the river and its fisheries face a number of threats, all of which could intensify if not managed properly.

A major challenge is to achieve sustainable economic development that improves livelihoods, especially those that depend on natural resources. Most GMS countries hope to stimulate economic growth by developing their water resources, particularly by building dams and weirs for hydroelectric power, irrigation, water supply and flood control. Dams are common throughout the lower Mekong basin, though only two have been built across the mainstream Mekong. Internationally, the World Commission on Dams reports that dams can cause fragmentation of aquatic habitats, block fish migration routes, alter water levels and flow patterns, and increase water loss by evaporation (WCD 2000).

Other threats to the Mekong system include habitat loss from the conversion of floodplains to arable land. Between 1973 and 1993, more than a quarter of the flooded forest around Cambodia's Tonle Sap Lake was cleared (Degen and others 2000, cited by MRC 2003). Selective over-fishing also poses a threat, even though overall fish yields have been increasing. Large, slow-growing fish species such as the giant Mekong catfish (*Pangasianodon gigas*) and giant barb (*Catlocarpio siamensis*) are declining most rapidly (MRC 2003). However, work to tackle this threat is under way, for example captive breeding programmes of endangered fish species.

On land, the region's rich biological diversity faces many threats. The Mekong basin sits at the juncture of several biogeographical zones, resulting in a great variety of ecosystems and species. Under the WWF ecoregion⁴ classification system, the GMS can be divided into 40 distinct ecoregions. Six ecoregions lying wholly or partly within the GMS are recognized as areas of outstanding biodiversity: 1) Northern Indochina subtropical forests; 2) Annamite Range rain forests; 3) Cardamom Mountain rain forests; 4) Indochina dry forests; 5) Peninsular Malaysian rain forests; and 6) Kayah-Karen montane rain forests (ADB 2004b). All have exceptional levels of species richness and endemism, though globally the Northern Indochina forests are

most important. This ecoregion has the second-highest species richness of mammals in Asia and a diversity of tree species comparable to the humid tropical forests of Malaysia (ADB 2004b).

All six key ecoregions are threatened by human activity. Uncontrolled logging and wildlife hunting pose two of the greatest threats. Clearing of forests for cultivation or livestock pasture is also endangering habitats. Lowland forests are threatened by conversion to industrial crop plantations, roads, settlements and other infrastructure. Forest cover has declined in every country except Viet Nam and Yunnan, both of which have invested heavily in plantations. In 2000-05 the annual rate of forest loss averaged 0.2 per cent for the GMS as a whole (Table 6.1).

A serious concern is the illegal trade in wildlife, both within the GMS and across its boundaries. After habitat loss, it is the main threat to threatened and endemic species in the region (ADB 2006a). As populations of large mammals decline, the most visible trade flows increasingly involve small mammals, reptiles, fish and plants. The trade is also depleting protected areas. Many trade routes from Cambodia and Lao PDR, for example, link directly to protected areas (ADB 2005).

Land degradation is a major problem across the region. Land use changes—principally deforestation and the expansion of agriculture—are having serious impacts on soil quantity and quality. Typical effects of deforestation include soil erosion, soil compaction and gullyng. Deforestation is a particular concern in upland areas prone to erosion, especially where local farmers do not practise contour agriculture (for example in parts of Lao PDR, Thailand and Yunnan).

Irrigated agriculture also has far-reaching impacts on soil quality. International experience has shown that where saline soils occur, excessive irrigation, and irrigation with poor drainage, can cause salt to accumulate in surface waters. Salinization in the Khorat Plateau

⁴ See Glossary for definition of ecoregion.

in northeast Thailand, for example, has long been known to be such a case. However, recent improvements in surface water management in Thailand have helped to alleviate this problem (MRC 2003). In river deltas, for example the Mekong and Chao Phraya Deltas, salinization is caused by the intrusion of seawater. This is triggered by low outflows in the dry season, which can result in turn from over-extraction of water upstream.

Land degradation stems from improper soil, water and forest management. As such it has important legal and institutional aspects. Uncertain land tenure and a lack of alternative livelihoods, particularly for farmers with small landholdings, encourage over-intensive farming and lead to long-term degradation of land. A lack of strategic planning for land use and agrarian development also leads to land use conflicts and improper land management. Myanmar, for example, has no policy targets for land management, such as land zoning or demarcating conserved or critical land areas (ADB 2006a).

After land and water, the GMS faces growing threats from air pollution and the management of solid waste. Air pollution tends to be a localized but nonetheless serious problem. The rapid growth of the industrial, energy and transport sectors has led to serious air pollution in cities, industrial zones and around coal-fired power plants, particularly in Yunnan and Thailand. Forest fires, agricultural burning, open cooking and waste burning also affect rural and urban air quality. Land and forest fires contribute to the transboundary problem of smoke haze, which has caused economic losses in the far south of the region.

Providing services for waste management has become a key environmental issue for GMS countries. The volume of solid waste generated in urban areas is increasing with the growing population, higher levels of consumption, and the use of more packaging in the retail industry. Rates of waste generation are outstripping the capacities of local authorities to collect, treat and dispose of waste. In Viet Nam, the national rate of waste collection increased only slightly

from 71 per cent in 2000 to 74 per cent in 2003 (ADB 2006d). In Hanoi and Ho Chi Minh City, an estimated 1 million tonnes of solid waste are left uncollected every year. In Thailand, rates of municipal waste collection average 75–85 per cent in urban areas, but only 15–25 per cent in rural areas (ADB 2006b).

The disposal and treatment of industrial, toxic and hazardous waste also present challenges. The response of several GMS countries to these is beginning to show encouraging results. In Yunnan, the adoption of the Law on Prevention and Control of Environmental Pollution by Solid Waste in 1996 led to an increase in industrial waste recycling from around 20 per cent to over 40 per cent in 2004 (ADB 2006c). Nevertheless, Yunnan has yet to formulate a coherent approach to recycling covering both industrial and municipal wastes.

2.3 THE INSTITUTIONAL CONTEXT

The countries of the GMS are all committed to Agenda 21, the blueprint for achieving sustainable development adopted at the 1992 Earth Summit in Rio de Janeiro (ADB 2004b). The principles underlying Agenda 21 were reaffirmed and translated into a plan of implementation at the 2002 World Summit on Sustainable Development, held in Johannesburg, South Africa. The Johannesburg Plan of Implementation (JPOI) refocuses attention on the need to increase access to clean water and proper sanitation, as well as to energy, improved health services, more efficient agriculture and better protection of biodiversity and ecosystems.

The JPOI, together with the Millennium Development Goals adopted by the UN Millennium Declaration of 2000, provides the global context and framework for achieving sustainable development in the GMS. The region still lacks an overall plan or strategy for meeting the goals this framework embodies, but every country is part of the Regional Implementation Plan for Sustainable Development in Asia and the Pacific (2006–10). This plan, adopted in 2005 by members of the United Nations Economic

and Social Commission for Asia and the Pacific (ESCAP), seeks to integrate and support the various regional and national programmes aimed at the JPOI and Millennium Declaration.

Every country in the GMS has made some progress towards setting national priorities and enacting plans and policies in line with global targets for sustainable development. Much remains to be done, however, especially in terms of integrating social, economic and environmental concerns.

The range of plans and strategies for managing sustainable development is wide. In most countries, strategic planning has long been conceived in terms of fixed five-year development plans that set specific targets. These are still a vital tool for governments, but increasingly they are being supplemented by more participatory and process-oriented approaches (Dalal-Clayton and Bass 2002, UNDESA 2002). These include poverty reduction strategies (Cambodia, Lao PDR, Myanmar and Viet Nam); national environmental action plans and conservation strategies (Cambodia and Lao PDR); national Agenda 21 (China, Myanmar, Viet Nam), and national biodiversity strategies and action plans (all countries).

In general, these various national approaches have had mixed results. Although they have fostered institutions and legislation, especially for the environment, they have also suffered from many weaknesses. The most serious has been a lack of integration—both with other plans and initiatives, and with national decision-making and budgeting processes. Other weaknesses include limited national ownership, inadequate public consultation, and a lack of monitoring and evaluation (UNDESA 2002).

At the sub-regional level, the range of frameworks, initiatives and agreements promoting development is also wide. The 1995 Mekong Agreement (which gave rise to the Mekong River Commission, or MRC) is perhaps the most prominent inter-governmental agreement with its focus on transboundary management of the water and related resources of the Mekong basin.

The Association of South-East Asian Nations (ASEAN) is another major initiative, involving five of the six GMS countries. In 1996 ASEAN established the Mekong Basin Development Cooperation (AMBDC) programme to support sustainable development in the basin and strengthen links between ASEAN members and the Mekong riparian countries. All GMS countries are participating in the AMBDC.

Another key influence on development is the GMS Economic Cooperation Program, or simply the “GMS Program”, established in 1992 and financed by the Asian Development Bank (ADB). This has several focal areas. The GMS Program on Environment, for example, is coordinating development of a strategic environmental framework for the region.

Various United Nations bodies are also active in the region. ESCAP is responsible for regional cooperation and integration in the Asia-Pacific region and, by extension, the GMS. In 2000 ESCAP proclaimed 2000–09 the Decade of GMS Development Cooperation, hoping to focus international attention and support on enhancing development and environmental protection.

Besides these national and inter-governmental initiatives, various international non-governmental organizations are actively promoting sustainable development. They include the World Conservation Union (IUCN), WWF, the Wildlife Conservation Society and BirdLife International. Local non-governmental organizations and other civil society groups are also active in some countries.

Much remains to be done, however, before a truly regional framework for coordinating sustainable development becomes a reality. One key weakness is that the GMS still lacks a genuinely regional body with the mandate to develop and implement a shared vision of sustainable development. Without this, GMS countries will find it difficult to integrate global, regional and national sustainable development policies, and to adapt and extend them to the sub-regional level. ■



*Mekong Valley, taken from the cliffs of
Pha Taem National Park, Ubon Ratchathani, Thailand
Source: Matthew Markopoulos*

3 AIR

3.1 SOURCE OF AIR POLLUTION

As already noted, air pollution tends to be localized in the GMS, but still raises serious threats. The rapid growth of the industrial and agro-industrial sectors, particularly in Thailand and Yunnan, has caused severe air pollution in urban and peri-industrial areas. This has been exacerbated by local and regional sulphur dioxide (SO₂) and particulate matter pollution from coal-fired power plants. Air pollution is a major public health threat, and its associated treatment and cleanup costs are a serious drain on public finances.

Table 3.1 details levels of SO₂ and particulate matter of 10 micrometres (µm) or less in diameter (PM₁₀) in GMS capitals. This table highlights a serious problem in the GMS, and one which recurs throughout this report: the lack of environmental data.

As countries take measures to curb air pollution, PM₁₀ is emerging as one of the main airborne threats to health in urban areas. The primary source of PM₁₀ is vehicle traffic, particularly diesel vehicles. Next are area sources such as agricultural burning and forest fires, followed by industrial facilities, crematoria and other point sources. Sulphur dioxide from power plants, high-sulphur fuels and other sources also poses a serious health threat. When SO₂ combines

with nitrogen oxides and volatile organic compounds, and reacts with water and sunlight to form acid rain, it poses a threat to forest health and agricultural productivity. In 2005, the proportion of cities in Yunnan experiencing acid rain rose from 67 per cent to 73 per cent (YEPB 2005). Yunnan emitted 521 900 tonnes of SO₂ in 2005, almost 10 per cent more than the year before (YEPB 2005).

3.2 SOURCES OF AIR POLLUTION



Urban traffic, Bangkok, Thailand
Source: Thailand Environment Institute

Vehicles, and particularly diesel vehicles, are heavy emitters of particulate matter, SO₂ and other pollutants. Vehicle numbers are growing rapidly in Yunnan and Thailand, though remain relatively low elsewhere. The growing size of

Table 3.1. Levels of PM₁₀ and SO₂ in GMS capital cities, various years (unit: µg/m³).

	PM ₁₀			PM ₁₀ Standard ^a	SO ₂		SO ₂ Standard ^a
	1999	2002	2004		1995-2001 ^b	2003-2004	
Phnom Penh, Cambodia	...	410 ^c	...	330 ^c	3.4	...	300
Vientiane, Lao PDR	...	68 ^d	130 ^e	-	...	12 ^b	-
Yangon, Myanmar ^f	116	...	...	-	5.4 ^g	...	-
Bangkok, Thailand	82	83	...	120	11	...	300
Hanoi, Viet Nam	160	170	240	-	25 ^g	41	300
Kunming, Yunnan	84	78	86	50 ^h	19	57	50 ^h

^a National air quality standard (24-hour average concentration in µg/m³).

^b Data are for the most recent year available.

^c Data and standard refer to total suspended particulates. Cambodia does not routinely monitor levels of PM₁₀ or other particulate matter.

^d Average for September 2002-February 2003.

^e Average for March-April 2004.

^f No data are available for the new capital, Nay Pyi Taw.

^g Average for 1999.

^h Class 1 standard (Classes 2 and 3 allow higher levels).

Sources: ADB (2006d, 2006e, 2006h), China Statistical Yearbook (various years), GMS country submissions, World Bank World Development Indicators 2005 (http://devdata.worldbank.org/wdi2005/Table3_13.htm), World Bank World Development Indicators 2006 (http://devdata.worldbank.org/wdi2006/contents/Table3_13.htm).

Table 3.2. Commercial vehicles and passenger cars, selected years from 1990 to 2002 (unit: number of vehicles per thousand people).

	Commercial vehicles				Passenger cars			
	1990	1995	2000	2002	1990	1995	2000	2002
Cambodia	0.1	0.2	0.2	...	0.5	0.7	0.6	...
Lao PDR	...	...	...	...	...	...	...	...
Myanmar	2.5	3.4	5.3	5.5	1.9	3.4	3.4	3.4
Thailand	26.8	47.3	69.3	...	22.5	33.1	43.7	...
Viet Nam	0.4	0.5	0.9	...	...	...	...	...
Yunnan	...	...	7.3	7.3	...	...	6.7	8.8

Note: The data for Yunnan are calculated from provincial data on population and civil vehicle ownership. The data for passenger cars refer to all types of passenger vehicles; those for commercial vehicles refer to all types of trucks. As such they are not directly comparable to the data for other GMS countries.

Sources: China Statistical Yearbook (various years), GMS country submissions, UNEP (2006).

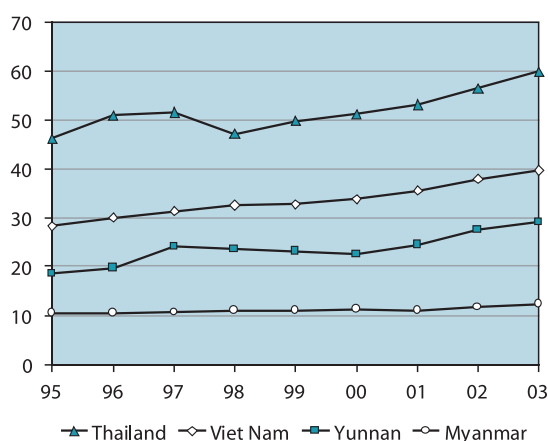


Figure 3.1. Total final energy consumption, 1995-2003 (unit: mtoe). Sources: Figures for Yunnan calculated from data in ADB (2006c), International Energy Agency Energy Statistics (<http://www.iea.org/Textbase/stats/index.asp>), UNEP (2006).

vehicle fleets is only part of the problem, however. Low emissions standards, poor road networks and outdated technology also contribute to high levels of air pollution. Table 3.2 details the growth in vehicle fleets to 2002.

As Table 3.2 shows, the proportion of passenger cars in Thailand almost doubled between 1990 and 2000. The proportion of passenger cars in Myanmar rose by a similar amount, though from a much lower base. The data for Yunnan also suggest rapid growth in passenger vehicles. Commercial vehicle numbers have grown even faster in Thailand, from 26.8 to 69.3 per 1 000 people. Elsewhere in the region they have risen more slowly.

Besides the transport sector, the energy sector is a major source of air pollution. It is also

the main anthropogenic source of carbon dioxide (CO₂), a key greenhouse gas. Total energy supply and consumption have risen steadily in the past decade, after falling slightly in the aftermath of the 1997-98 Asian financial crisis. Thailand is the region's largest consumer of energy (59.8 million tonnes oil equivalent in 2003), followed by Viet Nam (39.7 mtoe), Yunnan (29.1 mtoe) and Myanmar (12.3 mtoe). No data are available for Cambodia or Lao PDR (Figure 3.1).

The fuels used vary from country to country. In Thailand, for example, crude oil and petroleum products account for 47.5 per cent of primary energy supply, followed by natural gas (27.4 per cent), combustible renewables and waste (17.2 per cent), coal (7.1 per cent) and hydropower (0.8 per cent) (UNEP 2006). Yunnan, however, depends heavily on coal, which contributed between 60.7 per cent and 71.4 per cent of total primary energy supply between 1991 and 2003 (ADB 2006c).

3.3 IMPACTS ON HEALTH

All air pollutants are toxic to some degree, but fine particulate matter of 10 µm or less in diameter poses the greatest threat because the particles carry toxic substances deep into lung tissue (WHO 2000). Studies in Thailand and elsewhere have found a positive correlation between PM₁₀ levels and the number of cases of respiratory disease (Schwela and Gopalan 2002, Wangwongwatana 2002, World Bank 2002, Murray 2004). A similar link exists between respiratory disease and other pollutants, for

Table 3.3. Estimated deaths from respiratory diseases by WHO region, cause and mortality stratum, 1999-2002 (unit: thousand people).

Region	Cause Respiratory disease	Mortality stratum ^a	1999	2000	2001	2002
South-East Asia (includes Myanmar and Thailand)	Chronic obstructive	Low child, low adult	104	135	130	153
		High child, high adult	473	482	693	721
	pulmonary disease	Low child, low adult	46	52	66	100
		High child, high adult	249	255	548	556
	Asthma	Low child, low adult	20	22	21	20
		High child, high adult	34	35	66	77
Western Pacific (includes Cambodia, China, Lao PDR and Viet Nam)	Respiratory disease	Very low child, very low adult	55	57	59	59
		Low child, low adult	1 871	1 728	1 513	1 550
	Chronic obstructive pulmonary disease	Very low child, very low adult	22	23	23	22
		Low child, low adult	1 708	1 545	1 324	1 354
	Asthma	Very low child, very low adult	7	7	6	6
		Low child, low adult	50	55	33	37

^a WHO member countries are divided into five mortality strata, or groups, based on mortality rates in children under five and men aged 15-59. Source: WHO World Health Report (various years).

Table 3.4 Attributable mortality per million people by risk factor and WHO sub-region, 2000.

	SEAR-B	SEAR-D	WPR-B
Urban air pollution	11	10	23
Indoor fuel smoke	12	41	33
Population (000)	297 525	1 262 285	1 546 770

Note: SEAR-B includes Thailand; SEAR-D includes Myanmar; WPR-B includes Cambodia, China, Lao PDR and Viet Nam. Source: WHO World Health Report 2002 (<http://www.who.int/whr/2002/en/>).

example ozone and SO₂ (Schwela and Gopalan 2002). The World Health Organization (WHO) estimates that 30-40 per cent of asthma cases and 20-30 per cent of all respiratory diseases are linked to air pollution in some populations (WHO 2000).



Wearing masks going to school
Source: Thanh Thuy

Quantifying the health impacts of air pollution in the GMS is problematic, owing to a lack of data and the difficulty of identifying root causes. The available data on mortality usually

distinguish between cause of death, such as respiratory disease, but tend not to identify the factors (environmental or otherwise) leading to disease and death. Tables 3.3 and 3.4 provide some estimates of mortality, though these do not refer specifically to the GMS.

The health impacts of indoor air pollution are sometimes underestimated. In Yunnan, many rural residents burn smoky coal inside their homes with little or no ventilation. This practice causes high rates of debilitating respiratory diseases. Women in rural Xuan Wei county, for example, have the highest recorded rate of lung cancer among Chinese women, even though less than one per cent of them smoke (Hricko 1994). The cause has been traced to high levels of particulate matter suspended in smoke from burning coal. Women are at greater risk because they spend more time inside the home, and traditionally do the cooking. Besides indoor emissions from burning coal, wood and other biomass fuels, studies have shown that stir-frying, deep-frying and other high-temperature frying methods (common in the GMS) can produce carcinogenic emissions (Straif, Baan, Grosse, Secretan, El Ghissassi and Coglianò 2006).

The health costs of air pollution can be substantial. The World Bank (2002) estimated the health costs of PM₁₀ in six cities in Thailand (including Bangkok) in 2000 to be US\$643.9 million.

The health costs in Bangkok alone were equivalent to 0.5 per cent of GDP, with each resident paying an average of US\$46 every year (World Bank 2002).

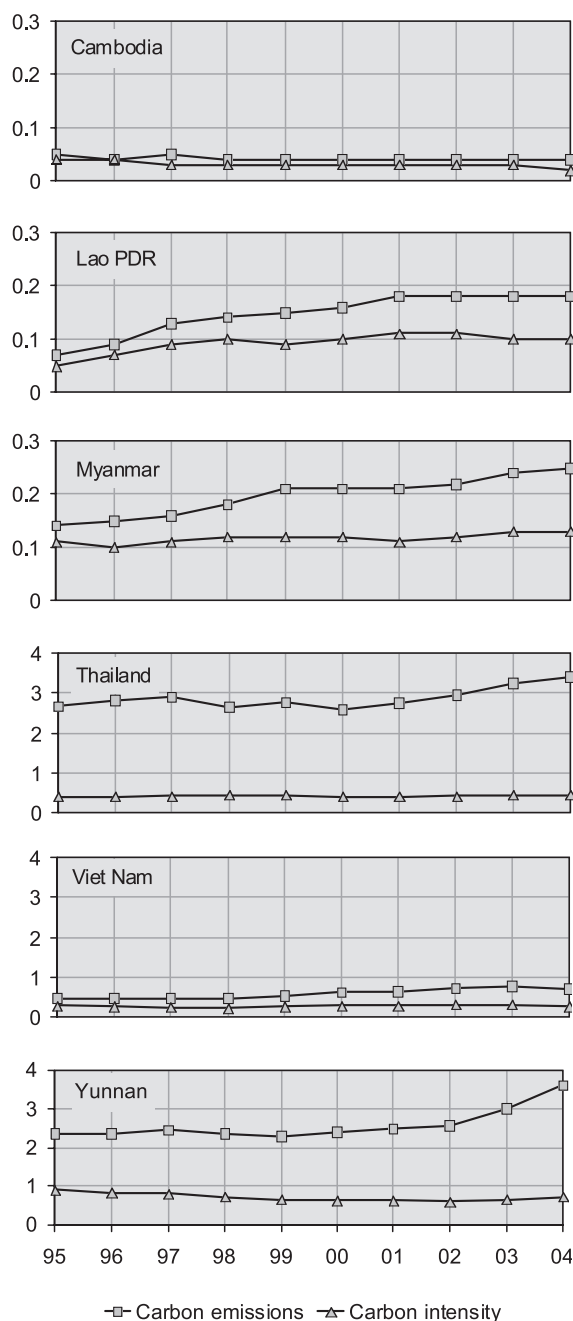


Figure 3.2. Carbon dioxide emissions and carbon intensity from the consumption and flaring of fossil fuels, 1995-2004 (emissions units: tonnes CO₂ per capita; intensity units: tonnes CO₂ per thousand 2000 PPP US\$ of GDP). The data for Yunnan refer to the whole of China. Note the difference in the scale of the vertical axis between Cambodia, Lao PDR and Myanmar; and Thailand, Viet Nam and Yunnan. Source: EIA (2006).

3.4 CLIMATE CHANGE

Atmospheric concentrations of CO₂ have been rising since the industrial revolution, largely because of anthropogenic emissions from burning fossil fuels. Carbon dioxide is one of the main greenhouse gases, and the rise in concentrations has been linked to the enhanced greenhouse effect known as "global warming" (UNEP 2002).

Table 3.5. Ratification of key international treaties on atmospheric pollution.

	Climate change ^a	Ozone layer	CFC control	Kyoto Protocol
Cambodia	1996	2001 ^b	2001 ^b	2002 ^b
Lao PDR	1995	1998 ^b	1998 ^b	2003 ^b
Myanmar	1994	1993 ^b	1993 ^b	2003 ^b
Thailand	1995	1989 ^b	1989	2002
Viet Nam	1995	1994 ^b	1994 ^b	2002
Yunnan	1994	1989 ^b	1992 ^b	2002 ^c

Note: The data for Yunnan refer to the whole of China.

^a Years shown refer to the year the treaty entered into force.

^b Accession.

^c Approval.

Sources: GMS country submissions, World Bank World Development Indicators 2006 (http://devdata.worldbank.org/wdi2006/contents/Table3_14.htm).

Greenhouse gas emissions are unevenly distributed among countries and regions. In general, industrialized countries are responsible for the majority of historical and current emissions, though fast-growing economies such as India and China are now emitting large quantities of greenhouse gases.

Overall, the GMS is not a major emitter of CO₂ (Figure 3.2). Although Thailand is the region's leading emitter, its emissions are low in comparison with industrialized countries. Carbon intensity, however, is rising in most countries, in particular Thailand and Yunnan. This means that CO₂ emissions are growing faster than GDP, and that economic growth is becoming more, not less, carbon-intensive.

3.5 REGIONAL AND INTERNATIONAL AGREEMENTS

The countries of the GMS are committed to multilateral actions to reduce atmospheric pollution and maintain air quality. The threat from smoke haze, for example, provided the impetus for the adoption of a Regional Haze Action Plan by ASEAN in 1997 (covering every

country in the GMS except China). This was later formalized by the 2002 ASEAN Agreement on Transboundary Haze Pollution. Members of ASEAN in the GMS have recently proposed forming a regional group to intensify cooperation in implementing this Agreement (ASEAN 2006). The importance of cooperation has been underscored by the severe haze pollution of 2006, the worst since 1997-98 (The Economist 2006).

At the international level, all governments in the GMS have signed treaties governing atmospheric pollution. Table 3.5 above details each government's commitment to four key treaties (Chapter 12 includes more detailed country treatments of international environmental co-operation):

1. THE FRAMEWORK CONVENTION ON CLIMATE CHANGE aims to stabilize atmospheric concentrations of greenhouse gases at levels that will prevent human activities from interfering dangerously with the global climate.

2. THE VIENNA CONVENTION FOR THE PROTECTION OF THE OZONE LAYER aims to promote research on the effects of changes in the ozone layer and on alternative substances (such as substitutes for chlorofluorocarbons, or CFCs) and technologies, monitoring the ozone layer and taking measures to control the activities that produce adverse effects.

3. THE MONTREAL PROTOCOL FOR CHLOROFLUOROCARBON CONTROL requires that countries help protect the earth from excessive ultraviolet radiation by cutting CFC consumption by 20 per cent from 1986 levels by 1994 and by 50 per cent from 1986 levels by 1999, with allowances for increases in consumption by developing countries.

4. THE KYOTO PROTOCOL on climate change was adopted at the third conference of the parties to the Framework Convention on Climate Change, held in Kyoto, Japan, in December 1997. ■

4 LAND

4.1 AGRICULTURE AND FOOD PRODUCTION

The main cause of pressure on the land resources of the GMS is increasing food production. Food was needed for 16 million more people in 2005 than in 2000—almost as many as the combined populations of Cambodia and Lao PDR. The region's population is set to increase to almost 300 million people by 2015, putting more pressure on land (see Chapter 2).



Agricultural land (defined as land under arable use plus permanent crops) has increased steadily. Viet Nam and Yunnan have recorded some of the highest rates of growth (Table 4.1). Between 1990 and 2003, Viet Nam's arable land grew by a quarter, and its permanent cropland more than doubled. This expansion allowed Viet Nam to outpace population growth, increasing its area of cropped land per capita by 14.8 per cent to 1 110 m². In the same period, Yunnan more than doubled its arable land area, increasing per capita distribution by 85 per cent to 1 410 m². As ADB (2006c) notes, however, the quality of Yunnan's extra land and the environmental effects of this expansion are poorly documented. In the GMS as a whole, the increase in cropped land has not kept pace with population growth, causing overall per capita allocation to fall by almost 11 per cent to 1 866 m².

Poor agricultural practices, often aimed at intensifying production, contribute to increased land pressure. The excessive use of fertilizers

Table 4.1. Land use, 1990 and 2003.

Share in total land area (%)									
	<i>Land</i> area ^a (000 ha)	Agriculture				Others		Cropped land per capita (m ²)	
		Arable land		Permanent cropland					
		1990	2003	1990	2003	1990	2003	1990	2003
Cambodia	17 652	20.9	21.0	0.6	0.6	78.5	78.4	4 413	2 862
Lao PDR	23 080	3.5	4.1	0.3	0.4	96.3	95.5	2 077	1 815
Myanmar	65 755	14.5	15.3	0.8	1.4	84.7	83.3	2 469	2 063
Thailand	51 089	34.2	27.7	6.1	7.0	59.7	65.4	3 690	2 778
Viet Nam	32 549	16.4	20.5	3.2	7.1	80.4	72.4	967	1 110
Yunnan	38 264	7.2	15.7	...	...	...	...	763 ^b	1 410 ^b
GMS	228 389	17.3	18.2	—	—	—	—	2 095	1 866

^a Land area refers to the total area of a country, excluding areas under inland waterbodies. For all countries except Yunnan, the source of these data is FAO (2006). The source for Yunnan is ADB (2006c).

^b Data refer to arable land only.

Sources: Asian Development Bank Key Indicators 2006 (http://www.adb.org/documents/books/key_indicators/2006/default.asp), Yunnan State of the Environment (various years).

Table 4.2. Consumption and intensity of use of chemical fertilizer, 1995-2004.

	Cambodia		Lao PDR		Myanmar		Thailand		Viet Nam		Yunnan	
	000 t	kg/ha	000 t	kg/ha	000 t	kg/ha	000 t	kg/ha	000 t	kg/ha	000 t	kg/ha
1995	9.8	2.6	6.2	6.9	363.6	17.8	1 507.0	73.8	1 223.7	181.3	880.0	...
1996	7.8	2.0	3.8	4.2	316.2	17.2	1 519.8	75.7	1 484.5	212.0	972.3	...
1997	21.9	5.8	7.8	8.3	185.9	17.5	1 481.0	75.4	1 471.7	204.3	1 057.9	...
1998	7.6	2.0	4.6	4.9	228.8	16.9	1 637.0	85.0	1 856.9	250.5	1 052.2	...
1999	...	...	9.9	10.4	122.7	15.9	1 763.0	91.7	2 057.6	264.8	1 084.4	...
2000	...	...	6.0	6.3	260.0	19.6	1 560.9	81.1	2 267.0	278.6	1 120.9	...
2001	...	...	12.3	12.8	117.2	9.0	1 684.1	87.2	1 906.5	215.6	1 200.4	...
2002	...	...	7.0	7.0	80.9	12.5	1 700.6	87.8	1 975.2	224.1	1 250.9	...
2003	...	...	...	...	18.6	...	...	...	...	...	1 292.0	...
2004	...	...	...	...	...	...	...	...	...	...	1 372.0	...

Sources: China Statistical Yearbook (various years), FAOSTAT (<http://faostat.fao.org/site/422/default.aspx>), GMS country submissions.

Table 4.3. Consumption and intensity of use of pesticides in Thailand and Viet Nam, 1995, 1998 and 2001.

	Total Consumption (000 tonnes)									Intensity of use (kg/ha)		
	Insecticides			Herbicides			Fungicides			1995	1998	2001
	1995	1998	2001	1995	1998	2001	1995	1998	2001			
Thailand	6 827	7 374	...	11 935	8 727	...	4 827	2 468	...	1.2	1.1	...
Viet Nam	16 452	9 714	9 661	4 979	5 269	3 982	3 465	5 474	5 391	3.7	2.9	2.3

Sources: FAOSTAT (<http://faostat.fao.org/site/424/default.aspx>), UNEP (2006).

grew rapidly between 1995 and 2005, particularly in Thailand, Viet Nam and Yunnan (Table 4.2). In 2002, these three countries together consumed more than 4.9 million tonnes of fertilizer, or about 27 kg, 25 kg and 29 kg per capita respectively. The intensity of fertilizer use is still relatively low, except in Viet Nam, where it remains high after peaking at 278 kg/ha in 2000.

Pesticides are used throughout the region, often indiscriminately, and are often disposed of without proper precautions. The available data on pesticide use are limited, but indicate high levels of consumption in Thailand and Viet Nam (Table 4.3). They also suggest, however, that the intensity of pesticide use in these two countries is gradually declining.

Irrigation is an important element of agricultural production in the GMS. Planned increases in irrigated areas (see Chapter 5) have implications for land resources, since poorly designed or implemented irrigation schemes can cause waterlogging, salinization and alkalization of soils (UNEP 2002). These problems can lead to large areas of irrigated land being abandoned, even though the total area of irrigated land may continue to rise.

The focus of irrigated agriculture in the GMS is on rice, the region's staple food crop. The main rice producers are Myanmar, Thailand and Viet Nam. Of these, Viet Nam is the largest, with a planted area of 6.3 million ha, or 82 per cent of its total farm area (ADB 2004b). Viet Nam became a net exporter of rice in 1989 and is now competing strongly for market share with Thailand, the world's largest rice exporter for more than a decade (OAE 2005).

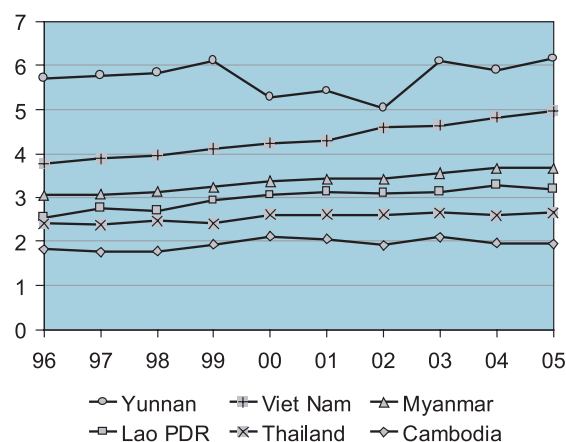


Figure 4.1. Rough rice yields, 1996-2005 (unit: tonnes/ha). Sources: FAOSTAT (<http://faostat.fao.org/site/408/default.aspx>); yields for Yunnan calculated from data on production and area in China Statistical Yearbook (various years).

Rice yields in the region have grown relatively slowly over the past decade, and are still low compared with other Asian countries (see Figure 4.1 above). The exceptions are Viet Nam and Yunnan. The former has increased rice yields by more than 1 tonne per hectare in the past decade through the use of high-yielding modern varieties and more intensive production practices. The low yields in Cambodia, Lao PDR and Thailand are due to such factors as variable rainfall, low soil fertility, limited farm infrastructure, and the cost and limited supply of chemical fertilizers. Many Thai farmers also prefer to grow high-quality but low-yielding rice varieties as these fetch top prices both domestically and

internationally (ADB 2004b).

With the exception of Thailand, agriculture is still the mainstay of most economies in the GMS. It provides the main source of livelihood for most of the region's poor, as well as the main contribution to GDP and export earnings (for GDP see Table 4.4). Agriculture accounts for almost half of GDP in Lao PDR and Myanmar, between 20 per cent and 33 per cent in Cambodia, Viet Nam and Yunnan, and just over 10 per cent in Thailand. In recent years rapid growth in non-agricultural sectors has reduced the importance of agriculture in the Thai economy, though it still employs about half of the labour force (ADB 2004b).

Table 4.4. *The contribution of agriculture to GDP, selected years from 1995-2004*

	GDP growth (%)				GDP share of agriculture (%)			
	1995	2000	2002	2004	1995	2000	2002	2004
Cambodia	6.5	8.4	5.2	7.7	49.6	37.9	34.2	32.9
Lao PDR	7.1	5.8	5.9	6.9	55.2	52.6	50.4	47.0
Myanmar	7.0	13.7	12.0	13.8 ^a	37.1 ^b	...	47.4 ^c	44.0 ^d
Thailand	9.2	4.8	5.3	6.2	9.5	9.0	9.4	10.1
Viet Nam	9.5	6.8	7.1	7.8	27.2	24.5	23.0	21.8
Yunnan	11.2	7.1	8.2	11.5	...	22.3	21.1	20.4

^a Financial year (FY) 2003 (April 2003-March 2004).

^b FY 1995

^c FY 2001

^d FY 2004

Sources: Asian Development Bank Key Indicators 2006 (http://www.adb.org/documents/books/key_indicators/2006/default.asp), China Statistical Yearbook (various years), GMS country submissions, World Bank (2006).

Table 4.5. *Public expenditure on agriculture in total and as a proportion of total public expenditure, 1995 and 2001-05 (unit: million US\$).*

	Cambodia		Lao PDR		Myanmar		Thailand ^a		Viet Nam ^b		Yunnan ^c	
	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%
1995	5.4	1.0	5.8	1.6	3 025.2 ^d	13.9	13.9	10.2	316.6	7.2	...	...
2000	10.6	1.2	145.5	4.7	9 473.3 ^e	11.8	11.8	8.0	511.6	5.5	231.0	4.7
2001	12.4	1.2	539.3	13.7	...	...	...	8.3	638.1	5.9	236.0	4.0
2002	16.2	1.3	...	...	...	...	...	7.9	633.5	5.2	205.4	3.3
2003	15.9	1.3	...	...	...	...	...	6.9	...	...	481.3	6.8
2004	15.8	1.3	...	...	...	...	...	...	...	...	746.7	9.4
2005	17.0	1.4	...	...	...	...	...	...	...	...	726.9	7.9

Note: National currencies have been converted to US\$ at a constant 1995 rate.

^a Data refer to agriculture, forestry and fisheries.

^b Data refer to agriculture and forestry.

^c Data for 2000-02 refer to provincial government expenditure on "agricultural production and agricultural development"; data for 2003-05 refer to expenditure on agriculture and forestry.

^d FY 1994.

^e FY 1999.

Sources: Asian Development Bank Key Indicators 2006 (http://www.adb.org/documents/books/key_indicators/2006/default.asp), China Statistical Yearbook (various years), GMS country submissions, World Bank (2000a, 2005a).

Public expenditures on the agricultural sector vary with the importance of the sector, development priorities, economic growth and other variables. The available data indicate that expenditures have grown in both absolute and proportional terms in Lao PDR, Yunnan and, to a lesser extent, Cambodia. Expenditures in Thailand and Viet Nam increased in absolute terms between 1995 and 2002-03, but declined as a proportion of total spending (by 3.3 percentage points in Thailand and by 2 percentage points in Viet Nam) (see Table 4.5 above).

4.2 LAND DEGRADATION

Land degradation greatly reduces the productive capacity of land. Human activities contributing to land degradation include unsuitable agricultural land use, poor soil and water management practices, deforestation (see Chapter 6), removal of natural vegetation, frequent use of heavy machinery, overgrazing, improper crop rotation and poor irrigation practices (UNEP 2002). Natural disasters, including droughts and floods, also contribute (see below).

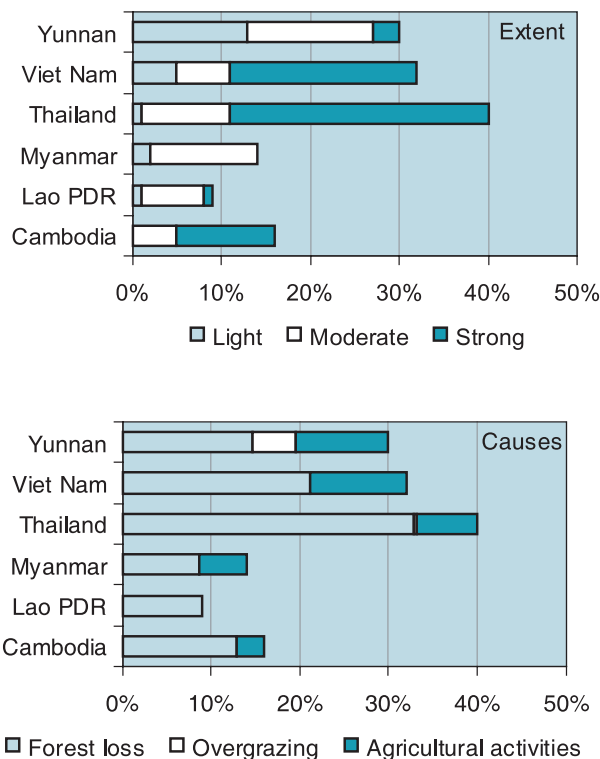


Figure 4.2 Extent and causes of land degradation, 1990. The data for Yunnan refer to the whole of China. Source: ADB (2006b).

Table 4.6. Soil erosion estimates, various years and sources.

	Year	Estimate	Source
Cambodia	1998	>2 m/year	WHO (2004b)
Lao PDR	2003	5–10 m/year	WHO (2005b)
Myanmar	1998	10.1% of agricultural land area vulnerable	ADB (2006e)
Thailand	1995	41.95% of land area affected	WHO (2004c)
	2000	34.04% of agricultural land area vulnerable	ADB (2006b)
	2002	33.95% of agricultural land area vulnerable	ADB (2006b)
Viet Nam	1999	69.4% of land area vulnerable	Country submission
	2005	2 000 million tonnes/ year	World Bank (2005b)
Yunnan	1987	37.17% of land area affected	ADB (2006c)
	1997	30.36% of land area affected	Wang and Otsubo (2002)
	1999	514 million tonnes/year	ADB (2006c)
	1999	366 million tonnes/year	Shen (2004)
	2000	35.87% of land area affected	ADB (2006c)
	2000	12.85% of land area affected	Shen(2004)

Land degradation is a major problem across the GMS (see Figure 4.2 above). In the early 1990s it was estimated that about 40 per cent of all usable land in Thailand had been degraded. In Viet Nam and Yunnan, about a third of usable land had been degraded. Lao PDR had the least degradation, caused solely by deforestation. In fact, forest loss has been the main cause of land degradation in the GMS, followed by agriculture. Only in China, which has extensive grasslands, has overgrazing caused serious degradation. In Yunnan itself, 7.22 million ha, or just over 47 per cent of the province's available grazing land, are classed as moderately to severely degraded (YEPB 2004).

The mountainous nature of much of the GMS means that soil erosion is a major factor in land degradation. Table 4.6 above collects some of the data available on the actual or potential extent of erosion. These suggest that erosion is a serious, albeit declining, problem in Thailand and Yunnan, and a critical problem in Viet Nam. Erosion still poses a relatively minor threat to Myanmar, though more than 1.9 million ha, or just over 10 per cent, of the country's agricultural land area are classed as vulnerable.

4.3 DESERTIFICATION

Desertification is defined as land degradation in arid, semiarid and dry subhumid areas caused by climatic variations and human activity (UN 1992). It is a localized problem in the GMS, often conflated with other processes of degradation.

Data on the extent or threat of desertification in the region are limited. Eswaran, Lal and Reich (2001) estimate that 67 per cent of Cambodia's land area is moderately or highly vulnerable to desertification; 15 per cent of Lao PDR; 27 per cent of Myanmar; 64 per cent of Thailand and 18 per cent of Viet Nam. The Government of Viet Nam (2002) reports that desertification affects about 7.55 million ha, or 23 per cent, of the country.

Data on vulnerability are unavailable for Yunnan, though rock desertification is known to threaten its karst landscapes (ADB 2006c). A serious problem in the karst environments of southwest China, rock desertification involves soil and water erosion, exposure of bedrock and reduced soil productivity. Its main causes are intensive cultivation on steeply sloping hillsides, excessive collection of fuelwood and a lack of proper land management, all of which stem partly from population pressure (Wang, Liu and Zhang 2004, Zhang, Li, Zhou, Zhang and Yu 2006). YIES (2005) estimates that rock desertification affects 2.2 million ha, or 5.7 per cent, of Yunnan's land area.

4.4 NATURAL DISASTERS

The people and environment of the GMS are increasingly suffering the effects of natural disasters. Growing economic activity and population densities, migration and unplanned urbanization, and environmental degradation are all contributing to greater economic losses from extreme weather and other events.

It is unclear whether natural disasters are becoming more frequent or extreme, as a possible result of climate change. Table 4.7 below does not show any obvious upwards trend in the incidence or extent of drought or flooding, though it is limited to a six-year period. A much longer analysis of flooding in one river basin, the Mekong, has revealed no exceptional floods between 1982 and 1999, a series of extreme floods in 2000-02, and a return to normal flood conditions in 2003-04 (MRC 2005). The flood of 2005 was also exceptional, though confined to the central area of Lao PDR and parts of north-east Thailand (MRC 2006a). Overall, severe floods are quite common in the lower Mekong basin, and there is no evidence yet of any change—upwards or downwards—in the average flow volume of the Mekong River between 1960 and 2004 (MRC 2005).

Table 4.7 Occurrence and impact (area affected) of fire, flooding and drought, 2000-05 (unit: thousand ha).

			2000	2001	2002	2003	2004	2005
Fire	Cambodia	Area	...	...	...	...	...	...
		No.	...	...	...	...	...	...
	Lao PDR	Area	...	...	...	...	...	...
		No.	...	...	...	...	...	...
	Myanmar	Area	...	...	...	...	...	...
		No.	104	161	128	110	...	...
	Thailand	Area	0.2	0.03	0.09	0.9	0.2	...
		No.	1 814	1 498	1 135	2 267	1 727	...
	Viet Nam	Area ^a	1.5	2.5	15.6	1.4	4.2	...
		No.	477	490	...	...	995	...
	Yunnan	Area ^a	0.3	2.3	0.7	2.2	1.3	...
		No.	192	673	396	786	550	...
Flooding	Cambodia	Area ^b	421.6	114	43.2	...	...	9.9
		No.	...	...	...	...	...	...
	Lao PDR	Area ^b	42.9	42.2	34.1	0.8	14.4	54.8
		No.	...	...	...	...	...	...
	Myanmar	Area	208.9	105.1	247.8	35.7	...	...
		No.	9	13	28	10	18	...
	Thailand	Area ^b	1 654.5	4 661.4	1 669.9	255.3	317.6	143.2
		No.	12	14	5	17	12	6
	Viet Nam	Area ^b	141.6	9.8	...	>120	...	3.9 ^c
		No.	...	...	...	...	...	...
	Yunnan	Area	204	231	259	119	143	113
		No.	...	...	...	...	...	...
Drought	Cambodia	Area ^b	...	...	191.9	...	...	...
		No. ^d	...	...	8	...	...	...
	Lao PDR	Area	...	...	...	...	...	...
		No.	...	...	...	...	...	...
	Myanmar	Area	383.3	...	23.5	64.0	...	...
		No.	...	...	...	...	...	...
	Thailand	Area	75.6	274	805.3	77.5	236.9	2 197.9
		No. ^d	59	51	68	63	64	71
	Viet Nam	Area	...	...	143.6	...	...	...
		No.	...	...	...	...	...	...
	Yunnan	Area	113	280	194	491	104	1 192
		No.	...	...	...	...	...	...

^a Forest fires. ^b Area of crop damage. ^c Mekong basin only. ^d Number of provinces affected.

Sources: ADB (2004b, 2006d), China Statistical Yearbook (various years), FAO (2001), GMS country submissions, Government of Cambodia (2002a), Government of Viet Nam (2002, 2004), IFRC (2002), MRC (2006a), OCHA (2000, 2002), Phonevilay (2006), Sounnalath (2006), Thailand Department of Disaster Prevention and Mitigation Statistics (<http://www.disaster.go.th/disaster01/page/report00.htm>), UNDP/MARD (2002), World Bank (2005b), Yunnan State of the Environment (various years).

The difficulty of identifying and attributing the effects of climate change on a complex system such as the Mekong is exacerbated by their uncertain nature. Different predictive models disagree on the exact effects of a warmer climate on low-latitude rivers such as the Mekong,

though in general they predict lower annual flows (Nijssen, O'Donnell, Hamlet and Lettenmaier 2001). As noted, no such change has been registered in the flows of the Mekong. Overall, at the scale of the Mekong basin, there is still no clear indication of any significant

change in local or regional climate and hydrology due to greenhouse gas emissions (Chinvanno 2003).

Chapter 7 discusses issues of land degradation and natural disasters in more detail. ■

5 WATER

5.1 WATER RESOURCES AND AVAILABILITY

Surface run-off is the main supply source of water in the Mekong and other river basins of the GMS. Table 5.1 details water yield and annual run-off for five of the region's major river basins.

Table 5.1. Catchment area, run-off and annual water yield for five major river basins.

	Mekong	Ayeyarwady		
Catchment area (km ²)	795 000	411 000		
Mean annual run-off (mm)	560	1 000		
Water yield (million m ³)	475 000	410 000		
	Thanlwin (Salween)	Chao Phraya	Red	
Catchment area (km ²)	325 000	160 000	169 000	
Mean annual run-off (mm)	466	188	782	
Water yield (million m ³)	151 000	29 800	177 000	

Source: ADB (2004b).

The Mekong exhibits a wide seasonal variation in flow, with consistent dry season and wet season patterns. The flow increases dramatically from the dry-season lows of December–April to the wet-season highs of May–November (ADB 2004b). Most of this flow enters the Mekong system in the lower half of the basin below Chiang Saen in Thailand (see Figure 2.1). Upstream of Chiang Saen, the flow is dominated by run-off mostly from Yunnan, with smaller contributions from Myanmar and Lao PDR (ADB 2004b). Almost two-thirds of the total flow enters the river between Vientiane in Lao PDR and Kratie in Cambodia. Downstream of Kratie, the flow regime is dominated by the Tonle Sap system and the dynamics of the Mekong Delta (ADB 2004b).

The GMS as a whole does not suffer from a lack of water. A common measure of water resources is per capita water availability, the amount of water available per person per year. According to the international water stress index (Engelman and LeRoy 1993), a per capita water availability of 1 700 m³ indicates periodic or regular water stress; less than 1 000 m³ indicates chronic water scarcity; and less than 500 m³ indicates absolute water scarcity, outright shortages and acute scarcity. Table 5.2 shows that the GMS has substantial water resources, though they are unevenly distributed. Per capita

water availability in Lao PDR, for example, is an order of magnitude greater than in neighbouring Thailand or Yunnan.



Can Tho, Viet Nam
Source: Mekong River Commission

The data in Table 5.2 refer only to renewable fresh water. They do not include the groundwater resources that many countries draw on to supplement their supplies. Moreover, aggregate measures of water availability say nothing about the timing or seasonality of this availability (Gardner-Outlaw and Engelman 1997). Most countries in the GMS have a plentiful, often excessive, supply of fresh water during the wet season, but can experience severe, though temporary, water shortages during the dry season. Economic constraints and inadequate water supply systems can also restrict water availability. Rapid urbanization is putting pressure on existing water and sanitation systems, causing localized water shortages and pollution. Chapter 8 discusses water scarcity in more depth.

Table 5.2. Per capita water availability, 1993–2007 (unit: m³/person/year).

	1993–97	1998–2002	2003–07
Cambodia	9 917	8 731	8 133
Lao PDR	38 719	34 440	32 176
Myanmar	19 353	18 026	17 370
Thailand	3 554	3 377	3 277
Viet Nam	4 882	4 565	4 385
Yunnan ^a	2 251	2 160	2 115
GMS	8 041	7 462	7 161

Note: Data are for the most recent year available in each five-year period.

^a Data refer to the whole of China. As such, they are likely to under estimate per capita water availability in Yunnan, which lies in the water-rich southern rivers area of China (World Bank 2001a).

Source: FAO AQUASTAT (<http://www.fao.org/waicent/faoinfo/agricult/agl/aglw/aquastat/dbase/index.htm>).

5.2 WATER CONSUMPTION

Agriculture is the largest consumer of the region's water resources, and will remain so for the foreseeable future (Figure 5.1). In the larger economies such as Thailand, however, future demand for water is expected to grow most rapidly in non-agricultural sectors such as tourism, industry and the residential sector (UNEP 2001).

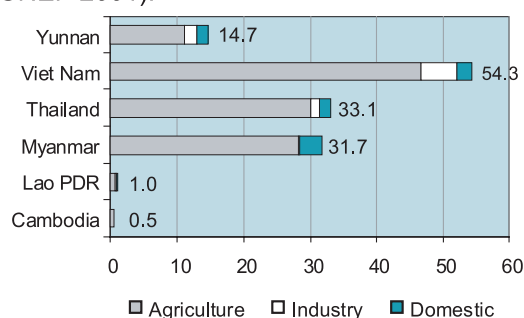


Figure 5.1. Annual freshwater withdrawals by major sector, 2000 (unit: thousand million m³). Total withdrawals are shown at the end of each column. Withdrawals by industry in Cambodia and Myanmar are negligible (around 1 per cent); in Lao PDR they account for 10 per cent. Sources: Based on data in ADB (2004b) and GMS country submissions.

Within the agricultural sector, irrigated agriculture accounts for most of the demand for water. Development of the region's agricultural sector depends heavily on intensifying production by increasing the area of cropland under irrigation (ADB 2004b). In the past decade, every country in the GMS has increased its area of land under irrigation or equipped with irrigation (Table 5.3). This trend is set to continue as countries such as Cambodia, Lao PDR, Thailand and Viet Nam

develop new irrigation schemes. Large-scale irrigation schemes are associated with dams and water diversions, with their consequent impacts on fish populations and habitats. Groundwater is a potential alternative supply, though its long-term sustainability is uncertain (ADB 2004b).

5.3 WATER QUALITY

Water quality is a growing concern affecting many different uses in the Mekong and other river basins of the GMS. Quality of water is especially relevant to domestic water use and sanitation, where the quality of water at the point of consumption has a direct effect on personal health, well-being and productivity (MRC 2003).

Pollution of water supply sources, both surface and groundwater, with human and animal waste, and solid wastes, is common and increasing in the GMS. In Lao PDR, for example, the length of rivers where farming, food processing and other activities have adversely affected water quality was estimated in 1997 to be 10 per cent with severe impact, and 20 per cent with moderate impact (ADB 1997, cited by MRC 2003).

Sources of contamination are widespread. The main sources of organic water pollution are domestic, industrial and agricultural discharges. In some countries, for example Thailand, the most important of these in terms of volume and some pollutants is the discharge of untreated

Table 5.3. Irrigated land area, 1996–2005 (unit: thousand ha).

	Cambodia	Lao PDR ^a	Myanmar	Thailand	Viet Nam ^b	Yunnan
1996	...	...	1 557	4 714	...	1 284
1997	...	104	1 592	4 749	...	1 321
1998	407	146	1 692	4 789	...	1 350
1999	...	218	1 841	4 948	...	1 374
2000	...	246	1 910	4 986	8 000	1 403
2001	...	257	1 986	4 986	7 400	1 424
2002	...	...	1 869	4 986	8 000	1 442
2003	...	...	1 960	4 986	8 200	1 457
2004	...	...	...	...	8 300	1 469
2005	589 ^c	...	...	...	8 400 ^d	1 485

^a Data refer to the average area of land equipped with irrigation in the wet and dry seasons.

^b Data refer to the area of land equipped with irrigation. The area actually irrigated is much less, owing to incomplete systems, a lack of water, poor design or a lack of upkeep (World Bank 2000a).

^c Estimated.

^d National development plan target.

Sources: China Statistical Yearbook (various years), FAOSTAT (<http://faostat.fao.org/site/419/default.aspx>), GMS country submissions, Government of Cambodia (2005).

domestic wastewater (World Bank 2001b, ADB 2006b). Table 5.4 shows that domestic wastewater discharges in Thailand are high and have continued growing over the past decade. The proportion of untreated wastewater is also high and has remained static since 2001. The lack of data for some countries makes it difficult to draw comparisons across the GMS. Untreated industrial discharges in Yunnan are declining, however. In Viet Nam, well over 90 per cent of wastewater is still discharged without treatment.

Table 5.4 Amount and proportion of wastewater discharged without treatment, 1995–2005 (unit: m³/day).

	Thailand ^a		Viet Nam		Yunnan ^b	
	Total	%	Total	%	Total	%
1995	1 615 404	82	...	>90	491 342	37
1996	1 611 988	81	...	...	311 288	30
1997	1 621 158	80	...	...	412 110	33
1998	1 622 429	79	...	...	300 411	26
1999	1 605 266	78	...	...	177 890	18
2000	1 587 327	77	...	>90	152 904	16
2001	2 409 577	75	...	...	...	...
2002	2 426 559	75	...	...	...	...
2003	2 435 583	75	...	92	...	...
2004	...	...	...	...	...	...
2005	...	...	...	96	...	...

^a Data refer to domestic wastewater from urban areas only.

^b Data refer to industrial wastewater only.

Sources: ADB (2006b, 2006c), GMS country submissions.

Two key indicators of overall water quality are biochemical oxygen demand (BOD) and chemical oxygen demand (COD). The former is the amount of oxygen consumed in the biological processes that oxidize organic matter. The greater the BOD, the greater the degree of organic pollution. The latter is the amount of oxygen required to oxidize all compounds, both organic and inorganic, in water.

As with wastewater discharges, a lack of data makes it difficult to compare BOD discharges across the GMS. Table 5.5 details BOD discharges from industrial sources in Thailand and Viet Nam. The only country for

which complete data are available, Viet Nam, shows a rapid increase in discharges over the past decade, attributable to growing population and industrial development (ADB 2006d).

Table 5.6 details COD discharges from industrial sources in Yunnan, the only member of the GMS for which these data are readily available. These reveal declines in both total and industrial pollution loads, although the latter have declined more rapidly (by 39.7 per cent in 2000–05, compared with just 4.2 per cent for total loads).

Table 5.5. Estimated BOD discharges from industrial activity, Thailand and Viet Nam, 1995–2003 (unit: kg/day).

	Thailand	Viet Nam
1995	...	352 362
1996	...	358 959
1997	...	450 452
1998	...	500 274
1999	...	529 019
2000	...	617 027
2001	355 819	699 279
2002	...	792 534
2003	...	904 668

Sources: ADB (2004b, 2006d), UNEP (2006).

Table 5.6. COD discharges from industrial sources, Yunnan, 2000–05 (unit: kg/day).

	Total	Industrial	Proportion (%)
2000	813 973	486 027	60
2001	846 261	390 342	46
2002	824 384	329 589	40
2003	781 370	254 247	33
2004	795 068	267 123	34
2005	780 000	292 877	38

Source: Yunnan State of the Environment (various years).

Organic water pollution is linked to a high frequency of gastroenteric, worm-related and other water-borne diseases, particularly in rural areas. Wild and cultured fish, shrimp and other aquatic animals consumed as human food in the GMS can all carry faecal bacteria in their gut and on their surfaces, and serve as intermediate

hosts for parasites. Table 5.7 details the prevalence of diarrhoea, a critical public health problem in the GMS, particularly among young children, whose incidence is higher than that of adults.

Table 5.7. Proportion of children aged under 5 with diarrhoea, 1998–2004 (unit: per cent).

Cambodia	Lao PDR	Myanmar	Thailand	Viet Nam	Yunnan
59	37	48	7.2	39	7 ^a

Note: Data are for the most recent year available.

^a 1990–2004 national estimate for children under six in rural areas.

Sources: China CDC (2005), MOPH (2005), World Bank World Development Indicators 2006 (http://devdata.worldbank.org/wdi2006/contents/Table2_15.htm).



5.4 ACCESS TO CLEAN WATER

As Figures 5.2 and 5.3 show, safe drinking water was accessible to more people in most GMS countries in 2002 than in 1990. Nevertheless, about 80 million people do not yet have access to clean water, increasing their exposure to such diseases as diarrhoea and dysentery (ADB 2004b).

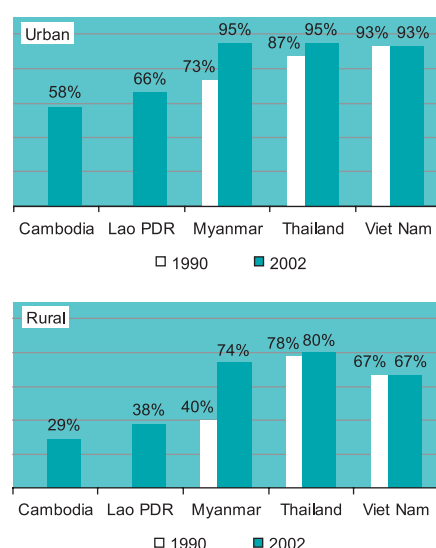


Figure 5.2. Access to improved drinking water sources, 1990 and 2002. No data are available for Cambodia and Lao PDR for 1990. For Yunnan see Figure 5.3. Source: UNEP (2006).

Providing adequate access to domestic water (and sanitation) is a priority for every GMS country. Three countries—Myanmar, Thailand and Viet Nam—are close to achieving full access in urban areas, but expanding access in rural areas is more difficult.

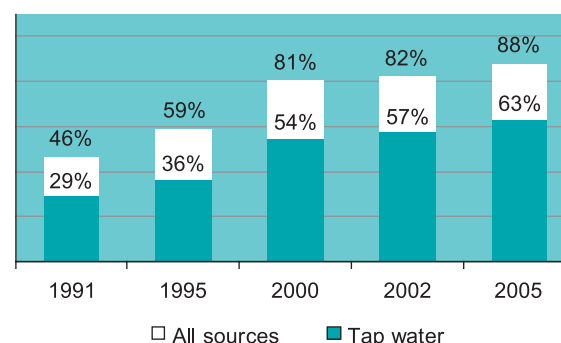


Figure 5.3. Improvement in rural drinking water supply in Yunnan, selected years from 1991–2005. Source: China Ministry of Health Statistics Digest (various years) (<http://www.moh.gov.cn/12.htm>).

The challenges to ensuring access are not confined to expanding water supply alone, though this is a key issue. In urban areas in particular, governments are finding it difficult to meet the demand for water and sanitation services from growing populations. Other problems include deteriorating infrastructure and a lack of maintenance, which lead to water losses and contamination. These, in turn, further reduce supply.

Apart from physical coverage, other challenges to expanding access include drought and water shortages, the intrusion of saline tidal water (for example in the Mekong Delta), changes in land use, and a lack of understanding of groundwater resources and threats (MRC 2003).

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the six countries in the GMS are members of the MRC. China and Myanmar have not yet exercised their option to join the organization, which means that the MRC's influence on river basin development in the upper Mekong basin, particularly in Yunnan, is currently limited (though it supports a constructive dialogue between all riparian countries).

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5 WATER

5.1 WATER RESOURCES AND AVAILABILITY

Surface run-off is the main supply source of water in the Mekong and other river basins of the GMS. Table 5.1 details water yield and annual run-off for five of the region's major river basins.

Table 5.1. Catchment area, run-off and annual water yield for five major river basins.

	Mekong	Ayeyarwady		
Catchment area (km ²)	795 000	411 000		
Mean annual run-off (mm)	560	1 000		
Water yield (million m ³)	475 000	410 000		
	Thanlwin (Salween)	Chao Phraya	Red	
Catchment area (km ²)	325 000	160 000	169 000	
Mean annual run-off (mm)	466	188	782	
Water yield (million m ³)	151 000	29 800	177 000	

Source: ADB (2004b).

The Mekong exhibits a wide seasonal variation in flow, with consistent dry season and wet season patterns. The flow increases dramatically from the dry-season lows of December–April to the wet-season highs of May–November (ADB 2004b). Most of this flow enters the Mekong system in the lower half of the basin below Chiang Saen in Thailand (see Figure 2.1). Upstream of Chiang Saen, the flow is dominated by run-off mostly from Yunnan, with smaller contributions from Myanmar and Lao PDR (ADB 2004b). Almost two-thirds of the total flow enters the river between Vientiane in Lao PDR and Kratie in Cambodia. Downstream of Kratie, the flow regime is dominated by the Tonle Sap system and the dynamics of the Mekong Delta (ADB 2004b).

The GMS as a whole does not suffer from a lack of water. A common measure of water resources is per capita water availability, the amount of water available per person per year. According to the international water stress index (Engelman and LeRoy 1993), a per capita water availability of 1 700 m³ indicates periodic or regular water stress; less than 1 000 m³ indicates chronic water scarcity; and less than 500 m³ indicates absolute water scarcity, outright shortages and acute scarcity. Table 5.2 shows that the GMS has substantial water resources, though they are unevenly distributed. Per capita

water availability in Lao PDR, for example, is an order of magnitude greater than in neighbouring Thailand or Yunnan.



Can Tho, Viet Nam
Source: Mekong River Commission

The data in Table 5.2 refer only to renewable fresh water. They do not include the groundwater resources that many countries draw on to supplement their supplies. Moreover, aggregate measures of water availability say nothing about the timing or seasonality of this availability (Gardner-Outlaw and Engelman 1997). Most countries in the GMS have a plentiful, often excessive, supply of fresh water during the wet season, but can experience severe, though temporary, water shortages during the dry season. Economic constraints and inadequate water supply systems can also restrict water availability. Rapid urbanization is putting pressure on existing water and sanitation systems, causing localized water shortages and pollution. Chapter 8 discusses water scarcity in more depth.

Table 5.2. Per capita water availability, 1993–2007 (unit: m³/person/year).

	1993–97	1998–2002	2003–07
Cambodia	9 917	8 731	8 133
Lao PDR	38 719	34 440	32 176
Myanmar	19 353	18 026	17 370
Thailand	3 554	3 377	3 277
Viet Nam	4 882	4 565	4 385
Yunnan ^a	2 251	2 160	2 115
GMS	8 041	7 462	7 161

Note: Data are for the most recent year available in each five-year period.

^a Data refer to the whole of China. As such, they are likely to under estimate per capita water availability in Yunnan, which lies in the water-rich southern rivers area of China (World Bank 2001a).

Source: FAO AQUASTAT (<http://www.fao.org/waicent/faoinfo/agricult/agl/aglw/aquastat/dbase/index.htm>).

5.2 WATER CONSUMPTION

Agriculture is the largest consumer of the region's water resources, and will remain so for the foreseeable future (Figure 5.1). In the larger economies such as Thailand, however, future demand for water is expected to grow most rapidly in non-agricultural sectors such as tourism, industry and the residential sector (UNEP 2001).

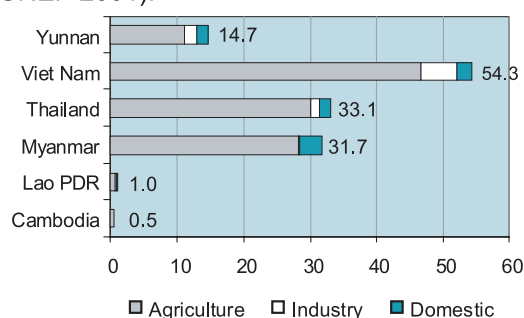


Figure 5.1. Annual freshwater withdrawals by major sector, 2000 (unit: thousand million m³). Total withdrawals are shown at the end of each column. Withdrawals by industry in Cambodia and Myanmar are negligible (around 1 per cent); in Lao PDR they account for 10 per cent. Sources: Based on data in ADB (2004b) and GMS country submissions.

Within the agricultural sector, irrigated agriculture accounts for most of the demand for water. Development of the region's agricultural sector depends heavily on intensifying production by increasing the area of cropland under irrigation (ADB 2004b). In the past decade, every country in the GMS has increased its area of land under irrigation or equipped with irrigation (Table 5.3). This trend is set to continue as countries such as Cambodia, Lao PDR, Thailand and Viet Nam

develop new irrigation schemes. Large-scale irrigation schemes are associated with dams and water diversions, with their consequent impacts on fish populations and habitats. Groundwater is a potential alternative supply, though its long-term sustainability is uncertain (ADB 2004b).

5.3 WATER QUALITY

Water quality is a growing concern affecting many different uses in the Mekong and other river basins of the GMS. Quality of water is especially relevant to domestic water use and sanitation, where the quality of water at the point of consumption has a direct effect on personal health, well-being and productivity (MRC 2003).

Pollution of water supply sources, both surface and groundwater, with human and animal waste, and solid wastes, is common and increasing in the GMS. In Lao PDR, for example, the length of rivers where farming, food processing and other activities have adversely affected water quality was estimated in 1997 to be 10 per cent with severe impact, and 20 per cent with moderate impact (ADB 1997, cited by MRC 2003).

Sources of contamination are widespread. The main sources of organic water pollution are domestic, industrial and agricultural discharges. In some countries, for example Thailand, the most important of these in terms of volume and some pollutants is the discharge of untreated

Table 5.3. Irrigated land area, 1996–2005 (unit: thousand ha).

	Cambodia	Lao PDR ^a	Myanmar	Thailand	Viet Nam ^b	Yunnan
1996	...	...	1 557	4 714	...	1 284
1997	...	104	1 592	4 749	...	1 321
1998	407	146	1 692	4 789	...	1 350
1999	...	218	1 841	4 948	...	1 374
2000	...	246	1 910	4 986	8 000	1 403
2001	...	257	1 986	4 986	7 400	1 424
2002	...	...	1 869	4 986	8 000	1 442
2003	...	...	1 960	4 986	8 200	1 457
2004	...	...	...	...	8 300	1 469
2005	589 ^c	...	...	...	8 400 ^d	1 485

^a Data refer to the average area of land equipped with irrigation in the wet and dry seasons.

^b Data refer to the area of land equipped with irrigation. The area actually irrigated is much less, owing to incomplete systems, a lack of water, poor design or a lack of upkeep (World Bank 2000a).

^c Estimated.

^d National development plan target.

Sources: China Statistical Yearbook (various years), FAOSTAT (<http://faostat.fao.org/site/419/default.aspx>), GMS country submissions, Government of Cambodia (2005).

domestic wastewater (World Bank 2001b, ADB 2006b). Table 5.4 shows that domestic wastewater discharges in Thailand are high and have continued growing over the past decade. The proportion of untreated wastewater is also high and has remained static since 2001. The lack of data for some countries makes it difficult to draw comparisons across the GMS. Untreated industrial discharges in Yunnan are declining, however. In Viet Nam, well over 90 per cent of wastewater is still discharged without treatment.

Table 5.4 Amount and proportion of wastewater discharged without treatment, 1995–2005 (unit: m³/day).

	Thailand ^a		Viet Nam		Yunnan ^b	
	Total	%	Total	%	Total	%
1995	1 615 404	82	...	>90	491 342	37
1996	1 611 988	81	...	...	311 288	30
1997	1 621 158	80	...	...	412 110	33
1998	1 622 429	79	...	...	300 411	26
1999	1 605 266	78	...	...	177 890	18
2000	1 587 327	77	...	>90	152 904	16
2001	2 409 577	75	...	...	...	...
2002	2 426 559	75	...	...	...	...
2003	2 435 583	75	...	92	...	...
2004	...	...	...	...	...	...
2005	...	...	...	96	...	...

^a Data refer to domestic wastewater from urban areas only.

^b Data refer to industrial wastewater only.

Sources: ADB (2006b, 2006c), GMS country submissions.

Two key indicators of overall water quality are biochemical oxygen demand (BOD) and chemical oxygen demand (COD). The former is the amount of oxygen consumed in the biological processes that oxidize organic matter. The greater the BOD, the greater the degree of organic pollution. The latter is the amount of oxygen required to oxidize all compounds, both organic and inorganic, in water.

As with wastewater discharges, a lack of data makes it difficult to compare BOD discharges across the GMS. Table 5.5 details BOD discharges from industrial sources in Thailand and Viet Nam. The only country for

which complete data are available, Viet Nam, shows a rapid increase in discharges over the past decade, attributable to growing population and industrial development (ADB 2006d).

Table 5.6 details COD discharges from industrial sources in Yunnan, the only member of the GMS for which these data are readily available. These reveal declines in both total and industrial pollution loads, although the latter have declined more rapidly (by 39.7 per cent in 2000–05, compared with just 4.2 per cent for total loads).

Table 5.5. Estimated BOD discharges from industrial activity, Thailand and Viet Nam, 1995–2003 (unit: kg/day).

	Thailand	Viet Nam
1995	...	352 362
1996	...	358 959
1997	...	450 452
1998	...	500 274
1999	...	529 019
2000	...	617 027
2001	355 819	699 279
2002	...	792 534
2003	...	904 668

Sources: ADB (2004b, 2006d), UNEP (2006).

Table 5.6. COD discharges from industrial sources, Yunnan, 2000–05 (unit: kg/day).

	Total	Industrial	Proportion (%)
2000	813 973	486 027	60
2001	846 261	390 342	46
2002	824 384	329 589	40
2003	781 370	254 247	33
2004	795 068	267 123	34
2005	780 000	292 877	38

Source: Yunnan State of the Environment (various years).

Organic water pollution is linked to a high frequency of gastroenteric, worm-related and other water-borne diseases, particularly in rural areas. Wild and cultured fish, shrimp and other aquatic animals consumed as human food in the GMS can all carry faecal bacteria in their gut and on their surfaces, and serve as intermediate

hosts for parasites. Table 5.7 details the prevalence of diarrhoea, a critical public health problem in the GMS, particularly among young children, whose incidence is higher than that of adults.

Table 5.7. Proportion of children aged under 5 with diarrhoea, 1998–2004 (unit: per cent).

Cambodia	Lao PDR	Myanmar	Thailand	Viet Nam	Yunnan
59	37	48	7.2	39	7 ^a

Note: Data are for the most recent year available.

^a 1990–2004 national estimate for children under six in rural areas.

Sources: China CDC (2005), MOPH (2005), World Bank World Development Indicators 2006 (http://devdata.worldbank.org/wdi2006/contents/Table2_15.htm).



5.4 ACCESS TO CLEAN WATER

As Figures 5.2 and 5.3 show, safe drinking water was accessible to more people in most GMS countries in 2002 than in 1990. Nevertheless, about 80 million people do not yet have access to clean water, increasing their exposure to such diseases as diarrhoea and dysentery (ADB 2004b).

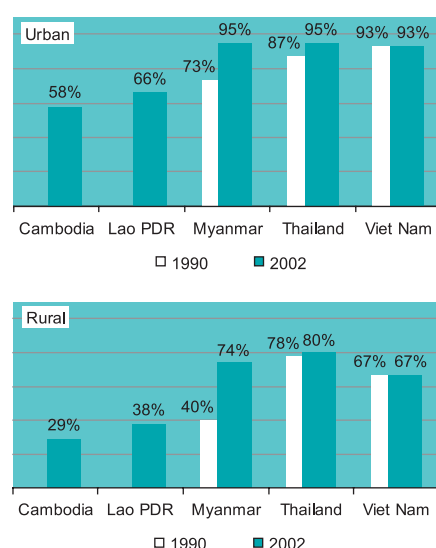


Figure 5.2. Access to improved drinking water sources, 1990 and 2002. No data are available for Cambodia and Lao PDR for 1990. For Yunnan see Figure 5.3. Source: UNEP (2006).

Providing adequate access to domestic water (and sanitation) is a priority for every GMS country. Three countries—Myanmar, Thailand and Viet Nam—are close to achieving full access in urban areas, but expanding access in rural areas is more difficult.

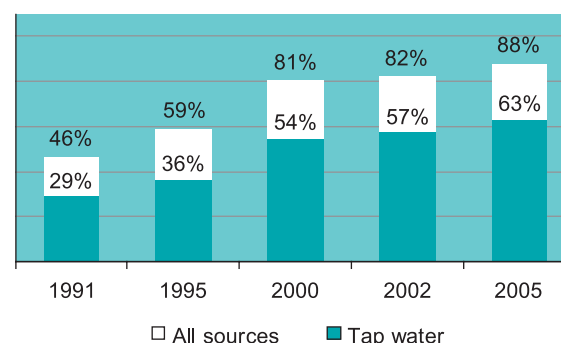


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The challenges to ensuring access are not confined to expanding water supply alone, though this is a key issue. In urban areas in particular, governments are finding it difficult to meet the demand for water and sanitation services from growing populations. Other problems include deteriorating infrastructure and a lack of maintenance, which lead to water losses and contamination. These, in turn, further reduce supply.

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6 BIODIVERSITY



6.1 BIODIVERSITY STATUS AND TRENDS

The GMS is a highly biodiverse region. Across the region, however, this diversity faces serious threats from human activity and from natural changes caused in part by humans. As Chapter 2 notes, the forests of the GMS are its main reservoir of biodiversity. Six forest ecoregions with exceptional levels of biodiversity lie wholly or partly within the region:

1. Northern Indochina subtropical forests
2. Annamite Range rain forests
3. Cardamom Mountain rain forests
4. Indochina dry forests
5. Peninsular Malaysian rain forests
6. Kayah-Karen montane rain forests

Of these, the Northern Indochina forests are globally exceptional for their biodiversity. These forests extend across the northern Myanmar highlands, the southern part of Yunnan, Thailand, Lao PDR and Viet Nam. About 183 mammal species, four of them endemic and five near-endemic, and 707 species of birds, occur in this ecoregion (ADB 2004b).

The remaining forests of the GMS face serious threats from uncontrolled logging, land clearance for agriculture and settlements, and legal and illegal hunting. In 2005, a little over 44 per cent of the region was still classed as forest. The largest area of forest is in Myanmar, followed by Lao PDR, Thailand and Yunnan. However, as Table 6.1 shows, forest cover has declined at a varying rate in every country except Viet Nam and Yunnan (both of which have invested heavily in establishing plantations). In 1990–2000, the region as a whole lost 2.17 million ha (21 700 km²) of forest. Annual rates of forest loss ranged from 0.54 per cent in Lao PDR to 1.34 per cent in Myanmar, averaging 0.3 per cent for the region as a whole.

Wetlands and other aquatic ecosystems, some comparable to forests in their diversity and productivity, are also a major reservoir of biodiversity. The Mekong River basin itself is characterized by a high degree of biodiversity and endemism. Estimates of the number of fish

Table 6.1. Changes in forest cover, 1990–2005 (unit: thousand ha).

	Land area ^a	Total forest ^b			% of land area, 2005	Annual change, 1990–2000		Annual change, 2000–2005	
		1990	2000	2005		000 ha/yr	%	000 ha/yr	%
Cambodia	17 652	12 946	11 541	10 447	59.2	-140	-1.1	-219	-2.0
Lao PDR	23 080	17 314	16 532	16 142	69.9	-78	-0.5	-78	-0.5
Myanmar	65 755	39 219	34 554	32 222	49.0	-466	-1.3	-466	-1.4
Thailand	51 089	15 965	14 814	14 520	28.4	-115	-0.7	-59	-0.4
Viet Nam	32 549	9 363	11 725	12 931	39.7	236	2.3	241	2.0
Yunnan ^c	38 264	9 405	12 873	15 015	39.2	347	3.7	428	3.3
GMS	228 389	104 212	102 039	101 277	44.3	-217	-0.3	-152	-0.2

^a See notes to Table 4.1 for the definition and sources of land area.

^b Total forest includes forest plantations.

^c The data for Yunnan refer to 1992, 1997 and 2002.

Sources: ADB (2006c), FAO (2006).

species in the Mekong River vary from around 700 to well over 1 000. The number of species per unit area of catchment is several times that of the Amazon River basin (Coates 2001). A notable aspect of the fish fauna is the high number of fish families. In all, 91 families have been listed from the Mekong basin, indicating that the Mekong has highest number of fish families of any river in the world (Groombridge and Jenkins 1998).

The largest wetland in the GMS, and the largest lake in Southeast Asia, is Tonle Sap Lake in western Cambodia (see Figure 2.1). In the wet season, the lake covers 16 000 km², and, together with the Tonle Sap River, supplies almost two-thirds of the inland fisheries production of Cambodia (ADB 2004b).

Some 62 per cent of Tonle Sap Lake's annual flow comes from the Mekong River. By absorbing around 20 per cent of the Mekong's floodwater, the lake acts as a crucial natural flood regulator for the Mekong Delta, and contributes substantially to the hydrological and ecological stability of the Delta in the dry season. The Tonle Sap ecosystem not only is the main source of animal protein for much of Cambodia's population, but also provides the last refuge for some of Asia's most important biodiversity (MRCS/UNDP 1998, cited by Sokhem and Sunada 2006). In addition, the flooded areas have a high agricultural potential, and furnish seasonal breeding and nursery grounds for fish that migrate to the Mekong River (Sokhem and Sunada 2006).

By far the largest wetland area in Viet Nam is the Mekong Delta in the south of the country. Myanmar also has extensive mangrove forests in the Ayeyarwady Delta and other coastal areas. Lake Inle, a well-known tourist attraction in eastern Myanmar, is the second-largest lake in Myanmar and a global freshwater biodiversity hotspot (ADB 2006e). Both Yunnan and Lao PDR have important and extensive wetlands, most of which lie in the catchment of the Mekong (known as the Lancang river in China). Rapid economic development has reduced many of Thailand's important wetland resources, but several sites of global importance are now under protection.

Like forests, wetlands face threats from habitat degradation, pollution, over exploitation and agricultural encroachment. Lake Inle, for example, shrunk from 23 km long and 11 km wide in 1967 to 11 km long and 5 km wide in 1996, owing to land reclamation and sedimentation caused by soil erosion in the adjacent watershed (ADB 2006e). Around Tonle Sap Lake, clearance of flooded forest for agriculture and settlements has been extensive. Areas of flooded forest and mangrove declined by nearly 10 per cent in the space of five years from 0.43 million ha in 1992 to 0.4 million ha in 1997 (ADB 2006f).

Table 6.2 shows overall declines in mangrove areas in Cambodia and Myanmar. Those in Thailand and Viet Nam have increased

Table 6.2. *Changes in mangrove forest cover, 1990–2001 (unit: thousand ha).*

	Cambodia		Myanmar		Thailand		Viet Nam	
	Total	Annual rate of change (%)	Total	Annual rate of change (%)	Total	Annual rate of change (%)	Total	Annual rate of change (%)
1990	74.6	...	164.4	...	...	...	165	...
1991	...	...	...	...	173.6	...	...	...
1992	77.7	...	...	...	...	...	...	...
1993	77.7	-0.43	...	...	168.7	...	...	...
1994	77.7	-0.43	...	...	...	...	...	...
1995	...	...	161.0	...	...	...	132	...
1996	72.8	-0.40	...	...	167.6	...	...	...
1997	72.8	-0.40	...	...	...	...	...	...
1998	...	...	...	...	...	...	...	...
1999	...	...	...	...	...	...	155	...
2000	63.7	...	147.8	...	245.3	...	...	...
2001	...	...	111.9	...	...	...	170	...

Sources: ADB (2004b, 2006d), FAO (2003a), GMS country submissions.



slightly, the latter owing to several government and donor-sponsored programmes of mangrove rehabilitation (ADB 2006d).

The loss and degradation of forests, wetlands and other habitats have had a substantial impact on populations of flora and fauna. The GMS is home to some of the world's most threatened species. These include mammals such as the Irrawaddy dolphin (*Orcaella brevirostris*), banteng (*Bos javanicus*), Indochinese tiger (*Panthera tigris corbetti*), and Sumatran rhinoceros (*Dicerorhinus sumatrensis*), believed still to exist in the Cardamom Mountains ecoregion (ADB 2004b). Other threatened groups include large water birds and foraging birds, freshwater turtles and large migratory fish (ADB 2004b). Table 6.3 below details numbers of threatened species in the GMS

Besides the existing threats to biodiversity from habitat loss, resource depletion and other economic activity, a growing threat is posed by

Table 6.3. Cumulative number of threatened species, selected years from 1996–2004

	Plants				Animals ^a			
	96	00	02	04	96	00	02	04
Cambodia	30	30	30	32	16	42	47	85
Lao PDR	17	18	18	20	18	42	47	81
Myanmar	36	37	37	38 ^b	30	61	67	125
Thailand	...	...	...	84	...	...	...	136
Viet Nam	125	128	128	147	25	71	77	158
Yunnan	...	...	...	...	92	59	...	...

Note: Threatened species are defined as vulnerable, endangered or critically endangered species on the IUCN Red List of Threatened Species (<http://www.iucnredlist.org>).

^a Includes mammals, birds, reptiles, amphibians and fish (endemic and non-endemic).

^b Figure refers to 2003.

Sources: ADB (2006b, 2006c, 2006d, 2006e, 2006f, 2006g).

invasive alien species. Several exotic wetland species either threaten or could potentially threaten biodiversity in the Mekong basin. These include the invasive shrub *Mimosa pigra*, which has colonized flooded forests around Tonle Sap; the South American apple snail (*Pomacea* spp.), a pest of rice and aquatic plants; and various fish species, including the Nile tilapia (*Oreochromis niloticus*), mosquito fish (*Gambusia affinis*) and African catfish (*Clarias gariepinus*).

Some exotic fish species have become major aquaculture species without any notable adverse consequences. Others, however, are thought to have contributed to declines in native populations of the same genus, for example the African catfish and Rohu carp (*Labeo rohita*) (Welcomme and Vidthayanom 2003).

6.2 CONSERVATION OF BIODIVERSITY

The countries of the GMS have tackled biodiversity protection in two main ways. The first is to use law, both national and international. All of the GMS countries, for example, are signatories to the Convention on Biological Diversity (CBD) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

The second main response centres on protected areas. These vary widely in extent from one country to another (Table 6.4). Cambodia, Lao PDR and Thailand have relatively large

Table 6.4. National protected areas as a proportion of total land area, selected years from 1994–2004 (unit: per cent).

	1994	1996	1998	2000	2002	2004
Cambodia	...	18.1	18.1	18.3	32.0 ^a	...
Lao PDR	12.6 ^b	14.0 ^c	...	14.3	14.3	...
Myanmar	...	1.7	...	...	3.4	7.2 ^d
Thailand	...	...	...	...	...	18.2 ^e
Viet Nam	2.03	3.3	3.4	4.1	6.2	...
Yunnan	...	...	5.1	6.1	7.6	8.8

^a Includes 7.32 per cent of land area classified as "protected forest".

^b Figure refers to 1993.

^c Figure refers to 1995.

^d Includes "proposed" protected areas.

^e Another 18.1 per cent of Class 1 watersheds may eventually be declared protected areas.

Sources: ADB (2006b, 2006c, 2006d, 2006e, 2006f, 2006g), GMS country submissions.

protected area systems, but, except for Thailand, these are of recent origin. The systems of Myanmar, Viet Nam and Yunnan not only are smaller in size, but also protect smaller areas (ADB 2004b). Across the region, protected areas face threats from illegal logging, hunting, encroachment and other human activities. Chapter 9 explores these threats, and current responses, in more detail.

Governments in the GMS are coming to realize that law enforcement and protected area management can both benefit from transboundary cooperation. This can take various forms, one of which is the creation of transboundary protected areas. These provide opportunities for promoting biodiversity conservation and sustainable use across ecosystems and landscapes divided by national borders, while at the same time encouraging collaboration in management and information sharing. Effective transboundary cooperation can promote economic exchange, help in the control of wildlife trade, and enhance the provision of environmental services.

A recent review of protected areas in the lower Mekong basin identified 10 potential transboundary areas (ICEM 2003). Formal cooperation is already being pursued in some of these areas, for example the Pha Taem Protected Forests Complex along the border between Thailand, Cambodia and Lao PDR (Trisurat 2003). A related approach, currently the focus of the GMS Program's Biodiversity Conservation Corridors Initiative (BCCI), is to create networks or clusters of protected areas linked across a shared landscape (which may or may not cross national borders). The main aim of this approach is to prevent or reverse the fragmentation of high conservation value forest ecosystems. The BCCI has identified nine priority landscapes covering over 55 protected areas (ADB 2005).

6.3 PEOPLE AND BIODIVERSITY

Population growth is a key driver of biodiversity loss, through such effects as land

clearance for agriculture and settlements, overfishing, and illegal hunting for food and income. The population of the GMS is growing steadily, and although its rate of growth should slow in the coming decades, it is expected to reach 290 million people by 2015. Most of this growth will take place in Myanmar and Viet Nam, countries with large population bases (ADB 2004b).

The effects of population growth on biodiversity are crucial, since the region's biological diversity, be it natural or agricultural, supplies the main source of livelihood for much of its rural population.

Key livelihood sources provided by agricultural biodiversity include the local rice varieties still grown by many farmers in Cambodia, Lao PDR and Thailand, particularly in highland areas. In some villages that grow upland rice, for example, it is common to find 3–5 varieties grown by each household, and 20–30 varieties grown by the village as a whole (Rerkasem and Rerkasem 2005). However, with the intensification of agriculture and the spread of irrigated rice cultivation, many local varieties have been replaced by a smaller range of modern, improved varieties. In the Mekong Delta, where over 1 600 traditional rice varieties were once cultivated, less than 50 introduced high-yielding and hybrid varieties are now commonly used (Miller, Nguyen and Do 1999).

Crucial livelihood sources provided by natural biodiversity include aquatic organisms and non-timber forest products (NTFPs) such as resins, fuelwood and medicinal plants. Data on NTFP use by rural communities in the GMS are limited, but it is possible to gauge their importance from some examples.

Table 6.5 and Table 6.6 detail the value of NTFPs for consumption and export in Lao PDR. Lao PDR is unique in the GMS in relying on NTFPs and other natural biodiversity for a major part of government revenues (ADB 2006g). At times, the value of NTFPs outstrips that of timber, and rural households derive about half of

their cash income from NTFPs (NBSAP 2003). Local studies of NTFP consumption in Lao PDR have found bamboo shoots to be the single most important product. Women usually attach more importance to products such as vegetables and bamboo shoots, whereas men prefer products such as wildlife and fish. In terms of income, the most valuable NTFPs include cardamom (*Elettaria cardamomum*), fish, wildlife, damar resin and bamboo shoots (NBSAP 2003).

Table 6.5. Annual value of NTFPs for household income and subsistence in Lao PDR.

	US\$ per household	US\$ million total
Household subsistence	223	159.8
Household income	36	25.6
Total	259	185.4

Note: Household values exclude firewood, fish and other aquatic species. Totals are drawn from the data source.
Source: NBSAP (2003).

Table 6.6. Export value of NTFPs in Lao PDR, 1993–98 and 2003 (unit: million US\$).

	1993	1994	1995	1996	1997	1998	2003
Value % of total exports	6.3	31.8	31.8	31.8	31.8	31.8	6–7
	3	...	...	...	...	...	...

Note: The data for 1993 and 2003 are estimates; data for 1994–98 are estimated averages.
Source: Compiled from NBSAP (2003).



PART III

ENVIRONMENTAL PRIORITIES

7 CONTROLLING LAND DEGRADATION

7.1 INTRODUCTION

Land degradation refers to the temporary or permanent lowering of the productive capacity of land (UNEP 1992). It is a complex, multidimensional process covering the various forms of soil erosion, adverse human impacts on water resources, deforestation and lowering of the productive capacity of rangelands. Land degradation in arid, semi-arid and dry sub-humid areas, the result of climatic variations, human activities and other factors, is referred to as desertification (UN 1992).



As Chapter 4 notes, land degradation affects large areas of the GMS. It has several causes, principally deforestation and agricultural activities (improper soil and water management, excessive use of chemicals, inefficient irrigation, and so on). In Yunnan, over-grazing and poor pasture management have contributed to grassland degradation, though not as much as in other Chinese provinces, for example Inner Mongolia, Xinjiang or Gansu (World Bank 2001a).

The main underlying cause of land degradation across the GMS has been forest loss. Forest clearance for agriculture,

or uncontrolled logging and consequent deforestation, have caused widespread soil and water erosion. At the boundary between forests and agriculture stands swidden cultivation, the main farming system among upland ethnic minorities (ADB 2004b). In many places, land and population pressures have disturbed the ecological balance of this system, leading to forest loss and erosion.

UNEP (2004) characterizes the loss of topsoil from surface water erosion as the most pervasive form of land degradation in Southeast Asia. The problem of water erosion is acute in such countries as Cambodia, Lao PDR, Thailand and Viet Nam. Water also accounts for the bulk of erosion in Yunnan (ADB 2006c). In 1999, for example, water erosion affected 14.1 million ha, or almost 36 per cent of Yunnan's land area, eroding more than 500 million tonnes of soil. This represents some 10 per cent of the annual volume of soil eroded in China (ADB 2006c).

Attempts to reduce land degradation have met with mixed success. A consistent problem has been the inability to intervene in economic planning systems or the dominant sectorial approaches to land management. The competing influences of fiscal and market incentive programmes, and the underpricing of resources and subsidizing of agricultural inputs such as fertilizers, have also helped to maintain pressures on land. Major policy failures leading to land degradation have included insecure land tenure and misjudged attempts to reform tenure patterns by encouraging fixed settlement and cultivation in upland areas.

7.2 DRIVING FORCES AND PRESSURES

Population growth and deforestation

Overall population size and density in the GMS are still relatively low. In the lower Mekong basin, for example, population density is only 87 people per km² (MRC 2006a). If the limits of arable land are considered, however, net densities are much higher, particularly in Lao PDR (465/km²) and Viet Nam (395/km² and up to 900/km² in some districts of the Mekong Delta) (MRC 2006a).

Rapid population growth and high densities, particularly in upland areas, have driven demand for cultivable land, fuelwood and other forest products. This demand has been the predominant factor in deforestation, although demand for forest products from urban markets and the export sector has also been important (see below). Another factor is migration, which has caused or accelerated rural population growth, particularly in forested areas. Ironically, migration and deforestation have in some cases resulted from policies designed to stabilize land use and tenure. In Viet Nam, for example, land reform and the emergence of a land market have created a new class of landless farmers in such places as the heavily populated Red River Delta. These farmers have been drawn to cash-cropping opportunities in upland frontier areas, where they have displaced traditional ethnic minority swidden cultivators (Barney 2005a, Douglas 2006).

After subsistence demand for forest land and products, the next main cause of deforestation and forest degradation in the GMS has been commercial demand. The increase in agricultural land in Viet Nam (see Table 4.1), for example, has been driven largely by market demand for sugar, tea, coffee, cashew nuts and other products (World Bank 2005b). The expansion of these cash crops in upland areas of Viet Nam such as the Central Highlands has led to extensive forest conversion.

An indirect cause of forest loss and degradation has been uncontrolled and often illegal logging. Before the enactment of a logging ban in 1998, state forest enterprises in Yunnan were illegally exceeding their harvest quotas by about 768 000 m³, or 21 per cent, each year (Xu, Tao and Amacher 2003). In the late 1990s, about 95 per cent of all timber harvested by concessionaires in Cambodia was thought to be illegal (Barney 2005b). In Viet Nam today, between 0.5 and 2 million m³ of timber are extracted illegally each year from protected areas and other forests (World Bank 2005b).

Uncontrolled forest exploitation, and the subsequent degradation of landscapes and ecosystems, have been so severe as to measurably affect macro-economic performance. In 1997, the combined effects of drought and intensive irrigation temporarily halted the flow of China's Yellow River. In the following year, severe floods along the lower Yangtze River led to major losses of income and livelihoods for hundreds of thousands of people, and inflicted high costs on the public sector. The Chinese government attributed the severity of these disasters to the effects of deforestation and unsustainable forest management practices, and imposed a complete ban on commercial logging across an area of 30.4 million ha in 13 provinces, including Yunnan (Yang 2001).

Natural disasters and the role of climate change

Floods, droughts and other environmental hazards are often attributed to deforestation, though the available evidence does not necessarily support this view. Logging and deforestation can worsen small floods, but they have only a limited impact on large floods. Furthermore, removing forest cover in most cases will not cause streams or rivers to dry up, not even during the dry season (Bruijnzeel 2004). The key variable in water flow is not forest cover but soil quality, and this depends on the soil management regime that follows changes in vegetation cover (see below).

Effects of soil and vegetation apart, the role of climate change in extreme weather events such as major floods is receiving greater scrutiny. One predicted effect of climate change is an increase in extreme weather, and the already vulnerable countries of the GMS are expected to suffer as a result. Climate risks are not new to farmers in the region, but the warmer, wetter Mekong basin forecast by some climate change models could sustain a greater magnitude and frequency of flooding (Chinvanno, Souvanalath, Lersupavithnapa, Kerdasuk and Nguyen 2006). As yet it is not possible to tell whether these changes have already begun. None of the floods recorded in Table 4.9 can be attributed directly to climate change. The damage they have caused, however, serves to highlight the vulnerability of such countries as Cambodia and Viet Nam to changing climate.

Land use and soil management

After forest loss, improper land management has been singled out as the next main cause of land degradation in the GMS. This is essentially the failure to match agricultural systems to soil quality and land topography (Beinroth, Eswaran, Reich and Van Den Berg 1994). Population pressure may contribute to this mismatch, but more often than not the main cause is the economic conditions of poor farmers, coupled with agricultural policies that discourage them from adopting improved practices.

Across the GMS, farmers' land management decisions are constrained by

the poor quality of much of the land. Table 7.1 below shows that the region is endowed with land resources of mostly inferior agricultural potential. Land in Classes I to III constitutes the best arable land, but covers only about 30.7 million ha, or some 16 per cent of the region (excluding Yunnan). Most of this land is already under production. Land in Classes IV to VI accounts for more than 80 per cent of the region. These lands are susceptible to degradation and require careful management. Their productivity and fertility are low, so poor farmers need considerable support to manage them properly (Beinroth, Eswaran and Reich 2001). Last are Classes VII to IX, which are highly susceptible to degradation and unsuited to cultivation.

Working on poor quality land, and with limited management options, farmers tend to adopt practices that contribute to land degradation. The low rates of adoption of soil conservation measures such as contour farming and terraces have already been mentioned. In northern Thailand and Yunnan, for example, up-and-down slope cultivation of maize and other crops has long been the norm, leading to high erosion rates. A lack of options for stabilizing and intensifying swidden cultivation, coupled with external land and population pressures, has led to shortened fallow periods, which in turn have caused a loss of soil fertility, declining crop yields and localized erosion (MRC 2003).

As agriculture intensifies and becomes more market-oriented, excessive or inefficient use of inputs is causing land degradation. The overall rate of chemical application in the

Table 7.1. Land quality classes in the GMS (unit: million ha).

	IX	VIII	VII	VI	V	IV	III	II	I
Cambodia	0	0	0	4.92	4.27	3.48	4.07	0.89	0
Lao PDR	0	0	0.48	1.69	19.50	0	1.08	0.33	0
Myanmar	1.36	0	2.15	1.39	47.16	8.90	0.01	6.80	0
Thailand	0	0	1.54	9.71	22.67	2.39	12.16	2.70	0
Viet Nam	0	0	1.36	7.62	16.98	3.93	0.77	1.71	0.16
Yunnan	...	...	...	...	...	...	...	...	...

Note: Land quality classes are based on two main criteria: soil resilience and soil performance, primarily for grain production. Soils in Class I are highly productive with few management-related constraints. Soils in Classes II and III are also good and suitable for sustained production. Soils in Classes IV, V and VI lack plant nutrients and are unproductive. They are susceptible to degradation and require careful management. Soils in Class VII, VIII and IX are unsuitable for production and prone to degradation. Biodiversity management and protection is crucial on these soils, and is also recommended for Classes IV to VI.

Source: Compiled from Beinroth and others (2001).

Mekong basin is comparatively low. Many irrigation projects, however, have failed or proved less successful than expected because of soil problems, including soil salinization and alkalization, waterlogging, erosion and reduced productivity.

Not all water-related land problems are associated with irrigation. In the Mekong Delta, saltwater intrusion has degraded some of the most productive agricultural land. Another problem in the Mekong Delta is the conversion of acid sulphate soils in grasslands and mangroves to crop land. In the dry season, acid sulphate run-off rises to the surface and is flushed into waterways at the onset of the rains. The acidity reduces soil and water quality, and can lower crop yields and fish numbers locally (MRC 2003).



Slope cultivation
Source: Thailand Environment Institute

7.3 IMPACTS

Land degradation normally results in lower productivity, owing to a lack of nutrients and water available for crop growth, or to the higher costs and reduced efficiency of added nutrients. This fall in productivity has knock-on effects on farmers' incomes and on the overall economic performance of the agricultural sector, and can threaten food security (see Chapter 11).

In the GMS as a whole, the impacts of land degradation on the productivity of rice, the staple food, are not immediately obvious. Rice yields grew slowly but steadily between 1995 and 2004 (Figure 4.1). Yields are an imprecise measure of productivity, however, since they

reflect not only land and labour productivity, but also the effects of other inputs and weather conditions (Kupkanchanakul 2000, Na-Ranong 2004, Shimizu, Masumoto and Thanh 2006). In intensive, high-input systems, the effects of degradation on productivity may not surface until yields approach their ceiling. Alternatively, the reduced efficiency of inputs may show up in higher production costs rather than lower yields (Scherr 1999).

Studies of crop productivity on plot and field scales in the GMS have produced inconclusive results. For example, Sajjapongse (1998) reports that some soil treatments designed to limit erosion in Thailand actually produced lower rice yields than farmers' usual treatments. Wezel, Steinmüller and Friederichsen (2002), however, found that the low nutrient levels associated with erosion and degradation in northwest Viet Nam reduced maize and cassava yields by 27 and 31 per cent respectively.

Moving from yields to agricultural incomes, the impacts of land degradation are no clearer. Across the GMS, the contribution of agriculture to economic growth is either stagnant or declining (Table 4.4). The main reasons for this decline are structural, in particular the increasing importance of the manufacturing and service sectors. Land degradation may also be a limiting factor, but there are few data on its links to agricultural growth in the GMS. Studies elsewhere in South and Southeast Asia have produced estimates of the annual economic loss from land degradation ranging from under one to seven per cent of agricultural GDP (Scherr 1999). In China, the losses may run as high as 4–5 per cent of GDP (World Bank 2000b, Hao, Chang and Ning 2004).

7.4 THE RESPONSE

Across the GMS, farmers, governments and other actors are taking action to control and reverse land degradation. A range of technical, legal and institutional measures is being pursued, but each faces various constraints and its outcomes are not assured.

In some cases, the means to control land degradation are already in place, but weak monitoring and enforcement have undermined their application. In Yunnan, cultivation of crops on slopes greater than 25 degrees was prohibited by the 1991 Law on Soil and Water Conservation (ADB 2006c). However, the law was not rigorously enforced, and continued upland cultivation in Yunnan and other provinces—together with uncontrolled logging—contributed to the soil and water erosion blamed for the the 1998 Yangtze River floods. In response to the floods, the Chinese government launched two major programmes aimed at integrating water and soil conservation with agricultural restructuring, poverty reduction and sustainable development. The most prominent of these is the Natural Forest Protection Programme (NFPP). This calls for the termination or reduction of logging in natural forests in 17 provinces, and establishes plans for reforestation of degraded lands and an overhaul of China's state forest industry (Zuo 2001a). Complementing the NFPP's focus on forest lands is the Sloping Land Conversion Programme (SLCP), which aims to reduce erosion by converting cropland on steep slopes to grass and tree cover (Zuo 2001b).

Survey work for the SLCP has revealed the extent to which farmers in Yunnan have flouted the law against steep-slope cultivation. In the county of Heqing, for example, almost 18 per cent of the cultivated land was on slopes greater than 25 degrees (Zhao 2001). Raising awareness of soil and water conservation needs, and encouraging farmers to participate in land conversion has not been easy. Farmers participating in the SLCP are entitled to compensation for the loss of their cropland, but in some places the grain and cash earmarked for them have been withheld or given away (Zuo 2001b). In other places, such as Xishuangbanna prefecture in southwest Yunnan, the SLCP has prohibited traditional swidden cultivation without providing alternative livelihood sources (such as grazing land, which used to be supplied by the fallow of swidden plots) (Zuo, Chen, Wang and Song 2000).

Elsewhere in the GMS, governments have tried to address some of the underlying social and economic issues driving poverty and land degradation in upland areas. In Lao PDR, the government has introduced a land allocation policy aimed at increasing land tenure security and encouraging village communities to protect the forest environment by moving village land from swidden cultivation to controlled reserves (Ducourtieux, Laffort and Sacklokham 2005). Under the policy, land occupancy entitlements are issued to upland households and communities. Land allocation is combined with mapping of land use and preparation of a national soil map (ADB 2006g). By 2003, this initiative covered almost 9 million hectares and more than 400 000 households, or over half of all rural households in the country (ADB 2006g).

Land reform has also been the focus of Viet Nam's efforts to stabilize and rehabilitate degraded agricultural and forest land. Since the first revision of Viet Nam's Land Law in 1993, its land rehabilitation strategies have focused on allocating degraded land to farmers with long-term use rights. As many as eight million households have received land, but the process of allocation, particularly in poor and isolated upland areas, has been slow and problematic (Nikolic, Phan and Schultze-Kraft 2005). At present, only about half of the households in Viet Nam eligible for land allocation have received land (Ngoc, Heidhues and Buchenrieder 2004). Nevertheless, land allocation has induced local people to play a positive role in rehabilitation, and reportedly has increased the incomes of participating rural households (Ngoc and others 2004).

Besides these national responses, the countries of the GMS are also cooperating in regional and international initiatives aimed at controlling land degradation and desertification. One of the most prominent of these is the United Nations Convention to Combat Desertification (CCD). All of the GMS countries are signatories to the CCD (for more information see Chapter 12). Every country except Cambodia (which is

close to validating its programme) has adopted a national action programme for meeting its commitments, and in 2005 the countries of Southeast Asia launched a sub-regional action programme. This covers every GMS country except China, which is cooperating with Mongolia in a separate regional programme for Northeast Asia.

China is one of the main affected parties to the CCD in Asia. Yunnan, however, is relatively unaffected by desertification. Shen (2004) reproduces official statistics showing that only 0.79 per cent of the province's land area is affected by desertification. In comparison, the area affected in other western provinces, such as Qinghai, Ningxia and Xinjiang, ranges from 33 per cent to more than 86 per cent (Shen 2004). How China defines desertification is unclear, however, As noted in Chapter 4, some estimates put the area of rock desertification in Yunnan as high as 2.2 million ha, or about 5.7 per cent of the province's land area.

Desertification poses a more immediate threat to Viet Nam and, to a lesser extent, Thailand and Myanmar. Of the 9.34 million ha of degraded land in Viet Nam, desertification affects over 7.5 million ha. The main factors contributing to desertification are drought, sand movement, and various forms of soil erosion and degradation (Government of Viet Nam 2002). In response to this threat, Viet Nam has developed a national action programme on desertification. This has been integrated into other key development strategies, including Viet Nam's National Agenda 21 and Poverty Reduction Strategy. Five major laws related to the CCD have been approved since 1999, and 12 related development projects are being implemented (Government of Viet Nam 2006). These include the Five Million Hectare Reforestation Programme (5MHRP), which aims to re-establish 43 per cent forest cover over the country by 2010. ■

8 BALANCING DEMANDS ON WATER RESOURCES

8.1 INTRODUCTION

The water resources of the GMS are plentiful, though unevenly distributed. Lao PDR and Myanmar have high per capita water availabilities, whereas Thailand, Viet Nam and Yunnan have relatively low availabilities. In no country, however, is overall water availability below the levels triggering water stress or scarcity. At the river basin level, the Chao Phraya basin in Thailand is the only major catchment in the region to face severe water shortages. It is also the only major catchment with high levels of pollutants from human activities, although the Red River basin in Yunnan and Viet Nam is becoming increasingly polluted (ADB 2004b). For the Mekong River itself, declining water quality is not a serious problem. Nor are water shortages, although the river and its tributaries are facing increasing pressure from efforts to tackle poverty by developing water resources (Hirsch 2006).

As Chapter 5 notes, aggregate measures of water availability can hide local or seasonal variations in the storage, allocation and use of water. Notwithstanding the overall availability of water at the country or basin level, these variations can cause water shortages of varying length, frequency and severity. Localized shortages are becoming increasingly common in the region's cities, as rapid urban growth puts pressure on inadequate water and sanitation systems. Shortages are also common in rural areas where climatic variability, increased demand from irrigation and limited supply infrastructure restrict availability. Such areas include the dry zone of central Myanmar, and north and northeast Thailand.

Agriculture, and particularly irrigated agriculture, still accounts for most of the demand for water. Future demand for fresh water, however, is expected to grow fastest in the residential and industrial sectors (UNEP 2001). Inevitably, as the demand from cities and industries grows, the water available for agriculture will decline. Effective management of the competition, and likely conflict, between multiple water uses and users is crucial. The need for integrated management also has a regional perspective, as GMS countries receive a large part of their freshwater resources from shared rivers.

Across the GMS, the response to the challenge of managing water resources has historically been fragmented. Recently, however, such countries as Thailand and Viet Nam have led a move towards catchment-based water management. This approach is at times hampered by weak links to local governments and communities, and to existing processes of planning and decision making. Such initiatives as MRC's Watershed Management Project and Basin Development Plan aim to strengthen these links, and to improve sub-regional growth through Integrated Water Resources Management, or IWRM (see below).

Market mechanisms such as water pricing are increasingly being brought to bear in water resource management internationally. In the GMS, however, their political and economic viability is limited by the difficulty of charging small-scale, subsistence farmers for the water they consume.

8.2 DRIVING FORCES AND PRESSURES

Increasing water demand

Agriculture is by far the major consumer of fresh water in the GMS, accounting for 76 to 94 per cent of yearly withdrawals (Figure 5.1). Most of this water is used for irrigation. Between 1995 and 2003, the area of land under irrigation in the GMS increased by more than eight per cent to 11.8 million hectares. In Lao PDR and Cambodia, demand for irrigation is being driven by the desire to become self-sufficient in rice production. In Thailand and Viet Nam, the driving force is attempts to increase rice export revenues (ADB 2006b).

from urban areas in the Chao Phraya basin has grown exponentially. In Bangkok, daily demand rose from 0.46 million m³ in 1978 to about 7.5 million m³ in 2000 (Molle 2001). Underground water, most of which is extracted by industries, contributes a further 3 million m³/day. This volume exceeds the safe yield of Bangkok's aquifer (estimated at 1 million m³/day) and imposes high negative externalities through land subsidence and flood damage (Molle 2002).

Water quality

Problems of water quality can often be as severe as those of availability, though generally speaking the water quality of the mainstream Mekong River is good (Hien 2003).

Table 8.1. Water consumption by sector in Thailand, 1993, 2002 and 2006 (projected) (unit: million m³).

	1993		2002		2006		Increase 1993–2006
	Volume	%	Volume	%	Volume	%	
Domestic	3 118	4.6	3 521	4.6	6 593	6.0	3 475
Industry and tourism	1 311	1.9	1 480	1.9	2 154	1.9	843
Irrigated agriculture	48 172	54.3	54 394 ^a	55.8	61 747	56.5	13 575
Power generation	20 767	23.4	20 767 ^b	21.3	23 425	21.4	2 658
Maintaining downstream flows	15 326	17.3	17 305	22.6	15 434	14.1	108
Total	88 694	100	97 467	100	109 353	100	20 659

Note: Totals are drawn from the data source and may not add up because of rounding.

^a Irrigated agriculture plus power generation.

^b Data for 2002 are unavailable. No change since 1993 is assumed. Source: ADB (2006b).

Thailand has one of the largest areas of irrigated land in the GMS. Three-quarters of this land is in the Chao Phraya basin. The actual consumption of irrigation water is difficult to measure in practice, as it requires reliable measurement of water volume at key points of the water delivery system. Thailand does not yet have a system for such measurements (TEI 2006). Nevertheless, estimates of water demand suggest that irrigation in Thailand consumed 61 747 million m³ of water in 2006, or almost 60 per cent of total water consumption (Table 8.1).

Although irrigated agriculture continues to be the main consumer of water in Thailand, Table 8.1 shows that demand for water is growing fastest in the domestic, industry and tourism sectors. In recent years, the demand



In the rice field
Source: Sansana Malaiairisoorn, UNEP RRC.AP

Issues of possible concern for specific areas in the lower Mekong basin are sediment in the water, salinization (especially in northeast Thailand and the Mekong Delta) and eutrophication (MRC 2003). Total suspended solids, a measure of sediment loads, have decreased across the basin, including in the mainstream Mekong itself (MRC 2003). Salinity levels have also declined in northeast Thailand and the Mekong Delta. Indeed, MRC (2003) reports that northeast Thailand shows a clear improvement in water quality, with nutrient loads also decreasing. This is attributable to the effect of growing numbers of small reservoirs on dry season flows.

In the Mekong Delta, however, nutrient levels are increasing. Levels of phosphorus at Chau Doc in Viet Nam, for example, are approaching those usually associated with eutrophication and associated algal blooms (UNEP-IETC 2000). However, no major bloom events have been reported. It is thought that excessive use of fertilizers is responsible for the increased nutrient levels.

Outside the Mekong basin, water quality problems are more severe. Issues of water supply and demand apart, water pollution is perhaps the most serious environmental problem facing Thailand today. Water quality monitoring of the major river basins and lakes in Thailand during the 1990s revealed a steady rise in levels of pollution (World Bank 2001b). This trend has continued into the new millennium, with the proportion of surface water resources classed as good quality falling from 40 per cent in 2002 to 23 per cent in 2004 (PCD 2006). However, an increase in the proportion of water resources classed as moderate quality means that the overall proportion of poor quality water resources stood at 26 per cent in 2004, down from 35 per cent in 2002 (PCD 2006).

Monitoring of surface water quality in Viet Nam is still limited, but the available data indicate high levels of pollution in lakes and rivers. BOD levels in the major rivers exceed the national standard for domestic water use, and show no sign of improving (ADB 2006d).

However, rivers in the north and central regions (including the Red River) show lower levels of organic pollution than those in the south (such as the Saigon River). Viet Nam introduced a system of wastewater discharge fees for industry in 2003, but there is little evidence that these have reduced discharges. The average fee in 2003 was only US\$0.03/m³, and the procedures for collecting and using fees are unclear (ADB 2006d).

The chemical and biological quality of Yunnan's water resources is also generally poor. Organic pollution from both rural and urban sources is a particular problem, though water quality has improved in recent years as a result of new pollution control measures such as centralized wastewater treatment plants (ADB 2006c). In 2004, more than 53 per cent of major rivers were classed as good quality, compared with only 37 per cent in 1990 (ADB 2006c). This picture contrasts with that of Yunnan's lakes, which are still under heavy pollution pressure and show few signs of improvement. Between 1990 and 2004 the proportion of lakes classed as good quality remained static at around 52 per cent (YEPB undated, YEPB 2004).

Besides surface waters, coastal and groundwater quality in the GMS is also being adversely affected by increasing pollution and external pressures. Groundwater is contaminated by agricultural run-off, pesticide residues and saltwater intrusion from over-extraction of water. Coastal and marine waters face threats from both land-based and maritime pollutants. Thailand's coastal water quality has declined steeply in the past few years, largely because of uncontrolled discharges of untreated domestic wastewater. Between 2002 and 2004, the proportion of coastal sample stations recording excellent water quality fell from 47 per cent to just 3 per cent (PCD 2006). Conditions are especially bad in the Inner Gulf of Thailand, which covers the estuaries of four main rivers (Chao Phraya, Tha Chin, Mae Khlong and Bang Pakong). In 2004, every sample station in the Inner Gulf recorded either deteriorated or highly deteriorated water quality (PCD 2006).

8.3 IMPACTS AND HEALTH CONSIDERATIONS

Water shortages and water pollution can pose serious environmental threats to human health. Although the proportion of people with access to improved drinking water sources has increased in most GMS countries over the past decade, a large proportion of people in the region still does not have access to clean water (Figures 5.2 and 5.3). This is particularly so in Cambodia, Lao PDR and Viet Nam, which all have mainly dispersed rural populations. The distribution of people in these countries presents special challenges for the equitable upgrading of domestic water systems. However, the relatively slow growth of rural populations means that coverage can be extended quite rapidly, as it has been in Myanmar. By contrast, coverage may expand more slowly in urban areas owing to their faster population growth.

In Myanmar, overall access to safe drinking water increased by almost 20 per cent between 1995 and 2003. The increase in rural areas during this period was 24 per cent; in urban areas it was 14 per cent (ADB 2006e). The main sources of safe drinking water are protected open dug wells and ponds, followed by tube wells. Piped water supply to households has also increased, and stood at 15.4 per cent of the total population in 2003 (ADB 2006e). In urban centres, for instance Mandalay, about 62 per cent of the population has access to a piped water supply. Increased access to piped water is associated with a lower prevalence of water-borne diseases such as dysentery, viral hepatitis and typhoid (ADB 2006e).

Alongside diseases linked specifically with water quality and sanitation, such as cholera, typhoid, viral hepatitis and dysentery, general diarrhoea is widely prevalent in the GMS. Diarrhoea is usually linked to a lack of domestic water and sanitation, and exacerbated by poor hygiene practices and low availability of water. Together with other water-related diseases, diarrhoea is the most common cause of illness and death among the poor of

developing countries (UN Millennium Project 2005). Improvements in safe water supply, and particularly improvements in hygiene and sanitation, can have a drastic effect. This is well demonstrated in Thailand, where sanitary latrine coverage increased from less than 1 per cent in 1960 to over 98 per cent in 1999, reducing deaths from gastro-intestinal illness by sixteen-fold (MRC 2003).

Intestinal worms, cholera, dysentery, typhoid, viral hepatitis, schistosomiasis and trachoma are also closely linked with domestic water and sanitation, and hygiene practices. Domestic water and sanitation also contribute the spread of some insect-transmitted diseases such as malaria and dengue through poor storage of water, ponding in pits or discarded containers around the home, and the inadequate drainage of surplus domestic water (MRC 2003).

Of the eight most common health complaints in rural Cambodia, all but two are water-linked. Four of these diseases (diarrhoea, hepatitis, typhoid and cholera) can be directly impacted by interrupting transmission routes through access to better domestic water and sanitation and improved hygiene. Most importantly, simple diarrhoea is still one of the two main causes of death of Cambodian children under five years (MRC 2003).

8.4 THE RESPONSE

Water resources management in the GMS is a complex, dynamic issue. A large number of stakeholders play a role in this area, and their positions and initiatives can and do change quickly. Given the rapid rate at which new developments are coming forward, this section should be taken as no more than a snapshot of the current situation.

A variety of legal, institutional and economic measures are being brought to bear on the problems of water availability and water quality in the GMS. The international move towards catchment-based water management has affected every country in the region to a greater or lesser extent (Hirsch 2006). Thailand

in particular has made great strides towards establishing a river basin system of governance, through the division of the country into 25 catchment-defined regions and the creation of an institutional structure for administering these areas in the form of River Basin Committees (RBCs). RBCs are also being established in Viet Nam, Lao PDR and Cambodia (Hirsch 2006).

The establishment of catchment management organizations such as RBCs draws on principles of Integrated Water Resource Management. As its name suggests, IWRM represents a shift away from traditional, fragmented policy responses to the management of water and other resources. A geographical application of IWRM is Integrated River Basin Management, which is associated with institutional innovation through the establishment of river basin-specific organizations. In the GMS, this process has resulted in the formation of the MRC and its associated National Mekong Committee governance structure. This provides an integrated institution that is owned by, and whose agenda is set by, its riparian signatories.

The MRC's work on managing water availability spans the two extremes of flood and drought. Flood issues are addressed by its Flood Management and Mitigation Programme (FMMP), which forms part of the GMS Program's Flood Control and Water Resources Management Programme. The FMMP aims to prevent, minimize and mitigate human suffering and economic losses caused by floods, while preserving the environmental benefits of yearly flooding. In 2007, the MRC will begin playing a role in managing drought and water shortages through the launch of a new Drought Management Programme. Potential areas for action include modelling and policy design for improved water management options to mitigate drought impacts, including improved water storage and intra- and inter-basin transfers (MRC 2006).

Market mechanisms offer a potentially efficient way of allocating water to those who need it most, but their use in the GMS is

contentious. In Thailand in particular there is a vigorous debate on the appropriateness of agricultural water pricing. The perception that water is used inefficiently and wastefully as a free good by farmers, combined with the market-oriented nature of Thai agriculture, has encouraged reforms through a proposed Water Act that would see farmers charged for water on a user-pays basis (Molle 2001, Hirsch 2006).

The rationale for water fees is partly to encourage more considered use, partly to provide incentives for water to be allocated through transferable permits to highest value uses, and partly to provide revenue through transferable permits. However, the proposals for water pricing for farmers have been attacked as the imposition, in effect, of a regressive tax on some of the poorest sections of Thai society. In response to these and other criticisms, a revised draft of the Act contains a three-tiered pricing framework, in which small farmers would not pay water rates, commercial farmers would pay a lower rate, and industrial and urban consumers would be charged the highest rates (Hirsch 2006). ■

9 PROTECTING AND MANAGING BIODIVERSITY

9.1 INTRODUCTION

The GMS harbours globally important and irreplaceable elements of biodiversity. Besides covering six forest ecoregions of exceptional biodiversity (see Chapter 4), the region is part of a global biodiversity hotspot and contains several important bird areas (ADB 2005). Much of the region is biologically unexplored, and surveys over the past 10 years have revealed several species new to science, most recently the Laotian rock rat (*Laonastes aenigmamus*) and several frog species from Lao PDR and Viet Nam (Jenkins, Kilpatrick, Robinson and Timmins 2004, Bain, Stuart and Orlov 2006). Many species are endemic to the region and have extremely restricted ranges, so are vulnerable to habitat loss.

The natural biodiversity of the GMS is a crucial economic, social and cultural resource, yet it faces many serious threats. It is difficult to

assess rates of species loss in absolute terms. Using degradation and loss of habitats as a proxy for species loss, ADB (2005) estimates that the GMS will lose more than half of its remaining land and water habitats over the next century if countries fail to take any action.

The threats to biodiversity come from four main sources (ADB 2005). First and foremost is depletion of natural resources and habitat loss or degradation. As discussed in Chapter 7, some processes of degradation are linked to population growth. Second is over-exploitation for trade, both within countries and across borders. Large volumes of plant and animal species are shipped to markets outside the GMS, including countries in East Asia, Europe and North America. For some species, this trade is considered the single greatest threat, more serious even than habitat loss and degradation. Third is the construction of transboundary roads and other economic activities. These can exacerbate existing threats such as habitat loss and wildlife trading. Last is limited awareness and understanding of, and weak capacity for, biodiversity conservation, protection and management, common problems across the region.

Besides these four main threats, alien invasive species also pose a growing threat to the region's biodiversity. As noted in Chapter 6, numerous introduced plant, mollusc and fish species have established populations in the region, sometimes at the expense of native populations. The introduction of exotic fish species to the Mekong basin, for example, was undertaken for four major purposes:



Hornbill, Trang, Thailand
Source: Uthaiwan Kanto, Kasetsart University

aquaculture, stocking of lakes and reservoirs, pest control and the aquarium trade (Welcomme and Vidthayanom 2003). Many of these species have formed established populations, or are likely to do so. Most have had only minor negative effects, but some are thought to be contributing to declines in native fish populations. A far more destructive introduction has been apple snails (*Pomacea* spp.), which were originally introduced into Thailand for aquaculture. They have now established themselves in the wild and have had a major impact on aquatic habitats, including rice fields, because they destroy the bases of growing aquatic plants. They also compete with native snail species, such as *Pila* spp., which feed only on dying plants (Welcomme and Vidthayanom 2003).

Alien and invasive species are one aspect of a wider problem linked to habitat loss and degradation, which is the modification of ecosystems. This covers such processes as the degradation of forests and grasslands by the spread of inferior shrubs or bushes due to human activity; the alteration of peat bogs and marshlands in Viet Nam and Cambodia by insect infestation; the colonization of flooded forests around Tonle Sap Lake by dense stands of *Mimosa pigra*; and the colonization due to pollution of different mangrove species in the mangrove swamps of the Mekong Delta (Snidvongs and Teng 2006).

As Chapter 6 notes, the countries of the GMS have tackled biodiversity protection in two main ways: through the use of national and international law, and by establishing protected area systems. Both of these approaches are currently undergoing far-reaching changes as a result of governance reforms in GMS countries, including decentralization, greater democratization, the development of new natural resource management institutions, and a renewed emphasis on the rule of law (ADB 2005).



9.2 DRIVING FORCES AND PRESSURES

Resource depletion and habitat loss

The richest terrestrial habitats in the GMS are forests⁵. The region remains one of the most heavily forested in the world, though natural forest cover has decreased in every country. Viet Nam and Yunnan have increased their overall forest cover through large-scale reforestation programmes, but forest plantations tend not to harbour high levels of biodiversity.

The loss of forests has affected every ecoregion in the GMS to a greater or lesser degree. The Northern Indochina subtropical forests have been depleted by land clearing for swidden cultivation, poppy cultivation and logging (WWF 2001a). Almost all of these forests have been cleared in Viet Nam. Large areas of forest in the eastern Shan State of Myanmar, along the border with Lao PDR and Yunnan, also have been cleared. Forests in the hills of southern Yunnan are similarly degraded. The deforestation in border regions indicates that cross-border trade in timber and other forest products plays a key role in forest loss.

The Annamite Range rain forests situated along the border between Lao PDR and Viet Nam have a long history of human impact. This has led to the degradation of large areas of what were once montane evergreen forest. More

⁵ For further discussion of the threats to aquatic biodiversity see Chapter 11.

than half of the ecoregion has been cleared or degraded, although forests in its northwestern part are still in fairly good condition (WWF 2001b). Human population density is only moderate, but swidden cultivation and logging are major sources of deforestation and forest degradation.

The Cardamom Mountains rain forests sit astride the Cardamom Mountains and Elephant Range in southwestern Cambodia, extending slightly into southeast Thailand. The ecoregion is one of the few with intact forests, and its biota probably remains intact (WWF 2001c). The main threats to biodiversity are illegal logging operations and the wildlife trade.

The Indochina dry forests harbour large numbers of threatened large vertebrates, but are severely threatened by habitat loss and hunting for trade. Large blocks of forest remain in northeastern Cambodia, but most of the natural habitat has been extensively cleared in Thailand, Lao PDR and Viet Nam. Much of the ecoregion lies in densely populated areas, where the natural habitat has long been converted to agriculture and settlements. Fires, a natural feature of the forest environment, have been widely set to clear land for agriculture and promote pasture growth for livestock (WWF 2001d).

Both the Kayah-Karen montane rain forests and the Peninsular Malaysian rain forests have high levels of mammal diversity. However, they also face severe threats from land clearing for agriculture and intensive logging. Hunting has decimated most of the large mammal populations in the Kayah-Karen ecoregion (WWF 2001e). About a third of the Kayah-Karen ecoregion has been cleared or degraded, but the forest that remains is relatively intact and contiguous. Several large wildlife reserves are found in this region, including Huay Kha Kaeng wildlife sanctuary in Thailand (2 575 km²), and the Mulayit and Kahilu wildlife sanctuaries in Myanmar. By contrast, only about a fifth of the original forest in the Peninsular Malaysia ecoregion remains, and much of this is highly fragmented (WWF 2001f).

Over-exploitation and trade of wildlife

The legal and illegal trade in wildlife in the GMS is selective in the species it targets, but is leading to an “empty forest syndrome”, in which cumulative extractions result in impoverishment and disruption of the affected ecosystems (ADB 2005). The wildlife trade is badly affecting protected areas. Most of the main trade routes from Lao PDR and Cambodia, for example, link directly to protected areas (ADB 2005).

Underground routes and a variety of methods that deceive forest rangers and enforcement authorities are used in illegal sales in the region. Large networks and syndicates are often involved, using hunters and collectors in rural areas, and entrepreneurs and high-level traders in towns and cities (ADB 2005). Some species of wildlife are consumed locally, but there is probably more illegal trade of wildlife resources in and out of the GMS than there is within it (ADB 2006a). The trade in Viet Nam alone was estimated to be worth US\$66.5 million in 2002, much of it destined for foreign markets, particularly China (Van Song 2003). In Thailand in 2003, a one-day raid on Bangkok’s Chatuchak market seized 1 000 protected species worth US\$1.25 million (World Bank 2005c).

Much of the demand for wildlife arises from traditional Chinese medicine (World Bank 2005c). This ancient practice uses a variety of natural plant, mineral and animal-based ingredients, including tiger bone, rhinoceros horn and bile from bear gall bladders. Although alternatives are available, and many species once used are now protected by national and international laws, illegal trade and poaching have increased rapidly as the popularity of Chinese medicine has expanded, in part driven by the rise in personal incomes (World Bank 2005c).

The countries of the GMS play different roles in the wildlife trade (World Bank 2005c). China, as noted, is the largest consumer of wildlife, followed by Thailand and Viet Nam. Thailand was formerly a major source of wild species, but now is chiefly a consumer of high-value pets, trophies and food products. It also

plays an important role as a conduit for the regional and global trade. Viet Nam is unique in that it is both a source and a consumer of wildlife, as well as an important trade conduit to China. The other three countries of the GMS—Cambodia, Lao PDR and Myanmar—are important sources for a wide range of plant and animal species. Both Lao PDR and Myanmar are also trade conduits: Myanmar for wildlife products coming into the GMS from the Indian subcontinent; and Lao PDR (see below) to international markets in China, Viet Nam and Thailand (World Bank 2005c).

International trading in wildlife is illegal but common in Lao PDR. The species traded include reptiles, wild orchids and products for Chinese medicine; trophies from wild cattle, reptiles, pets and food animals to Thailand; and macaques, freshwater turtles, monitor lizards and pangolins to Viet Nam. The greatest threat to Lao PDR's wild species is the country's over-harvesting for international and domestic trade and consumption. A significant portion of rural people's incomes is derived from hunting and selling threatened wildlife at local markets. The volume of illegally traded wildlife is also high. The value of wildlife smuggled into Viet Nam from Lao PDR along one route alone was estimated at US\$11.8 million in 1999 (World Bank 2005c). And, according to CITES trade data, between 1993 and 2003 over 80 000 pangolin skins were illegally exported from Lao PDR to international markets, primarily in the United States and Mexico.

Road construction and other economic activities

Domestic and export demand for many commodities will increase with the construction of transboundary roads and economic development, and the remaining forest areas will become increasingly vulnerable. If not planned and managed effectively, the planned system of transboundary roads in the GMS could have severe impacts on biodiversity. Some of the roads bisect protected areas, or their "zones of influence" extend into protected areas or important biodiversity corridors (ADB 2005).

Other economic developments, especially the numerous dams planned for the region to meet the demand for flood control, irrigation and electricity generation, are also likely to affect adversely large areas of forest and other wildlife habitats. Unless they are properly managed, these dams could also have direct impacts on aquatic ecosystems by disrupting flow regimes and blocking spawning migrations and breeding of fish. Birds that use sand bars for nesting could also be affected (ADB 2005). Furthermore, the people displaced by dam developments often resettle in other forest lands or critical biodiversity areas, further disrupting ecological processes (ADB 2005).

Much of the concern about dams and their impacts centres on Yunnan. The province has an exploitable hydroelectric power potential estimated at more than 71 000 megawatts (Magee 2006). China's government is keen to exploit this potential, both to increase national energy supplies and to alleviate poverty (Makkonen 2005, Magee 2006). To this end, a series of eight hydropower projects is under way on the Lancang River (the upper stretch of the Mekong in Yunnan), and plans have been launched to construct a 13-dam cascade on the Nu Jiang River (upper Thanlwin)⁶. Besides these dams, China has initiated a project with Thailand, Lao PDR and Myanmar to improve navigation on the upper Mekong by removing several rapids and reefs with dredging and blasting. This project has been criticized for its failure to assess the potential impacts on the river's fisheries and food supply, and for its limited consultation with Cambodia and Viet Nam (Makkonen 2005).

The main concerns about the Yunnan dams centre on their effect on natural flow regimes. No assessments have been made of their basin-wide impacts, but the dams' proponents argue that they will help to regulate downstream flows, reducing the gap between wet-season and dry-season flows, and so contributing to irrigation, navigation and flood diversion work (Makkonen 2005, Magee 2006). However, it is possible that changing flow regimes will affect certain seasonal phenomena,

⁶ Construction of the Nu Jiang cascade was suspended in 2004, but a scaled-down version with four dams may still be authorized (Makkonen 2005).

such as river gardens. The dams will also block the passage of migratory fish and downstream sediment flows. The latter carry high nutrient loads, and are thought to be responsible for the high productivity of the Tonle Sap Lake, among other sites. Reducing these loads may therefore affect the important Tonle Sap fishery.

Limited awareness, understanding and capacity

Insufficient numbers of trained staff to undertake and implement biodiversity conservation effectively have been cited as a major underlying threat to biodiversity. Limited capacities mean unmanaged or poorly managed protected areas, low staff morale and an increased likelihood of collaborating with or contributing to illegal activities. Inappropriate or inadequate budget allocations for biodiversity conservation management, an overemphasis on infrastructure development, and other policy failures also have negative effects on biodiversity conservation (ADB 2005).



9.3 IMPACTS

Besides a decline in the area of key wildlife habitats, the impacts of biodiversity loss in the GMS include growing numbers of threatened and endangered species. National and provincial assessments of threats to biodiversity have identified a total of 109 threatened species endemic to the region (ADB 2006a). These include 35 mammals, 23 birds, 17 amphibians, 19 reptiles and 15 fish species, ranging in size from shrews and bats to monkeys and deer. Changes in the number of threatened species over time are difficult to track given the disparities in data quality and availability among countries. The IUCN Red List used as a basis for Table 6.3 has existed since 1996, but it is only recently that variations over time can be observed with confidence (ADB 2006a).

Table 9.1 details the number of threatened endemic species in each country as a proportion of the global number of threatened species. Without distinguishing between the level of threat (vulnerable, endangered or critically endangered), these figures indicate that GMS countries harbour an average of 2.1 per cent of globally threatened species (ADB 2006a). Viet Nam has the highest proportion of threatened species; Yunnan the lowest (though the difference is only 1.82 percentage points). Another notable point is that Myanmar, Thailand and Viet Nam hold between 7 and 9 per cent of globally threatened reptile species.

Given the overlap of threatened species among countries, it is not possible to say what proportion of globally threatened species occurs

Table 9.1. Threatened wildlife species as a proportion of globally threatened species (unit: per cent).

	Mammals	Birds	Reptiles	Amphibians	Fish	Total
Cambodia	2.54	2.15	4.93	0.17	1.62	1.64
Lao PDR	3.09	2.06	3.95	0.23	0.75	1.56
Myanmar	3.63	4.04	8.55	0.00	1.25	2.41
Thailand	3.45	4.13	7.24	0.17	4.74	2.91
Viet Nam	4.00	3.63	8.88	0.85	3.50	3.05
Yunnan	2.91	1.48	3.95	0.11	...	1.23
GMS ^a	3.27	2.92	6.25	0.26	–	2.13

^a Totals are drawn from the data source.
Source: ADB (2006a).

within the region as a whole. Using weighted averages of endemic species, ADB (2006a) supplies a rough estimate of 7 per cent in Cambodia, 11 per cent in Lao PDR, 12 per cent in Myanmar, 17 per cent in Thailand, 20 per cent in Yunnan and 33 per cent in Viet Nam. These figures indicate that Viet Nam has the greatest proportion of threatened species, and so bears much of the burden of responsibility for protecting the region's threatened biodiversity (ADB 2006a). Yunnan and Thailand also share part of the burden, but Cambodia, Lao PDR and Myanmar have relatively fewer threatened endemic species.

9.4 THE RESPONSE

All six GMS countries offer some form of legal protection to wildlife, but the requirements of law, as well as monitoring and enforcement, vary from one country to another. At present, few of the threatened endemic species discussed above are legally protected. ADB (2006a) reports that 63 per cent of the species are not protected by local laws, and that another 11 per cent are only partially protected. Protection is strongest for bird species, but weakest for fish species (ADB 2006a).

At the level of international law, CITES offers protection to species listed in its appendices. A CITES listing indicates that the species carries some commercial value and, as such, is vulnerable to illegal trading. Overall, more than a third of the threatened endemic species in the GMS are listed under CITES. More than half of these, however, enjoy no protection under national law (ADB 2006a).

These figures indicate that, in many cases, GMS governments are not using the CITES convention to its full potential in protecting wildlife from illegal trade. To a certain extent, this is because some countries have only recently begun serious counter-trafficking efforts. Lao PDR, which has long been considered the hub of illegal wildlife trading in the GMS, only acceded to CITES in 2004 (ADB 2006a).

However, concern about the impacts of illegal trading are now prompting GMS governments to take serious action. In 2004, Viet Nam approved a National Action Plan to Strengthen Control on Trade of Wild Fauna and Flora (ADB 2005). And, in the same year, ASEAN issued a statement calling for regional cooperation in implementing and enforcing wildlife trade controls, in particular CITES. A draft ASEAN action plan on wildlife trade was finalized in 2005, and member countries have signed several bilateral accords to combat illegal trade (ADB 2005).

In recent years, the main instrument used to protect both habitats and species has been the creation of protected areas. As Table 6.4 above makes clear, protected areas vary widely in age and extent from one country to another. Some of the wildlife sanctuaries in Thailand and Myanmar date back to the early 1900s. The bulk, however, have been designated only since the early 1990s, following a recommendation from IUCN that 10 per cent of a country's land area should be set aside for biodiversity conservation (ADB 2006a). To judge from Table 6.4, only Cambodia, Lao PDR and Thailand have met this recommendation, but Yunnan is close to doing so.

It is not just the extent of protected areas which varies within the GMS, but also the level of protection each offers. The entire protected area system in Lao PDR, for example, is classified as IUCN category VI. This, the lowest category of protection, means that protected areas are managed mainly for sustainable use of natural ecosystems (ADB 2006a). In Cambodia, more than half of the protected areas fall under IUCN category IV, meaning they are managed mainly for conservation through management intervention. The majority of Myanmar's protected areas are either wildlife sanctuaries (IUCN category I) or national parks (IUCN category II). Viet Nam has more of a mixture across all IUCN management categories (ADB 2006a).

An extra level of protection for the wetlands of the GMS is provided by the 1971 Ramsar Convention on Wetlands. Of the six GMS

Table 9.2. Ramsar sites in the GMS.

	NAME	DATE OF DESIGNATION	REGION/ PROVINCE	AREA (HA)
Cambodia	Boeng Chhmar and Associated River System and Floodplain	23/06/99	Kampong Thom	28 000
	Koh Kapik and Associated Islets	23/06/99	Koh Kong	12 000
	Middle Stretches of the Mekong River north of Stoeng Treng	23/06/99	Stoeng Treng	14 600
Myanmar	Moyingyi Wetland Wildlife Sanctuary	17/11/04	Southern Bago	256
Thailand	Bung Khong Long Non-Hunting Area	05/07/01	Nong Khai	2 214
	Don Hoi Lot	05/07/01	Samut Songkhram	87 500
	Had Chao Mai Marine National Park/ Ta Libong Island Non-Hunting Area/Trang River Estuaries	14/08/02	Trang	66 313
	Kaper Estuary/Laemson Marine National Park/ Kraburi Estuary	14/08/02	Ranong	122 046
	Krabi Estuary	05/07/01	Krabi	21 299
	Kuan Ki Sian of the Thale Noi Non-Hunting Area	13/05/98	Songkhla	494
	Mu Koh Ang Thong Marine National Park	14/08/02	Surat Thani	10 200
	Nong Bong Kai Non-Hunting Area	05/07/01	Chiang Rai	434
	Pang Nga Bay Marine National Park	14/08/02	Phang Nga	40 000
	Princess Sirindhorn Wildlife Sanctuary			
	Pru To Daeng Wildlife Sanctuary	05/07/01	Narathiwat	20 100
Viet Nam	Bau Sau (Crocodile Lake) Wetlands and Seasonal Floodplains	04/08/05	Dong Nai	13 759
	Xuan Thuy Natural Wetland Reserve	20/09/88	Nam Ha	12 000
Yunnan	Bitahai Wetland	07/12/04	-	1 985
	Dashanbao	07/12/04	-	5 958
	Lashihai Wetland	07/12/04	-	3 560
	Napahai Wetland	07/12/04	-	2 083
GMS	20	-	-	464 801

Source: Ramsar List of Wetlands of International Importance, 21 December 2006 (<http://www.ramsar.org/sitelist.pdf>).

countries, all except Lao PDR (which hopes to accede by 2008) are parties to the Convention. This means they have three main obligations: to promote wise use of their wetlands; to designate suitable sites as wetlands of international importance and to establish nature reserves on wetlands; and to cooperate with other parties in protecting transboundary wetlands and shared watercourses, and in conserving wetland flora and fauna (see Chapter 12).

At the time of writing, 20 sites covering almost 0.5 million ha have been designated as wetlands of international importance (see Table 9.2). The greatest number and area of these are in Thailand. Most Ramsar sites are also protected areas, though some are on state-owned forest lands or wetland areas. No new sites have been added since 2004, and moves to establish a regional Ramsar initiative have failed to bear fruit, in part because Lao PDR has yet to accede to the Convention.

As detailed above, protected areas in the GMS face a number of threats, including encroachment, illegal hunting and limited management capacities. At the same time, protected area policies and institutions are passing through a transitional phase driven by widespread reforms in governance. The results include devolved management authority and structures; greater emphasis on outreach and involvement of local communities and local governments; and more clarity in management controls, procedures and rights under the law (ADB 2005).

Cambodia and Thailand are drafting national protected area laws, and, following the introduction of protected area regulations, Viet Nam and Lao PDR are considering doing the same. As a first step, Viet Nam's government has adopted a National Protected Areas Strategy (ADB 2005). These changes to legal regimes have been accompanied by major reforms to the organizations managing natural resources and protected areas. Most recently, Thailand and Viet Nam have created new amalgamated

ministries of natural resources and environment. New agencies have been created at central and local levels to foster greater cross-sectorial integration.

Across the GMS, a growing trend is for public participation in biodiversity protection. This has several sources, including increased democratization and decentralization, as well as the growing recognition that communities which depend on local biodiversity for their livelihoods can be partners and allies, rather than obstacles, in conservation efforts. Hence GMS countries are introducing measures for public participation and consultation, mostly as part of policies for environmental impact assessments of development projects. At the local level, a growing number of communities is involved in the management of activities in the multi-use or buffer zones around and outside protected areas (ADB 2005).



A joint patrol by villagers and sanctuary rangers in Thung Yai Naresuan Wildlife Sanctuary, Thailand. Source: WWF-Canon/Sayan CHUENUDOMSAWAD

Public participation is for many GMS countries a relatively new phenomenon, and faces numerous technical, legal and institutional obstacles. Local communities in protected areas usually lack capacity and their management roles are frequently unclear. Furthermore, buffer zones around protected areas often lie outside official management jurisdiction and lack integrated systems of planning other than on an ad hoc basis through individual donor-

supported projects (ADB 2005). Across the region, top-down and proscriptive procedures, complicated by a lack of demarcation between agencies and their responsibilities, continue to hamper participation. ■



Along the river bank, Lao PDR
Source: Thailand Environment Institute

PART IV

THE IMPLICATIONS OF SOCIAL AND ENVIRONMENTAL CHANGE

10 POVERTY, LIVELIHOODS AND THE ENVIRONMENT

10.1 THE LINKAGES BETWEEN POVERTY AND THE ENVIRONMENT

Most GMS countries depend heavily on natural resources. Forests, fisheries and other resources make important contributions to economic growth and export earnings. The region as a whole has more than 180 million people living in rural areas; most depend directly on the quality and quantity of natural resources such as soil and water, and of natural ecosystems such as forests, rivers, wetlands, coastal zones, and marine ecosystems.



*Rural livelihoods in Lao PDR
Source: Thailand Environment Institute*

Often, the poorer the people, the more closely their welfare is linked to the condition of the natural resources they rely on. The poorer GMS countries, and poor people in general, depend disproportionately on environmental assets and natural resources. For the slower-growing countries (and regions within the larger countries), the majority of the rural poor continues to rely on agriculture (broadly defined to include arable and cash-crop farming, livestock, fisheries and forestry) for a large part of its income.

The poorest are often most adversely affected by the degradation of environmental resources, and they are frequently most at risk from environmental disasters because they live in the most vulnerable areas (Humphrey 2006). A number of studies in the region have shown a close correlation between certain measures of environmental quality and indicators of poverty. In China, for example, a very high level of overlap has been found between the vulnerability of land to degradation and the location of the rural poor. Similar connections have been found in Cambodia, Lao PDR and Viet Nam. An analysis of environmental conditions in the poorest districts of Lao PDR found the following (Dasgupta, Deichmann, Meisner and Wheeler 2002):

- **Deforestation and agricultural land:**

Although the deforestation rate for the poorest districts is close to the national average, these districts have seen a much greater decline in agricultural land. However, they average 52 ha of high-density forest per household, suggesting that with access and technical knowledge the well-being of the poor could be improved while conserving the forests.

- **Land degradation:** About half of the land in the poorest districts has an average slope of more than 30 per cent. The poor have little technical or financial support for finding more productive options to dry-rice cultivation, so have had to supplement low crop yields with already declining NTFPs.

- **Water resources and environmental health:** Daily water use in the poorest districts

is less than half the national average, owing to limited access to water for either personal use or irrigation. Water and sanitation-related health problems are acute, as are respiratory infections; indoor air pollution is a serious problem.

- **Biodiversity:** Thirteen of the poorest districts have a total forest cover of more than 50 per cent. Many are located in National Biodiversity Conservation Areas. The poor rely heavily on the availability of NTFPs, timber and other products from the forests. Biodiversity conservation is one of the crucial factors determining the livelihood of the poor.

- **Vulnerability from natural disasters:** Over the past decade, Lao PDR has suffered from some severe droughts and floods. In 2000, for example, more than 1 100 km² in seven provinces were flooded, affecting some 450 000 people.

These linkages suggest that the welfare of the poor depends on the way natural resources are managed, and that poverty reduction efforts could be enhanced by closely integrating environmental considerations into poverty reduction strategies. The challenges for GMS countries, therefore, are to ensure natural resources are used in sustainable ways that generate growth from which the poor are able to benefit, and to sustain the natural resource base

and its continued capacity for “pro-poor” growth (Humphrey 2006).

10.2 POVERTY IN THE GMS

Sustainable use of natural resources to lift people out of poverty is a key—perhaps the key—development challenge for the GMS. The incidence of poverty remains extremely high in the entire region, especially in rural areas and among ethnic minorities. Similarly, there is high and growing inequality in income and consumption.

Table 10.1 presents some of the available data on poverty and income distribution in the region. These indicate an uneven distribution of income in Thailand, where the richest 20 per cent earn almost eight times more than the poorest 20 per cent. Income inequality in Yunnan (to judge from the figures for China as a whole) is even greater. There the poorest 20 per cent earn less than one-tenth of the wealthiest 20 per cent. Income inequality in Cambodia, Lao PDR and Viet Nam has been widening, even though overall poverty rates have been falling. In Viet Nam, both trends can be attributed to the impact of market reforms in a formerly socialist economy.

Although the incidence of poverty has been declining across the region, it remains high

Table 10.1. Selected poverty indicators, 1980–2004.

	GDP per capita (PPP US\$)		Ratio of richest 20% to poorest 20%	Population below income poverty line ^a (%)			
	Poorest 20% 1980–1994	Richest 20% 1980–1994		US\$1 a day (PPP US\$) 1990–2004	US\$2 a day (PPP US\$) 1990–2004	National poverty line 1990–2003	
Cambodia	...	...	6.9	34.1	77.7	35.9	
Lao PDR	700	2 931	5.4	27.0	74.1	38.6	
Myanmar	...	...	...	...	...	26.6	
Thailand	1 778	16 732	7.7	<2.0	25.2	13.1	
Viet Nam	406	2 288	6.0	<2.0	33.4	28.9	
Yunnan ^b	722	5 114	10.7	16.6	46.7	11.1 ^c	3.7 ^d

Note: Data refer to the most recent year available.

^a See Glossary for definition of income poverty line.

^b Except where otherwise noted, data refer to the whole of China.

^c Figure refers to the incidence of rural poverty in Yunnan in 2002.

^d Figure refers to the incidence of urban poverty in Yunnan in 1998.

Sources: ASEAN (2005), Lin and Liu (2006), UNDP (1998, 2006), World Bank World Development Indicators 2005 (http://devdata.worldbank.org/wdi2005/Table2_5.htm), World Bank World Development Indicators 2006 (http://devdata.worldbank.org/wdi2006/contents/Table2_7.htm).

in Cambodia, Lao PDR, Myanmar and Viet Nam. Within these countries, the incidence of poverty among ethnic minorities tends to be higher than among the majority population (ADB 2002b). Poverty incidences of up to 100 per cent have been recorded among the Khome, Dao, Tay and Thai minorities in Viet Nam (ADB 2002b). In Thailand, rural poverty is concentrated in the north and northeast regions, particularly in areas where ethnic minority groups live (ADB 2002b).

Ethnic minorities are the poorest and socially most vulnerable groups in the GMS for several reasons. Typically, they live far from the economic mainstream in remote and upland areas, often with fragile ecosystems. They lack secure property rights in their productive resources, have low levels of education, and enjoy limited livelihood alternatives. They rely upon a declining natural resource base, and have to contend with a variety of pressures resulting from population growth (natural and immigration), resource extraction and development activities. Among these groups, women and children, in particular girls, tend to have less access than men and boys to scarce resources. Women's contributions are not adequately reflected in their rights and control of resources, and they tend to have limited influence on decisions affecting their needs and priorities (ADB 2002a).

Environmental change and the poverty it is associated with have many social and economic impacts. One key group of impacts relates to food security, which is explored in the next chapter. Food insecurity is often related to a lack of access. This, in turn, is related to inadequate purchasing power, a result of poverty, and to transport and marketing constraints, which affect poor, isolated groups. Inadequate levels and quality of food intake cause undernourishment and malnutrition, and prevent people from playing an active role in the economy.

The persistence of poverty despite the growing affluence of the GMS can be explained by a number of factors (ADB 2002a). Reducing poverty has not been a priority in infrastructure

development, though this is slowly changing. The nature of governance systems and institutional arrangements in rural areas has also created obstacles. Natural resource management is often based on customary arrangements, which have little legal or constitutional protection against political decisions or economic interests. The traditional governance systems of local communities have come under severe stress over the years, resulting in the erosion of trust, authority and legitimacy (ADB 2002a). Neither traditional systems nor conventional economic planning have been able to protect the rights of the poor in the face of large-scale changes. Despite some isolated and ad hoc attempts to redress this situation, what is still needed is a view of development aimed specifically at eradicating poverty. And, as discussed above, this must necessarily be based on good environmental governance. ■

11 FOOD SECURITY



*Agriculture along the Mekong River, Nong Kai, Thailand
Source: WWF Thailand*

11.1 INTRODUCTION

Changes in the quality and quantity of land, water and biodiversity resources in the GMS inevitably have serious human impacts. Human well-being is inextricably linked to natural ecosystems through the goods and services they provide. This link is especially strong in the GMS, with its predominantly agrarian populations and economies. Only a fine line exists, however, between using environmental resources to meet people's needs, and damaging or overexploiting those resources to the point where people's lives, health or well-being are put at risk (UNEP 2002).

Food security as a concept originated in the 1970s, in response to steep increases in food prices caused by the energy crisis of 1973. Attention initially focused on food supply problems—on ensuring the availability and relative price stability of basic foodstuffs at national and international levels (FAO 2003b). It later broadened to cover the behaviour of potentially vulnerable and affected people, and to incorporate new insights into the links between technological advances in producing food and reducing poverty and malnutrition.

Today, being food secure means that all people, at all levels and all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (FAO 2003b). This definition goes well beyond the traditional concept of hunger: it embraces a systematic view of the causes of hunger and poor nutrition with a community, recognizing both physical and economic vulnerability (UNEP 2002).

11.2 FOOD SECURITY IN THE GMS

Food security strategies in the GMS usually have had a narrow focus. The dominance of rice in the region's diet, coupled with the price instability in the world market for rice, has obliged countries to buffer their domestic rice price against the world price. Furthermore, most countries have paid little attention to formal efforts to define food security as a prelude to government interventions (Timmer 2005). Government policy in Thailand, for example, recognises that food security has four aspects: availability, accessibility, affordability and efficient use (Deethae 2004). In practice, however, Thailand's food security strategy has focused on ensuring the availability of rice, mainly by stabilizing domestic prices.

Stabilization of rice prices and strong economic growth mean that such countries as Thailand and Viet Nam can now, at the national level, produce sufficient food to meet their needs. Indeed, these two countries are net exporters of food and, at least in Thailand's case, a major contributor to world food security (Kachondham and Viravathana 2004). This picture is much the same in other countries such as Cambodia and Lao PDR, which are broadly self-sufficient in rice in years of good harvest.

A food surplus at the national level does not necessarily translate into food security at the

the household level, even in the more advanced economies of the GMS. Recent structural changes in Thailand's economy, for example, have realigned its food systems, shifting the emphasis of production from household consumption to large-scale commercial consumption. This shift, coupled with the effects of the 1997 Asian financial crisis on employment and consumption, has led to localized household food insecurity in both rural and urban areas (Kachondham and Viravathana 2004, Piaseu and Mitchell 2004).

A similar situation exists in Cambodia. The country's food production system is still recovering from three decades of conflict, but, after land reform in 1989 and a gradual restoration of law and order, it became food-surplus again in 1999 (Gill, Luttrell and Conway 2003). Yet official statistics show that almost a third of the population live below the food poverty line, and a similar proportion of communes faces chronic food shortages.

Thailand and Cambodia illustrate the phenomenon of adequate aggregate food supplies masking localized inequalities (what Sen (1986) has called "entitlement failures"). These countries may have enough food at the national level, but at lower levels the picture becomes more complicated. In both countries there is a wide variability in per capita production across provinces and regions. Thailand's southern region cannot produce enough rice to satisfy its needs, but must import rice from other regions, raising local rice prices (TEI 2006). In Cambodia, variable production is exacerbated by inadequate transport links and an array of illegal "taxes" on movement. Hence serious food security in some areas co-exists with gluts and low prices in others (Gill and others 2003).

The regional variations in rice production that contribute to household food security often stem from physical and environmental factors. Variations in rainfall and low soil fertility (whether natural or human-induced) are common factors affecting the productivity of rain-fed rice systems. Extreme weather events such as storms, floods and droughts can also have a substantial

impact, particularly on poor, vulnerable rural populations. Between June and December each year, typhoons regularly hit Viet Nam and cause widespread flood damage to the summer rice crop. The flooding in 2000 destroyed six per cent of the summer crop (Luttrell 2003).

11.3 STATUS OF RICE AND FISH PRODUCTION AND CONSUMPTION

Together with rice, inland capture fisheries production—particularly in the lower Mekong basin—forms the basis for the food security of much of the rural population (Kristensen 2001). Fish is the single most important source of animal protein for this population, and an important source of income too. Although the importance of rice for food security in the Mekong basin is widely recognised, the role of fish in the overall food security of the population is not always acknowledged, both in terms of its contribution to overall food production and in terms of its essential contribution to rural diets (Kristensen 2001). The common property nature of the Mekong fishery sector is causing increasing conflicts within the sector, and creating threats from other economic sectors dependent on the same resource base.



Figure 11.1 shows that, notwithstanding external shocks and other pressures, rice production has grown steadily in every country in the region. Some of the greatest gains have been made by Lao PDR, Myanmar and Viet Nam, the last two from relatively high bases. Lao PDR has increased production by two-thirds in the past decade, from 1.4 million tonnes in 1995 to 2.4 million tonnes in 2005. A comparison of these

trends with Figures 4.1 and 11.2 suggests that greater production is due partly to larger harvest areas, and partly to higher yields.

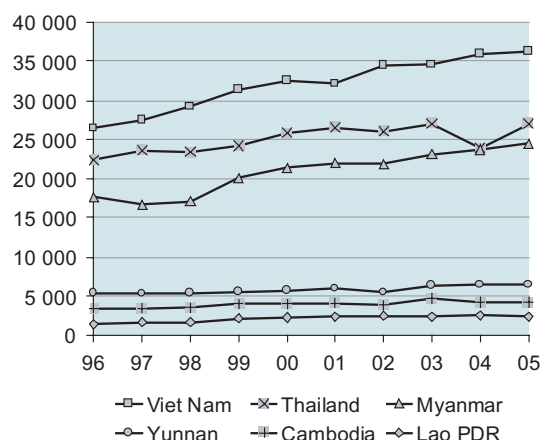


Figure 11.1. Annual rice production, 1996–2005 (unit: thousand tonnes).
Sources: China Statistical Yearbook (various years), FAOSTAT (<http://faostat.fao.org/site/408/default.aspx>).

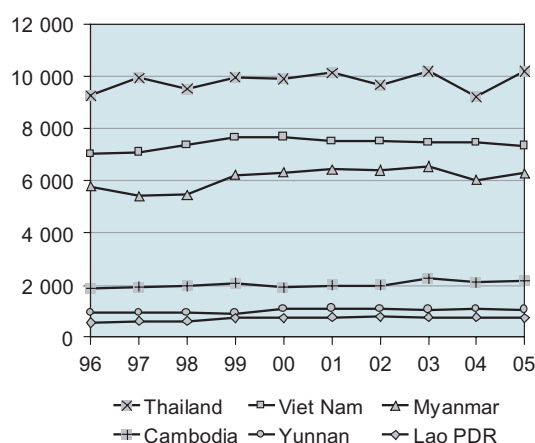


Figure 11.2. Rice harvest area, 1996–2005 (unit: thousand ha). The data for Yunnan refer to planted area.
Sources: China Statistical Yearbook (various years), FAOSTAT (<http://faostat.fao.org/site/408/default.aspx>), OAE (2005).

Some of the clearest evidence for the influence of extreme weather events on rice production comes from Thailand. The dips in harvest area in 1998, 2002 and 2004 are all largely attributable to unfavourable weather, in particular drought conditions in northeast Thailand. These badly affected the main, rain-fed rice crop (the second, irrigated crop was also affected by the low water levels in major dams).

Figure 11.3 highlights the importance of Thailand and Viet Nam as world rice exporters. Myanmar and Cambodia export much smaller quantities, and Myanmar's exports have declined sharply since 2001. Lao PDR does not yet produce a rice surplus for export. At the time of writing no data were available on Yunnan's rice exports, either internationally or to other provinces of China.

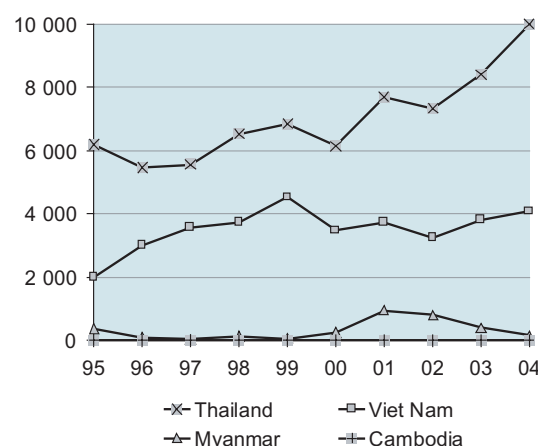


Figure 11.3. Total rice exports, 1995–2004 (unit: thousand tonnes).
Source: FAOSTAT (<http://faostat.fao.org/site/412/default.aspx>).

Rice, as already mentioned, is the staple food of the GMS. Figure 11.4 shows that it provides more than half of the total calorie supply in Cambodia, Lao PDR, Myanmar and Viet Nam. It provides around 44 per cent of the calorie supply in Thailand, where increasing affluence is leading to changes in traditional food consumption patterns (Kosulwat 2002). Figure 11.5, however, shows that per capita rice consumption in Thailand has grown slightly in the new millennium, from 103 kg in 2000 to 106 kg in 2004. Specific data on rice consumption in Yunnan are not available, but the national data in Figures 11.4 and 11.5 suggest that in (rural) China as a whole, rice is still a major, though declining, part of the diet. To judge from other countries, rice may account for 60 to 70 per cent of the total calorie supply of rural households in Yunnan. As in other fast-growing GMS countries, however, the long-term trend in food consumption in China is towards a high-fat, low-fibre diet (Du, Lu, Zhai and Popkin 2002).

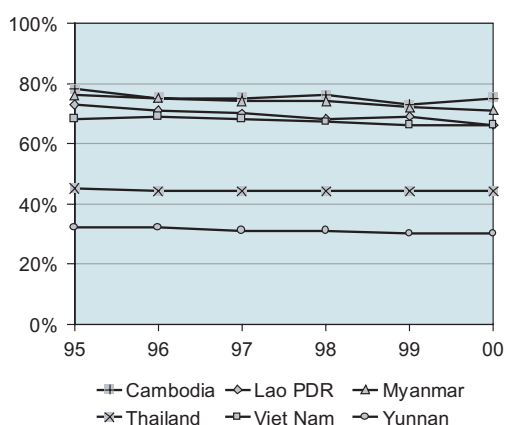


Figure 11.4. Rice calorie supply as a proportion of total calorie supply, 1995–2000 (unit: per cent). The data for Yunnan refer to the whole of China.
Source: International Rice Research Institute World Rice Statistics (<http://www.irri.org/science/ricestat/index.asp>).

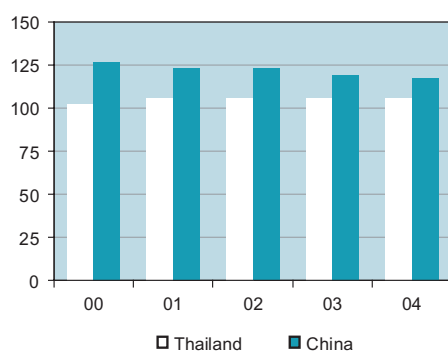


Figure 11.5. Per capita rice consumption in Thailand and rural China, 2000–04 (unit: kg/capita).
Sources: China Statistical Yearbook (various years), OAE (2005).

Figure 11.6 shows that inland capture fisheries across the GMS are either stable or declining, except in Myanmar. Only in Cambodia, however, do they contribute the bulk of fish production, though yields there have fallen sharply from a high of 385 000 tonnes in 2001. In general, freshwater aquaculture production is assuming greater importance (Figure 11.7). The relative decline in inland capture fisheries has various causes. In Thailand, it can be attributed mainly to economic development, particularly the building of multipurpose dams. These have reduced flooding in the floodplains and restricted the areas serving as natural spawning and nursing grounds for most freshwater fish species. Together with pollution and environmental degradation, this has caused a serious decline

in freshwater fisheries, providing the impetus for the development of aquaculture (Edwards and Virapat 2004).

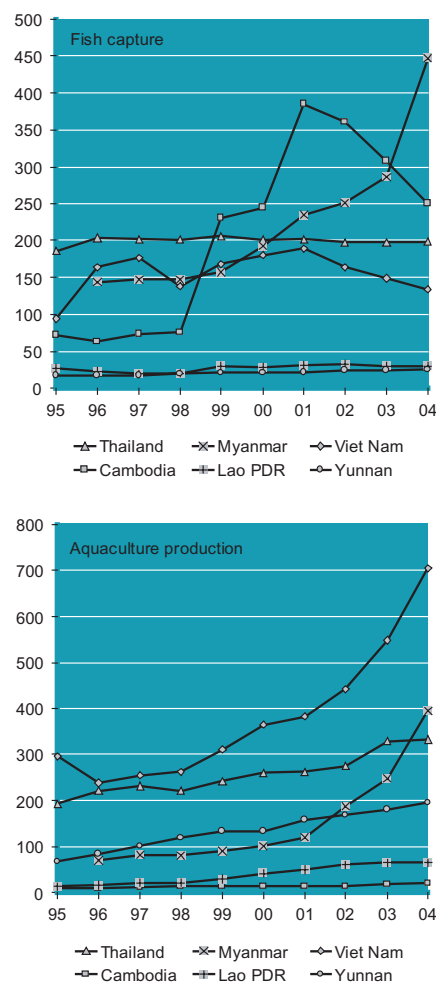


Figure 11.6. Inland freshwater fish capture and aquaculture production, 1995–2004 (unit: thousand tonnes). The data for Yunnan include crustaceans and other aquatic animals. No data are available for Myanmar for 1995.
Sources: China Statistical Yearbook (various years), FAO Fisheries Global Information System (<http://www.fao.org/figis/servlet/static?dom=root&xml=tseries/index.xml>), GMS country submissions.

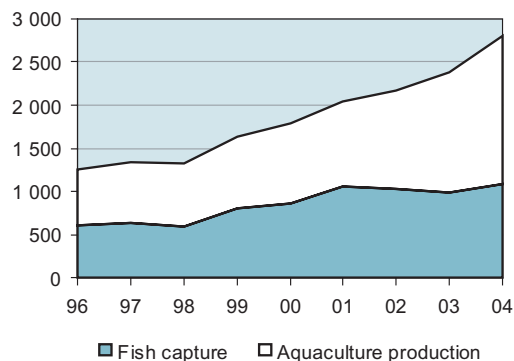


Figure 11.7. The growing contribution of aquaculture to total freshwater fish production, 1996–2004 (unit: thousand tonnes). Sources: See Figure 11.6

These trends notwithstanding, inland fisheries continue to support much of the rural population. Some 40 million rural inhabitants are active in the lower Mekong basin fishery, with captured fish forming a key part of household nutrition and income generation. In Lao PDR, 71 per cent of rural households (almost 3 million people) rely to varying degrees on fishing for subsistence and additional cash income. In Cambodia, more than 1.2 million people living in fishing communities around Tonle Sap Lake depend almost entirely on fishing as their principal livelihood. The net result is very high participation in the fishery, with recorded involvement ranging from 64 to 93 per cent of households (MRC 2003).



The Mekong fishery includes at least 120 commercial species and hundreds of types of fishing gear. At least 180 different types have been identified in Cambodia alone (MRC 2003). An equally diverse range exists in Lao PDR (Claridge, Sorangkhoun and Baird 1997). This situation makes it difficult to monitor fishing yield and effort accurately. The available data indicate that fish yields are closely correlated with average peak flood levels of the Mekong River. Local people complain that catches have declined over time, and this is borne out by yield monitoring. Despite this, the total fish yield from Tonle Sap increased by 84 per cent from 125 000 to 230 000 tonnes between the 1940s and 1995. Both trends are explained by a steep increase in the number of fishers (MRC 2003).

In Cambodia as a whole, the yields reported from registered boats do not reveal a clear decline in wild aquatic resources.

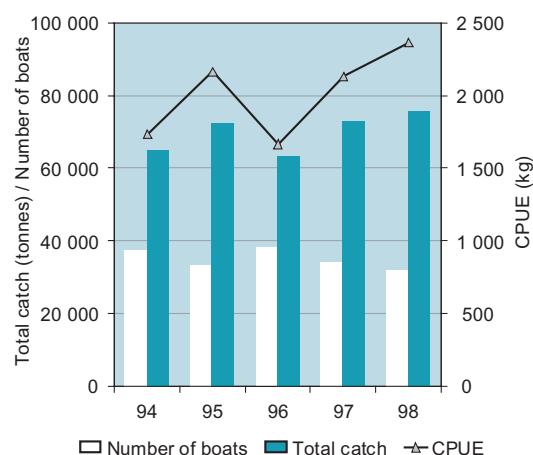


Figure 11.8. Inland fisheries catch per unit of effort (CPUE), Cambodia, 1994–98. CPUE is measured as the catch per boat (with or without engines) per year in kilogrammes.

Source: Department of Fisheries (2001).

Statistics from the Department of Fisheries of Cambodia show that the catch per unit of effort (CPUE), measured in kilograms per boat per year, averaged 1 843 kg in 1982–87, 1 684 kg in 1988–93, and 2 015 kg in 1994–98 (Figure 11.8). Species composition is changing, however, as catches of larger, slower maturing fish species decline and smaller, faster growing species form an increasingly larger proportion of the catch by weight. Fishery-related conflicts are also growing (MRC 2003).

11.4 IMPACTS

Given the overall increase in rice and fish production in the GMS, coupled with economic growth and greater affluence, it is no surprise that nutrition has improved markedly in the past decade. Every country has made large strides towards reducing the overall prevalence of undernourishment (Table 11.1). Child malnutrition, however, remains relatively high, except in Thailand. Few data are available for Yunnan, though official statistics reproduced in WHO/UNDP (2001) indicate that only 8 per cent of children under age 5 were underweight in 1999. Given China's overall excellent performance in reducing malnutrition, there is no reason to believe this figure is inaccurate. As such, it puts Yunnan at the forefront of regional efforts to reduce child malnutrition.

Table 11.1. Prevalence of undernourishment and child malnutrition, 1990–2004.

	Prevalence of undernourishment (% of population)		Prevalence of child malnutrition (% of children under age 5)	
			Underweight	Stunting
	1990–92	2001–03	1995–2004 ^a	1995–2004 ^a
Cambodia	43	33	45.2	44.6
Lao PDR	29	21	40.4	42.4
Myanmar	10	5	31.8	32.2
Thailand	30	21	17.6	13.4
Viet Nam	31	17	28.4	36.5
Yunnan ^b	16	12	8.0 (7.8) ^c	14.2

^a Data are for the most recent year available.

^b Except where otherwise noted, data refer to the whole of China.

^c Figure in parentheses refers to the whole of China.

Sources: WHO/UNDP (2001), World Bank World Development Indicators 2006 (http://devdata.worldbank.org/wdi2006/contents/Table2_17.htm)

As with food production, aggregate measures of nutrition hide local variations and inequalities. Although the nutritional status of Thai people improved in 1990–2002, the Asian financial crisis of 1997 led to a small upsurge in malnutrition. Moreover, there are large regional and socio-economic differences in nutrition. Children under five in Thailand's northern and northeastern regions are more likely to be malnourished than those in other regions. The malnutrition rate among young children in northern hill tribe communities is eight times greater than in Bangkok (MOPH 2005). Child malnutrition rates of up to 66 per cent have been recorded in some hill tribe communities (Kachondham and Viravathana 2004).

A similar gap between urban and rural malnutrition rates exists in Viet Nam, which has an overall undernourishment rate close to that of Thailand. In 1998, 43 per cent of rural children were underweight compared with 25 per cent of urban children. Among adults, the figures were 32 per cent and 25 per cent respectively (Luttrell 2003). In 2000, 37 per cent of children under five in rural areas were underweight, 44 per cent in mountainous areas, and only 27 per cent in urban areas. Higher rates of malnutrition are also found among Viet Nam's ethnic minorities. The prevalence of malnutrition among ethnic minority children is 14 per cent greater than it is for richer, urban children and

the majority Kinh population (Thang and Popkin 2003). Similar rural-urban and majority-minority nutritional gaps exist in Yunnan, where protein-energy malnutrition is higher among the children of rural minority groups. In a study of Hani, Yi, Hui and Miao children under seven, Li, Guo, Shi, Li, Anme and Ushijima (1999) found moderate malnutrition rates of up to 32 per cent and severe rates of up to 19 per cent. Li and others (1999) identified lower family incomes as one of the factors responsible for the poorer nutrition of minority groups compared with the majority Han group.

Despite a rapid recovery over the past decade, access to food is still a major concern for poor rural people in Cambodia. Large numbers of Cambodians are unable to meet their basic energy needs, and Cambodia has the highest rate of child malnutrition in the GMS (Table 11.1). The poor in rural areas show the highest rates of malnutrition, with moderate stunting of 61 per cent. The rural poor are also more likely to be underweight (16 per cent) than the better off in towns and cities (6 per cent) (Gill and others 2003).

11.5 THE RESPONSE

Food insecurity stems from a variety of factors. Poverty is the main factor limiting people's ability to access food, and much food

insecurity arises from households not having enough income to buy food. Despite rapid economic progress in recent years, poverty remains fairly widespread in the GMS. Much of the economic growth has benefited urban areas more than rural areas, leading to growing inequality and a concentration of poverty in rural areas. Other causes of poverty include social and geographic isolation, high risks from disease and natural disasters, inadequate access to such resources as land and credit, a lack of environmental sustainability, and weak participation at the local level in the formulation of poverty alleviation initiatives.

Shocks and hazards can push already vulnerable people into conditions of food insecurity. In recent years, flooding has put tens of thousands in the GMS into short-term food crisis and large foreign donations of food have been required. In 2000, Cambodia experienced its worst floods in 40 years. These were followed by heavy flooding in 2001 and 2002, the effects of which were exacerbated by a drought in 2002 (see Table 4.7). The floods made those normally on the borderline of food insecurity more vulnerable. The very poorest were not the worst affected because they rely on common property resources and had few losses to recoup. It was the small rice farmers who were worst affected as they were heavily indebted and lost many of their assets (Gill and others 2003).

Food security must be tackled as part of a poverty alleviation strategy that addresses agricultural growth and empowerment of the poor on one hand, and increased private sector involvement and investment on the other. Most of the national poverty reduction strategies being developed by GMS countries recognise the importance of agriculture and rural development for broad-based growth and poverty alleviation.

For example, Cambodia's national poverty reduction strategy identifies health, education and agricultural and rural development as priority sectors. The Cambodian government has also allocated specific responsibilities for the three main components of food security (availability,

access and efficient use). Primary responsibility for increased food availability lies with the Ministry of Agriculture, Forestry and Fisheries. Responsibility for increasing food access lies with various ministries concerned with increasing employment and income generation to ensure food accessibility, including access to land, forests and fisheries. Responsibility for better food use rests with ministries of Education, Health, Rural Development and others to increase crop diversification and intensification (Gill and others 2003). Cambodia is also tackling its HIV/AIDS epidemic, as experience in sub-Saharan Africa has demonstrated the disease's ability to undermine food security by killing the most economically active members of households (Gill and others 2003).

One of the main responses is the development of strategies for a shift away from narrowly based agricultural production to effective systems combining agriculture and trade. These will provide local employment and a more stable base for access to food. Local opportunities for livelihood diversification also need to be improved. This will mean addressing the issues of indebtedness and landlessness that affect many small farmers. These will require policy and institutional reforms aimed at expanding choice and access by farmers to such resources as land, credit and banking services. ■



Under the shade, Thailand
Source: Thailand Environment Institute

PART V

OUTLOOK AND RECOMMENDATIONS

12 ENVIRONMENT FOR DEVELOPMENT: RESPONSES AND OPTIONS FOR ACTION

12.1 INTRODUCTION

Across the GMS, the generally low level of development means that both the need and the opportunities for economic growth are high. The rapid economic growth of the past few decades is expected to continue, fuelled by industrialization, trade and investment. It should lift more people out of poverty, improving living standards, health, nutrition and livelihoods. However, concerns exist about the possible negative effects of this growth on the region's environment and vulnerable rural population. Much of the economic growth to date has bypassed rural areas, which continue to perform poorly by almost every social and economic indicator. In parts of the GMS, it has also put great pressure on the environment in the form of air and water pollution, water shortages, land degradation and the depletion of biodiversity.

These changes may not just cause irreversible ecosystem damage with far-reaching implications for the economic activities that depend on natural resources. They may also increase the vulnerability of poor, rural populations to health threats, natural disasters, food insecurity and community fragmentation, and in doing so lead to enduring social conflict.

An urgent need exists to reverse the trend of environmental degradation, and to secure the ability of natural resources to contribute to sustainable economic growth. This need can be met only by framing appropriate policy measures at local, national and regional levels,

and by ensuring their equitable and efficient implementation. Political will is indispensable to meeting this challenge, but so too are strong partnerships within and between government, business and civil society. The watchword of this effort must be integration, since only an integrated development strategy that improves productivity while ensuring the security of the environment and natural resources will be able to absorb the inevitable trade-offs and compromises.

12.2 ENVIRONMENTAL TRENDS AND CHALLENGES

Land degradation and agricultural productivity

Over the next few decades, population growth, income growth and continuing poverty alleviation efforts will exert growing pressures on the region's food production systems. In response, the region's farmers will be expected to intensify and diversify their crop production. The region has only limited good-quality arable land, however, and the benefits of intensifying irrigation and other inputs will be subject to diminishing returns. Viet Nam and Yunnan have shown that agricultural land can be extended, increasing per capita distribution. The environmental and social effects of this expansion are uncertain, however. Expansion through wetland conversion and forest encroachment has obvious detrimental effects. One approach would be to rehabilitate the millions of hectares of degraded cropland in

the region, as Yunnan, Thailand, Viet Nam and other countries are doing. Much of this degraded land must be taken out of production permanently as it is too vulnerable to be used for cultivation. The land that is brought back into production must be farmed using appropriate soil and water conservation measures. Small farmers will need financial, technical and institutional support to adopt such measures.

Water resources management

The use of water resources is one of the most difficult and sensitive issues in the region. Of particular concern to some stakeholder groups are China's plans to build a series of dams on the upper stretch of the Mekong River in Yunnan and a multi-dam cascade on the upper Thanlwin River. These have the potential to promote economic growth in Yunnan (and western China generally), and may also benefit lower Mekong basin countries by regulating flows, helping to combat drought and floods. There is concern, however, that the dams may disrupt the natural hydrological cycle, changing downstream water and sediment levels and damaging the valuable lower Mekong fishery. Much depends on how the dams are managed. A cooperative approach to developing operational guidelines would help to minimize any adverse impacts on downstream water users (Cogels 2007).

Other factors that may affect water resources in the lower Mekong basin include continued deforestation (or at least a lack of soil and water conservation on deforested lands), the diversion of water for irrigation schemes, and inappropriate catchment management practices.



Srinagarindra Dam, Thailand
Source: Thailand Environment Institute

Agriculture is the major consumer of the region's water resources, and likely to remain so for the foreseeable future. Further development of the agricultural sector in Cambodia, Lao PDR, Thailand and Viet Nam will depend heavily on increasing the area of land under irrigation. Irrigation schemes are invariably associated with dams and water diversions, with consequent impacts on fish and fish habitats. Poorly designed irrigation schemes have also caused severe land degradation across the region through soil salinization, waterlogging and other impacts.

Fisheries management

Inland fisheries play an important but often undervalued role in providing income and livelihoods for river basin dwellers. There is concern that the planned dam developments on the Mekong River and its tributaries will affect the downstream flow of water and the supply of nutrients, reducing the abundance of fish and changing the species composition of key fish communities. There is evidence to justify these concerns, but a more pressing issue is the already heavy fishing pressure on such rivers as the Mekong. Although fishery yields in the GMS have been stable or even increasing, signs of selective over-fishing are becoming apparent. These include a decline in the catch of large and medium-sized fish, an increase in the amount of time needed to catch the same amount of fish, and an increasing number of conflicts between fishery stakeholders.

Forest and biodiversity conservation

The forests of the GMS are globally important reservoirs of biodiversity, but are being exploited at unsustainable rates. The threats they face include illegal and uncontrolled logging, dam construction, clearance for agriculture, infrastructure development and illegal exploitation for the wildlife trade. The prospects for establishing sustainable natural forest management regimes in the region are not encouraging. Many countries have banned harvesting in natural forests, shifting the

emphasis of forest production to plantations. In doing so, they have cut off important sources of income and livelihoods for rural, forest-dependent people. It remains to be seen whether these people can find new livelihoods in forest protection.

As forest habitats decline, so do levels of biodiversity. The region is home to a significant proportion of the world's threatened or endangered species. Many have found sanctuary in protected areas, but continue to face threats from encroachment and illegal exploitation. Limited capacities and resources for biodiversity conservation also mean that many protected areas are not managed effectively. Protected area management policy in the GMS as a whole is currently passing through a transitional phase driven by widespread reforms in governance. These offer the prospect of more effective conservation through devolved authorities and institutions, greater community participation and a stronger rule of law.

Food security

Considerations of economic growth, resource depletion and rural livelihoods lead to the overarching issue of food security. Changes in the quality and quantity of natural resources in the GMS inevitably have serious human impacts. Human well-being is inextricably linked to ecosystems through the goods and services they provide. This link is especially strong in the GMS, with its predominantly agrarian populations and economies. Anything that threatens this link will create physical and economic vulnerability, leading to hunger and poor nutrition.

Food insecurity has various causes. Poverty is the main factor limiting people's ability to access food. The causes of poverty include concentration of the benefits from economic growth, social and physical isolation, high risks from disease and natural disasters, inadequate access to such resources as land and credit, a lack of environmental sustainability, and weak

or non-existent local participation in the formulation of poverty alleviation initiatives.

12.3 NATIONAL POLICY RESPONSES⁷

Cambodia

The sustainable management of natural resources and ecosystems for its population is an important strategic priority for Cambodia, as it is for the other countries of the GMS. The primary objectives of Cambodia's third five-year plan, the National Strategic Development Plan (2006–10), are to reduce poverty and move towards achieving Cambodia's Millennium Development Goals. Among other things, the Plan puts special emphasis on strengthening the role of natural resources in supporting rural livelihoods and national economic growth.

The Cambodian government is implementing major reforms in key natural resources management sectors, including forestry, fisheries and land. The main objective of the 2002 Forestry Law is to ensure sustainable forest management and customary user rights of forest products for local communities. A number of industrial forest concessions have been cancelled, and no new concessions are being issued. The government is currently considering the findings of a major independent forest sector review in 2004. Cambodia's community forestry programme has increased in scope and size since 1992, and a recent sub-decree on community forestry provides for further increases in the number and area of community forests.

Reforms in the fisheries sector currently under way include the introduction and expansion of community fisheries management. A royal decree on establishing community fisheries was issued in May 2005, and a sub-decree on the management of community fisheries in June 2005. A new Fisheries Law is awaiting approval.

Cambodia enacted a new Land Law in 2001, and in 2002 launched the first phase of a

⁷ The discussion in this section draws heavily on the national reports prepared by GMS countries under the ADB-supported National Performance Assessment and Sub-regional Strategic Environment Framework in the Greater Mekong Sub-region Project (see References).

15-year land reform programme to support the poor by providing land titles and strengthening land-use rights. As part of the programme, a sub-decree on social land concessions has been issued to allocate disposable state lands for social and economic development.

Water resources, especially those of the Tonle Sap system, are a crucial component of Cambodia's environment and natural resource base. They provide the basis for fisheries, irrigated agricultural production, domestic and industrial water supply, hydro-electric potential and navigation. To protect and manage these resources, a national policy on water resources management was adopted in January 2004, and a draft law on water resources management is under consideration. Progress in water, land, fisheries and agricultural management has helped to improve food security, but there are still wide social and geographical variations. To tackle these, the government has launched a national nutrition investment plan (2003–07), and has created a number of provincial nutrition coordination committees to prepare action plans on food security and nutrition.

Cambodia's National Biodiversity Strategy and Action Plan (NBSAP), prepared in response to its commitments under the Convention on Biological Diversity, was approved in 2002. A National Biodiversity Steering Committee has been established, and a draft law on protected areas is under consideration. Many of the recommendations of the NBSAP remain unimplemented, however, owing to a failure to integrate the strategy into the public budget and investment programme. A project supported by UNDP and the Global Environment Facility (GEF), the National Capacity Self-Assessment for Global Environmental Management (2004–06), looked at ways of coordinating Cambodia's response to the threats of biodiversity loss, climate change and land degradation. Table 12.1 below provides further details of Cambodia's commitments to key international environmental treaties.

Cambodia officially launched an Environmental Impact Assessment (EIA)

process in 2000. The EIA is an important legal tool for environmental assessment and planning, aimed at safeguarding the environment at each stage of project or programme development. Cambodia's EIA procedures embody a principle of initial screening which determines the intensity of subsequent environmental assessment and is modelled on international best practices.

Lao PDR

The role of biodiversity and natural resources in Lao PDR's economy, especially their contribution to government revenue and export earnings, is greater than in any other country of the GMS. Hence conservation of these resources is viewed with great seriousness, even when it conflicts with the development of new sectors of the economy. Sustainable natural resource management and environmental protection have been government priorities for at least a decade. Furthermore, in the past five years they have been more closely linked to efforts to reduce poverty. Programmes such as community forest management attempt simultaneously to improve environmental conditions and the well-being of local populations.

Policies favouring sustainable resource management in Lao PDR go back to at least the first National Forestry Conference in 1989, which defined the steps needed to conserve and extend the country's forest cover. The 1990s were a period of substantial legislative activity concerning the management of natural resources, though the results of this effort have been mixed (see below).

Important landmarks include establishment of the Science, Technology and Environment Agency in 1993, and approval of the National Environmental Action Plan in 1994. Others are the enactment of the Environment Protection Law in 1999, the formulation in 2002 of the National Forestry Strategy 2020, the Sustainable Forestry and Rural Development Program, the National Environment Strategy, and the National Biodiversity Action Plan of 2004. Environmental considerations also feature in the influential National Growth and Poverty

Table 12.1. Cambodia international conventions matrix.

Agreement/Convention	Signature	Ratification	National action plan/programme	Resources allocated to implementation	
United Nations Framework Convention on Climate Change (FCCC)	-	18/12/95 (Ac)	- Initial National Communication (2002) - Draft National Adaptation Programme of Action to Climate Change (NAPA) (2006)	...	
Kyoto Protocol	-	22/08/02 (Ac)	- Designated National Authority for Clean Development Mechanism (CDM) established	...	
Vienna Convention for the Protection of the Ozone Layer	-	27/06/01 (Ac)	- National Ozone Unit established	...	
Montreal Protocol for Chlorofluorocarbon Control	...	27/06/01 (Ac)	- Refrigerant Management Plan	...	
United Nations Convention on Biological Diversity (CBD)	...	09/02/95 (Ac)	- National Biodiversity Strategy and Action Plan (2002)	...	

	Main areas of action covered by plan	Relevant national laws, decrees and directives	Public awareness	Constraints to implementation
	The NAPA identifies water resources as a priority sector, particularly its links to agriculture and food security. Priority activities in the NAPA cover: - Coastal areas - Malaria - Water resources/agriculture - Cross-sectorial issues (including awareness raising and education)	- National Strategic Development Plan (2006–10) recognizes importance of NAPA	...	Constraints to implementing NAPA include: - Inadequate technical, financial and institutional capacities of government agencies and local communities - Limited inter-agency coordination - Limited integration of climate change issues into national policies and programmes - Limited awareness of climate change issues.
	...	...	...	...
	...	- Sub-Decree on the Management of Ozone Depleting Substances (2005)	- International Ozone Day activities	...
	- Promote recovery and recycling of CFCs - Training of refrigeration technicians in good practices - Training of customs officers - Enforcing law on ozone depleting substances - Monitoring and controlling imports and exports of ozone depleting substances	- See Vienna Convention	- See Vienna Convention	...
	The NBSAP addresses 17 main themes: - Protection of natural resources - Animal wildlife resources - Freshwater fisheries and aquaculture - Coastal and marine resources - Forest and wild plant resources - Agriculture and animal production - Energy resources - Mineral resources - Industry, technology and services - Environmental security - Land use planning - Water resources - Climate change and biodiversity - Community participation - Awareness, education, research coordination and development - Legislation and institutional structure - Quality of life and poverty reduction	- Draft Law on the Establishment and Management of Protected Areas - Draft Wildlife Law - Royal Decree on Establishment of Community Fisheries (2005) - Sub-Decree on Community Fisheries Management (2005) - Sub-Decree on Community Forestry (2003) - Forestry Law (2002) - Sub-Decree on Environmental Impact Assessment Process (1999)	- Tree planting activities on Arbor Day, Religion Day, etc.	...

Agreement/Convention	Signature	Ratification	National action plan/programme	Resources allocated to implementation	
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	03/03/73	03/03/73	...	- Ministry of Agriculture, Forestry and Fisheries designated as National Management Authority - Memorandum of Understanding signed with TRAFFIC in 2002	
Ramsar Convention	-	23/06/99 (Ac)	- Three sites designated as Ramsar sites	...	
United Nations Convention to Combat Desertification (CCD)	15/10/94	08/08/97 (R)	- National Action Plan under preparation	...	

	Main areas of action covered by plan	Relevant national laws, decrees and directives	Public awareness	Constraints to implementation
		- Sub-Decree on the Control of Water Pollution (1999) - Law on Environmental Protection and Natural Resource Management (1996) - Royal Decree on the Creation and Designation of Protected Areas (1993) - Fisheries Law (1987)	...	
...		- Draft Wildlife Law - Sub-Decree on International Trade in Endangered Fauna and Flora Species (2006) - MAFF Announcement on the Prohibited Wildlife Trade (2001)	- CITES documents available in Khmer	- Limited awareness and information on traded species - Limited resources and capacity to implement and enforce Convention
...			- World Wetlands Day activities	...
	- Land reform, land use planning and land management - Agricultural improvement - Sustainable forest management - Community forestry - Reforestation and plantation development - Water resources management	- Sub-Decree on State Land Management (2005) - Sub-Decree on Economic Land Concessions (2005) - Sub-Decree on Social Land Concessions (2003) - Forestry Law (2002) - Land Law (2001) - Law on Environmental Protection and Natural Resource Management (1996)	- Farmer training and on-farm demonstration activities - Extension materials for farmers	- Limited resources and capacity to implement Convention - Limited public awareness

Agreement/Convention	Signature	Ratification	National action plan/programme	Resources allocated to implementation	
Stockholm Convention	23/05/01	25/08/06 (R)	- National Implementation Plan under preparation - Preliminary inventory of persistent organic pollutants (2004)	...	
United Nations Convention on the Law of the Sea	...	- ^a	-	-	

Note: The status of ratification is denoted by: R (Ratification), Ac (Accession).

^a Cambodia has signed but not yet ratified the Convention on the Law of the Sea.

Sources: ADB (2006f), Chuon (2004), Convention websites, Government of Cambodia (2002b, 2002c, 2005, 2006a, 2006b).

Table 12.2. Lao PDR international conventions matrix.

Agreement/Convention	Signature	Ratification	National action plan/programme	Resources allocated to implementation	
United Nations Framework Convention on Climate Change (FCCC)	-	04/01/95 (Ac)	- First National Communication (2000) - National Adaptation Programme of Action under preparation	- The Science, Technology and Environment Agency (STEA) has central responsibility for co-ordinating the response to climate change	
Kyoto Protocol	-	06/02/03 (Ac)	- Designated National Authority for CDM established	-	
Vienna Convention for the Protection of the Ozone Layer	-	21/08/98 (Ac)	- National Action Plan (2004)	...	
Montreal Protocol for Chlorofluorocarbon Control	-	21/08/98 (Ac)	-	...	
United Nations Convention on Biological Diversity (CBD)	...	20/09/96 (Ac)	- National Biodiversity Strategy and Action Plan (2004)	-	

	Main areas of action covered by plan	Relevant national laws,decrees and directives	Public awareness	Constraints to implementation
	...	- Sub-Decree on Standards and Management of Agricultural Materials (1998)	- Text of Convention and other materials available in Khmer - Education and training for government officials, non-governmental organizations and students	- Limited awareness and expertise - No national policy for chemical management - No national mechanism for coordinating or promoting safe management - Inadequate data on chemical impacts and risks
	-	-	-	-

	Main areas of action covered by plan	Relevant national laws,decrees and directives	Public awareness	Constraints to implementation
	-	- Decree on the Implementation of the Environment Protection Law (2002) - Environment Protection Law (1999)	...	
	-	-	-	-
	...		- Activities organized on International Ozone Day	...
	...	...	...	...
	- The goal of the NBSAP is to maintain Lao PDR's biodiversity as one key to poverty alleviation and protect the current asset base of the poor. It has seven main objectives: - Identity important biological diversity components and improve the knowledge base	- Decree on the Implementation of the Environment Protection Law (2002) - Regulation on Environmental Assessment (2000) - Environment Protection Law (1999) - Forestry Law (1996) - Water and Water Resources Law (1997) - Decree 1074 of the Ministry of Agriculture and Forestry prohibiting wildlife trade and hunting of protected species (1996) - Decree 164/PM on National Biodiversity Conservation Areas (1993)	- National Strategy on Environmental Education and Awareness 2020 and Action Plan (2006–10) - Events and activities organized for special environmental days, for example Tree Planting Day, World Environment Day, etc.	...

Agreement/Convention	Signature	Ratification	National action plan/programme	Resources allocated to implementation	
	-	-	-	-	
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	-	01/03/04 (Ac)	...	...	
Ramsar Convention	-	- ^a	-	-	-
United Nations Convention to Combat Desertification (CCD)	30/08/95	20/09/96 (At)	- National Action Programme on Combating Drought/ Desertification (1999, under revision)	-	
Stockholm Convention	05/03/02	28/06/06 (R)	- National Hazardous Chemicals Strategy 2020 and Action Plan (2006–10)	...	
United Nations Convention on the Law of the Sea	...	05/06/98 (R)	...	...	

Note: The status of ratification is denoted by: R (Ratification), Ac (Accession), At (Acceptance).

^a Lao PDR is currently working towards accession to the Ramsar Convention.

Sources: ADB (2006g), Convention websites, Country submission, Government of Lao PDR (2004, 2006).

	Main areas of action covered by plan	Relevant national laws, decrees and directives	Public awareness	Constraints to implementation
	- Manage biodiversity on a regional basis, using natural boundaries to facilitate the integration of conservation and use-oriented management - Plan and implement a biodiversity-specific human resource management programme - Increase public awareness of and encourage participation in sustainable management of biodiversity - Adjust national legislation and regulations and harmonize them with international conventions - Secure implementation of the NBSAP - Promote international cooperation driven by country needs	- Decree 118/CCM on the Management and Protection of Aquatic Animals and Wildlife from Hunting and Fishing (1989) - Decree 185/CCM on the Prohibition of Wildlife Trade (1986)	-	-
	...	- Decree 1074 of the Ministry of Agriculture and Forestry prohibiting wildlife trade and hunting of protected species (1996) - Decree 185/CCM on the Prohibition of Wildlife Trade (1986)	...	...
	-	-	-	-
	The National Action Programme comprises four components: - Training and public awareness - Prevention and mitigation - Preparedness - Relief Its main objectives include: ■ Food security ■ Stabilization and reduction of swidden cultivation ■ Conservation of watershed forests ■ Enhancement of farmers' livelihoods ■ Poverty reduction	- Decree on the Implementation of the Environment Protection Law (2002) - Regulation on Environmental Assessment (2000) - Environment Protection Law (1999) - Agriculture Law (1998) - Land Law (1997) - Water and Water Resources Law (1997) - Mining Law (1997) - Forestry Law (1996)	- Information dissemination and extension through Lao Youth and Women's Unions	- Limited institutional capacity - Low public awareness - Weak law enforcement - Weak implementation at the community level - Lack of financial and technical resources - Weak harmonization of different land management initiatives
	...	- Recommendation 0620 on Control, Management and Usage of Pesticides (2005) - Environment Protection Law (1999)	...	...
	...	...	...	...

Eradication Strategy of 2003. Table 12.2 above details Lao PDR's international activities and commitments concerning the environment .

Lao PDR's environmental policy response has evolved quickly, and inconsistencies have surfaced in different legislative documents and initiatives as a result of poor inter-agency coordination. The principal faults are similar to those in other countries: conflicting provisions, overlapping mandates given to different ministries, and a lack of implementing regulations and supporting environmental standards. Moreover, in recent years a wide gap has opened between the large, donor-driven legislative and institutional agenda, and the financial resources made available to implement it.

Among the measures taken by Lao PDR to translate policy intent into action has been the enactment of EIA legislation and regulation of the wildlife trade in endangered species. To improve implementation, certain environmental functions of the EIA have been decentralized to provinces and a third-party monitoring protocol developed for reporting on the environmental impacts of development projects. Area-based development has also gained importance. The Ministry of Agriculture and Forestry began applying the Integrated Watershed Management approach in 1999. In theory this should lead to watershed zoning and participatory planning, but the approach has yet to be implemented fully.

Myanmar

Myanmar is a predominantly agrarian economy, and natural resource management is of key importance for national economic development. Until early 1990, no central government body existed for cross-sectorial oversight and coordination of environmental matters. With the introduction of a market-oriented economic policy in 1998 and the rapid changes that followed it, this situation eventually became untenable.

In response to the need for a central environmental agency, the government formed

the National Commission for Environmental Affairs (NCEA) in February 1990. The NCEA has overall responsibility for environmental management in Myanmar. It acts as the national focal point for international cooperation, coordinates the work of various line ministries and departments, and promotes environmentally sound and sustainable development. It also coordinates various ad hoc committees set up to address cross-sectorial issues, for example the National Committee for Combating Land Degradation under the CCD, and the National Water Committee (which is guiding implementation of Myanmar's Water Vision).

Myanmar adopted a national environmental policy in 1994. With a view to implementing the policy, Myanmar Agenda 21 was formulated in 1997 as a framework for multisectorial approaches to sustainable development. A comprehensive national environmental law, the Myanmar Environmental Protection Law, has been drafted by the NCEA and is awaiting approval. The NCEA also expects to prepare a regulation on the conduct of EIAs.

Myanmar is party to several international and regional conventions and agreements directly related to the environment, as well as others which may have an impact on the environment. For details of Myanmar's international commitments see Table 12.3 below.

Thailand

At the highest level, environment and development in Thailand are addressed by five-year national economic and social development plans. Thailand's new Tenth Plan (2007–11) aims for balance and sustainability in all areas of national development. Besides key objectives centred on developing human and social capital, strengthening communities, restructuring the economy, and improving governance, the Tenth Plan spells out the direction of natural resource and environmental management. In brief, this comprises four main strategies: conserving the natural resource base and ecological balance; enhancing environmental quality to raise living

standards and support sustainable development; developing local biological knowledge and resources; and developing a knowledge base on natural resources and the environment.

The objectives of Thailand's Tenth Plan are largely those formulated in 1992 at the time of the adoption of the Enhancement and Conservation of National Environmental Quality Act. This led to the Policy and Prospective Plan for Enhancement and Conservation of National Environmental Quality (1997–2016), which consists of six sets of policies (natural resources, pollution, natural and cultural environments, community environment, environmental education and promotion, and environmental technology).

The Enhancement and Conservation of National Environmental Quality Act has unified but not superseded other environmental legislation. This includes, in reverse chronological order, the Fisheries Act 1947 (revised 1994), Factories Act 1992, Public Health Act 1992, Hazardous Substances Act 1992, Energy Conservation Promotion Act 1992, National Forest Reserves Act 1964, National Parks Act 1961 and Forest Act 1941. Thailand also plays an active role in international environmental agreements (see Table 12.4 below).

Thailand's Constitution of 1997 (abrogated in 2006) provided for extensive fiscal and administrative decentralization, seen by many as the key to improved environmental performance. However, the slow and incomplete progress of decentralization has probably had the opposite effect on performance, especially in the area of wastewater and solid waste management.

Under the Tenth Plan and its predecessors, Thailand has continued the use of market-based instruments first introduced in the 1990s. These include subsidies for hazardous waste treatment, wastewater treatment charges in some places, and price differentiation between leaded and unleaded gasoline before the complete phase out of the former. To date, four broad areas of market intervention have been created: resource pricing; user charges for municipal solid waste disposal and hazardous waste disposal;

wastewater charges for selected industrial clusters and centralized municipal wastewater treatment plants; and others such as tax and price differentiation, green taxes, voluntary compliance mechanisms and clean production initiatives.

Experience with the use of these instruments has been mixed. For example, resource use fees by themselves have not been able to guarantee good environmental performance. When used in combination with other instruments, however, they have had greater success. This suggests that the introduction of new approaches does not necessarily guarantee better performance since it often requires not the simple replacement of one set of tools by another but their combination.

Viet Nam

In the 1980s, Viet Nam embarked on “doi moi”, a program of transition from rigid central planning to a more open, mixed market economy. This has led to rapid economic growth, but at the same time it has created serious environmental challenges.

The legal basis for environmental protection in Viet Nam is the 2005 Law on Environmental Protection. Other relevant laws include the Forest Protection and Development Law of 2004 and the Land Law of 2003. The National Strategy for Environmental Protection (2001–10) focuses on preventing and mitigating negative environmental impacts, improving environmental quality, and nature conservation and biodiversity protection.

EIA is the main tool for incorporating environmental concerns into economic planning in Viet Nam. However, the EIA process is still at an incipient stage and suffers from legislative and practical bottlenecks. The provisions for the timing of EIA do not fit well with project development planning itself. Furthermore, the implementation of EIA, especially the review stage, suffers from inadequate staffing and expertise, a lack of monitoring and evaluation, poor coordination between central government and

Table 12.3. Myanmar international conventions matrix.

Agreement/Convention	Signature	Ratification	National action plan/programme	Resources allocated to implementation	
United Nations Framework Convention on Climate Change (FCCC)	11/06/92	25/11/94 (R)	- First National Communication under preparation	...	
Kyoto Protocol	...	13/08/03 (Ac)	...	- Designated National Authority for CDM established	
Vienna Convention for the Protection of the Ozone Layer	...	24/11/93 (Ac)	- Country programme	16 officials	
Montreal Protocol for Chlorofluorocarbon Control	...	24/11/93 (Ac)	- Institutional Strengthening for the Establishment of Ozone Unit and Refrigerant Management Plan	...	
United Nations Convention on Biological Diversity (CBD)	11/06/92	25/11/94 (R)	- National Biodiversity Strategy and Action Plan - National Tiger Action Plan (2003)	...	
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	...	13/06/97 (Ac)	...	...	
Ramsar Convention	...	17/11/04 (Ac)	...	...	

	Main areas of action covered by plan	Relevant national laws,decrees and directives	Public awareness	Constraints to implementation
	- Identify options for emission reductions - Conduct vulnerability assessment	...	...	...
	...	...	...	...
	- Refrigeration and mobile air conditioning sectors	- Control of Imports and Exports Act (1947)	- International Ozone Day activities	...
	...	- Control of Imports and Exports Act (1947)	- International Ozone Day activities	...
	- Forest biological diversity - Biological diversity of inland water ecosystems - Marine and coastal biodiversity - Agricultural biological diversity - Protected Areas - Incentive measures - Alien species - Impact assessment - Liability and redress - Biodiversity and climate change	- Fertilizer Law (2002) - Protection of Wildlife and Wild Plants and Conservation of Natural Areas Rules (2002) - Protection and Preservation of Cultural Heritage Regions Law (1998) - Pearl Law (1995) - Protection of Wildlife and Wild Plants and Conservation of Natural Areas Law (1994) - Forest Rules (1994) - Mines Law (1994) - Plant Pest Quarantine Law (1993) - Marine Fisheries Law (1993) - Animal Health and Development Law (1993) - Freshwater Fisheries Law (1992) - Forest Law (1992) - Pesticide Law (1990) - Law Relating to the Fishing Rights of Foreign Fishing Vessels (1989) - Law Relating to Aquaculture (1989)	- Nationwide Tree Planting Programme - Celebration of CBD day through media - Distribution of pamphlets, posters, leaflets - Establishment of environmental education centre at Hlawga Park near Yangon - Lectures and presentations on biodiversity	- Weak law enforcement - Inadequate capacity building - Weak assessment, inventorying and monitoring - Limited public participation - Limited knowledge about the role and value of biodiversity - Inadequate coordination and management - Inadequate financial resources - Insufficient data and information
	...	- Protection of Wildlife and Wild Plants and Conservation of Natural Areas Rules (2002) - Protection of Wildlife and Wild Plants and Conservation of Natural Areas Law (1994)	- Distribution of pamphlets, posters, leaflets - Establishment of environmental education centres at wildlife sanctuaries	...
	...	...	...	...

Agreement/Convention	Signature	Ratification	National action plan/programme	Resources allocated to implementation	
United Nations Convention to Combat Desertification (CCD)		02/01/97 (Ac)	- National Action Plan (2005)	...	
Stockholm Convention		19/04/04	...	...	
United Nations Convention on the Law of the Sea	10/12/82	21/05/96 (R)	...	...	

Note: The status of ratification is denoted by: R (Ratification), Ac (Accession).
Sources: Convention websites, Country submission.

Table 12.4. Thailand international conventions matrix.

Agreement/Convention	Signature	Ratification	National action plan/programme	Resources allocated to implementation	
United Nations Framework Convention on Climate Change (FCCC)	12/06/92	28/12/94 (R)	- National Action Plan (2000) - Initial National Communication (2000)	- The Office of Natural Resources and Environmental Policy and Planning (ONEP) coordinates implementation of the Convention	
Kyoto Protocol	02/02/99	28/08/02 (R)	- Designated National Authority for CDM established - Guidelines for CDM projects approved by National Committee on Climate Change	...	
Vienna Convention for the Protection of the Ozone Layer		07/07/89 (Ac)	The Department of Industrial Works has established measures and procedures for enterprises in production and service sectors as follows: - Control ozone depleting substances - Use taxes to support the use of alternatives - Transfer alternative technologies to Thailand	...	

	Main areas of action covered by plan	Relevant national laws,decrees and directives	Public awareness	Constraints to implementation
	- Plantation development - Natural forest protection - Wood fuel substitution - Water resources development	- Fertilizer Law (2002) - Forest Law (1992) - Pesticide Law (1990) - Underground Water Act (1930)	- Distribution of pamphlets, posters, leaflets, articles	- Inadequate capacity building - Weak public participation - Limited knowledge - Inadequate financial resources
	...	- Pesticide Law (1990)	...	...
	...	- Territorial Sea and Maritime Zone Law (1977)	...	...

	Main areas of action covered by plan	Relevant national laws,decrees and directives	Public awareness	Constraints to implementation
	- Capacity building on adaptation - Public awareness and participation - Mitigation of greenhouse gas emissions - Research and development	- Enhancement and Conservation of National Environmental Quality Act (1992) - Energy Conservation Promotion Act (1992) - National Energy Policy Council Act (1992)	...	- Limited dissemination of information - Low public awareness
	...	- See FCCC above	- Capacity building for government officials, the private sector and non-governmental organizations	...
	- CFC Chillers replacement project	- Hazardous Substances Act (1992)	- The Ozone Protection Division of the Department of Industrial Works has disseminated information on the Vienna Convention and Montreal Protocol, as well as implementation in Thailand, on its website and in other publications	...

Agreement/ Convention	Signature	Ratification	National action plan/programme	Resources allocated to implementation	
Montreal Protocol for Chlorofluorocarbon Control	15/09/88	07/07/89 (R)	...	- About US\$52 million received from Multilateral Fund for the Implementation of the Montreal Protocol	
United Nations Convention on Biological Diver- sity (CBD)	12/06/92	29/01/04 (R)	- Second National Biodiversity Strategy and Action Plan (2003)	- Environmental Fund, Plant Varieties Fund, Traditional Thai Medicinal Intelligence Fund - No significant change in quantity of financial re- sources after Convention ratified. The second National Biodiver- sity Strategy and Action Plan has not been referred for budget allocation.	
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	03/03/73	21/01/83 (R)	...	...	
Ramsar Convention	...	13/05/98 ^a	- Ten sites designated as Ramsar Sites. - ONEP is the lead agency for expanding and strengthening wetland conservation and establishing a national system of protected wetland areas - Implementation of the CBD and Ramsar Convention has strong synergies owing to institutional focus (both under ONEP). The National Biodiversity Board will supervise both Conventions.	...	

	Main areas of action covered by plan	Relevant national laws, decrees and directives	Public awareness	Constraints to implementation
	- From 1995 reduce CFC imports by 10% a year - From 1997 stop using CFCs in all fridge factories and stop importing fridges that use CFCs in the production process - From 1997, no extension or establishment of CFC spray factories	- Hazardous Substances Act (1992)	...	-
	- Enhance knowledge, understanding and public awareness of value of biodiversity - Strengthen capacity in conservation, restoration and protection of natural habitats - Control, regulate, and reduce the threats to biodiversity - Promote and develop cooperation with international agencies in conservation and sustainable use of biodiversity - National targets to meet 2010 global target : ■ 40% of land area under forest ■ 30% conservation forest ■ 10% economic forest - 300 km² of marine ecosystems established as marine protected areas - 35% of national wetland areas targeted for conservation and restoration	- Plant Varieties Protection Act (1999) - Protection and Promotion of Thai Traditional Medicinal Intelligence Act (1999) - Fisheries Act (1947, revised 1994) - Enhancement and Conservation of National Environmental Quality Act (1992) - Hazardous Substances Act (1992) - Wild Animal Reservation and Protection Act (1960, revised 1992) - National Forest Reserves Act (1964) - Plant Quarantine Act (1964) - National Parks Act (1961) - Forest Act (1941)	- ONEP has produced a series of Thai publications on CBD and its provisions - Activities are arranged every year to celebrate International Biodiversity Day - Awareness raising on fire prevention and decentralization of fire management to local government are the two most successful measures to reduce threats - ONEP maintains an informative website - The Royal Development Projects promote and validate appropriate technologies with concerned agencies and communities	- Lack of resources for implementation
	...	- Wild Animal Reservation and Protection Act (1960, revised 1992) - Plant Act (1992)	- The National Parks, Wildlife and Plant Conservation Department has posted guidelines on importing and exporting wildlife species under CITES on the Internet	- Lack of information on species and implementation of the Convention
	...	- Enhancement and Conservation of National Environmental Quality Act (1992)	...	...

Agreement/Convention	Signature	Ratification	National action plan/programme	Resources allocated to implementation	
United Nations Convention to Combat Desertification (CCD)		07/03/01 (Ac)	- National Action Programme to Combat Desertification (2004), managed by the Land Development Department (LDD) - Land Development Villages Programme	- 2004 budget for combating desertification was over US\$90 million	
Stockholm Convention	22/05/02	31/01/05 (R)	- Imports of almost all specified chemicals have now been prohibited	-	
United Nations Convention on the Law of the Sea	...	- ^b	-	-	

Note: The status of ratification is denoted by: R (Ratification), Ac (Accession).

^a Thailand acceded to the Ramsar Convention by means of a signature without reservation as to ratification (see <http://erc.unesco.org/cp/convention.asp?KO=15398&language=E>).

^b Thailand has signed but not yet ratified the Convention on the Law of the Sea.

Sources: ADB (2006b), Convention websites, Country submission, Vessabutr (2005).

Table 12.5. Viet Nam international conventions matrix

Agreement/Convention	Signature	Ratification	National action plan/programme	Resources allocated to implementation	
United Nations Framework Convention on Climate Change (FCCC)	11/06/92	16/11/94 (R)	- No national plan yet - Initial National Communication (2003)	...	

	Main areas of action covered by plan	Relevant national laws,decrees and directives	Public awareness	Constraints to implementation
	- Develop land and water resource infrastructure - Develop GIS technology for agricultural land-use zoning - Develop soil and water resources to increase productivity. - Increase farmers' access to LDD services - Establish Volunteer Soil Doctors, learning centres and sub-district centres for land development services - Reform administrative system to improve learning and governance	- Draft Water Act - Enhancement and Conservation of National Environmental Quality Act (1992) - Land Development Act (1983)	- Farmers are encouraged to use organic fertilizers and agricultural micro-organisms for soil improvement, nutrient enrichment and pest control - Dissemination of land development information through different media - Establishment of continuous learning networks among Volunteer Soil Doctors, farmers and agencies - Administrative reform - Promotion of New Theory agriculture	-
	- Legal and non-regulatory mechanisms for managing chemicals - Coordination among all concerned government agencies	- Enhancement and Conservation of National Environmental Quality Act (1992) - Hazardous Substances Act (1992) - Factories Act (1992) - Public Health Act (1992)	- Television and radio programmes, training and workshops, and exhibitions - Statistics and information are available to the public at relevant ministries - Non-governmental organizations are involved - Convention published in Thai	.
	..-	-	-	-

	Main areas of action covered by plan	Relevant national laws,decrees and directives	Public awareness	Constraints to implementation
	-	- Environmental Protection Law (1993, revised 2005) - Electricity Law (2004) - Forest Protection and Development Law (1991, revised 2004) - Road Transportation Law (2001) - Water Resources Law (1999) - Ordinance on prevention of storms and floods (1993)	- Technical seminars and workshops on various special thematic areas of climate change - Several documents have been published on research on climate change and relating issues - Convention translated into Vietnamese - Collections of climate change studies (two volumes)	- Lack of finance for developing a mechanism for cross -sectorial coordination - Lack of human resources - Lack of an action plan

Agreement/ Convention	Signature	Ratification	National action plan/programme	Resources allocated to implementation	
Kyoto Protocol	03/12/98	25/09/02 (R)	- Under approval - Designated National Authority for CDM established	-	
Vienna Convention for the Protection of the Ozone Layer		26/01/94 (Ac)	- National Programme on Eliminating Ozone Depleting Substances (1995)	...	
Montreal Protocol for Chlorofluorocarbon Control	...	26/01/94 (Ac)		...	
United Nations Convention on Biological Diversity (CBD)	28/05/93	16/11/94 (R)	- National Biodiversity Strategy and Action Plan (prepared in 1995 and revised in 2005 but not yet approved)	...	

	Main areas of action covered by plan	Relevant national laws, decrees and directives	Public awareness	Constraints to implementation
	-		- Guidance on greenhouse gas inventories - Mitigation options - Questions and answers on climate change - Many scientific reports on climate change have been posted and published in various journals	- Lack of finance for developing a mechanism for cross-sectorial coordination - Lack of human resources - Lack of an action plan
	- Information, education and awareness raising for implementation - Development of a legal framework for the Protocol and CDM - Development of a plan for domestic and foreign investment in CDM projects - Development of a project on financial mechanisms for CDM projects - Promotion of State management of CDM projects - Promotion of basic surveying, scientific research, and capacity building for implementing the Protocol and CDM - Strengthening and improving the national focal point	...	- Protocol translated into Vietnamese	- Lack of finance for developing a mechanism for cross-sectorial coordination - Lack of human resources
	...	...	- Convention translated into Vietnamese - Media briefings and activities organized on Ozone Day	- Lack of finance for developing a mechanism for cross-sectorial coordination - Lack of human resources
	...	-	- Protocol translated into Vietnamese	...
	- Policies and legislation - Establishment and management of protected areas - Awareness raising - Capacity building and staff training - Scientific research - Socio-economic issues - International cooperation	- Environmental Protection Law (1993, revised 2005) - Forest Protection and Development Law (1991, revised 2004) - Fisheries Law (2003) - Water Resources Law (1999) - Decree 11/2002/ND-CP of the Prime Minister dated	- Biodiversity Awareness Raising Programme - In 2003 the Prime Minister approved the Strategy to Protect the Nature Reserve System to 2010. This defines clearly the need for training managers and staff of protected areas; and for raising public awareness	- Lack of finance for developing a mechanism for cross-sectorial coordination - Lack of human resources

Agreement/ Convention	Signature	Ratification	National action plan/programme	Resources allocated to implementation	
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)		20/01/94 (Ac)	- Approved in 2004	...	

	Main areas of action covered by plan	Relevant national laws, decrees and directives	Public awareness	Constraints to implementation
	-	22 May 2002 on import, export and transit of wild animals and plants - Decree 48/2002/ND-CP dated 22 April 2002 of the government providing revisions and supplements to categories of rare and valuable wild species of animals and plants - Resolution 12/2003/CT-TTg of the Prime Minister dated 16 May 2003 on strengthening measures to protect and develop forests	of the importance and value of biodiversity. - The National Strategy for Environmental Protection 2010 and Vision 2020 both identify biodiversity conservation as a key goal. To implement this, several solutions have been devised, with a special focus on promoting information, education and public awareness of environmental protection responsibilities. - Resolution 41/NQ - TW dated 15 November 2004 of the Political Bureau on Environmental Protection, and the government's plan to implement this resolution, both confirm that information, education and public awareness of environmental protection in general, and of biodiversity protection in particular, are important priorities - Convention translated into Vietnamese	
	- Awareness raising - Improvement of legal framework - Enhancing capacity - Scientific research - Captive breeding and artificial propagation of wildlife species - Increasing international cooperation to control wildlife trade	- Environmental Protection Law (1993, revised 2005) - Forest Protection and Development Law (1991, revised 2004) - Water Resources Law (1999) - Decree 02/CP, dated 5 January 1995, prohibiting the trade in some commercial commodities and services, and regulating the trade with conditions for other commercial commodities and services in the domestic market - Decree 11/2002/ND-CP, dated 22 January 2002, on the administration of imports, exports and transit shipments of wild species of fauna and flora - Decree 48/2002/ND-CP, dated 22 April 2002, to amend and supplement the list of precious and rare species attached to Decree 18/ HDBT issued by the Council of Ministers on 17 January 1992	- Convention translated into Vietnamese	...

Agreement/Convention	Signature	Ratification	National action plan/programme	Resources allocated to implementation	
Ramsar Convention	...	20/09/88 (Ac)	- Approved in 2004 - Two sites designated as Ramsar sites	...	
United Nations Convention to Combat Desertification (CCD)	...	25/08/98 (Ac)	- National Action Programme to Combat Desertification (2002)	...	
Stockholm Convention	23/05/01	22/07/02 (R)	- National Implementation Plan awaiting approval	...	
United Nations Convention on the Law of the Sea	...	25/07/94 (R)	...	...	

*Note: The status of ratification is denoted by: R (Ratification), Ac (Accession).
Sources: Convention websites, Country submission.*

	Main areas of action covered by plan	Relevant national laws, decrees and directives	Public awareness	Constraints to implementation
		- Decree 19/2003/ND-CP, dated 23 September 2003, on conservation and sustainable development of wetlands - Resolution 12/2003/CT-TTg of the Prime Minister dated 16 May 2003 on strengthening urgent measures to protect special-use, protection, production and natural forests		
	- Improvement of legal and institutional framework - Database development - Building and applying models of wise use of wetlands - Conserving wetlands of international and national importance - Improving scientific research capacity - Awareness raising - International cooperation	- Decree 109/2003/ND-CP of the Prime Minister, dated 23 September 2003, on the conservation and sustainable development of wetlands	- Convention translated into Vietnamese	...
	- Improvement of legal and institutional framework - Awareness raising and human resources development - Survey and assessment of status of desertification - International cooperation	- Environmental Protection Law (1993, revised 2005) - Forest Protection and Development Law (1991, revised 2004) - Land Law (1993, revised 2003) - Water Resources Law (1999) - Resolution 12/2003/CT-TTg of the Prime Minister, dated 16 May 2003, on strengthening measures to protect special-use, protection, production and natural forests - Decision 08/2001/QD-TTg of the Prime Minister, dated 11 January 2001, specifying management mechanism for special-use, protection, production and natural forests - Decision 661/1998/QD-TTg of the Prime Minister, dated 29 July 29, providing objectives, tasks, policies and procedures for implementing the 5MHRP	- Convention translated into Vietnamese	- Lack of finance for developing a mechanism for cross-sectorial coordination - Lack of human resources
		- Decree on Chemical Safety (2005)	- Convention translated into Vietnamese	...
	...	...	- Convention translated into Vietnamese	...

Table 12.6. Yunnan (China) international conventions matrix.

Agreement/Convention	Signature	Ratification	National action plan/programme	Resources allocated to implementation	
United Nations Framework Convention on Climate Change (FCCC)	11/06/92	05/01/93 (R)	- National plan under preparation - Initial National Communication (2004)	...	
Kyoto Protocol	29/05/98	30/08/02 (Ap)	- Designated National Authority for CDM established	...	
Vienna Convention for the Protection of the Ozone Layer	...	11/09/89 (Ac)	- Country Programme for Phase-out of Ozone Depleting Substances (revised 1999) - Nine sector plans for phase-out of ozone depleting substances	...	
Montreal Protocol for Chlorofluorocarbon Control	...	14/06/91 (Ac)	- See Vienna Convention above	...	
United Nations Convention on Biological Diversity (CBD)	11/06/92	05/01/93 (R)	- Biodiversity Conservation Action Plan (1994)		
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	...	08/01/81 (Ac)	...	...	

	Main areas of action covered by plan	Relevant national laws,decrees and directives	Public awareness	Constraints to implementation
	...	- Renewable Energy Promotion Law (2006) - Prevention and Control of Atmospheric Pollution Law (2000) - Energy Conservation Law (1998)	- Convention translated into Chinese	...
	...	- Renewable Energy Promotion Law (2006) - Measures for the Operation and Management of CDM Projects (2005) - Prevention and Control of Atmospheric Pollution Law (2000) - Energy Conservation Law (1998)	- Protocol translated into Chinese	...
	...	- Clean Production Promotion Law (2003) - Prevention and Control of Atmospheric Pollution Law (2000) - Environmental Protection Law (1989)	- Convention translated into Chinese - Information clearinghouse established - Awareness-raising activities organized on Ozone Day - Campaigns and contests, including children's painting competition, organized	...
	...	- See Vienna Convention above	- See Vienna Convention above	...
	- Strengthen fundamental studies on biodiversity - Improve network of national nature reserves and other protected areas - Protect wild species of significance to biodiversity - Protect the genetic resources of crops and domesticated animals - Carry out in-situ conservation outside natural reserves - Establish a national network of biodiversity information and monitoring - Coordinate biodiversity conservation with sustainable development	- Protection of Wildlife Law (1989, revised 2004) - Fisheries Law (1986, revised 2004) - Environmental Impact Assessment Law (2003) - Regulations for the Implementation of the Forest Law (2000) - Forest Law (1998) - Soil and Water Conservation Law (1991) - Environmental Protection Law (1989) - Grassland Law (1985, revised 2002)	- Convention translated into Chinese - Outline on National Action for Environmental Publicity and Education (1996–2010) - Science and Technology Popularization Law (2002) - Various awareness-raising activities, competitions, awards and campaigns organized - Various publicity materials, radio and television programmes, and other information produced and disseminated	- Lack of financial, human and technical resources - Lack of information and awareness - Lack of scientific research capacity - Lack of transfer of technology and expertise - Lack of appropriate laws and policies - Weak law enforcement capacity
		- Regulation for Import and Export of Endangered Species of Wildlife (2006) - Protection of Wildlife Law (1989, revised 2004) - Entry and Exit Animal and Plant Quarantine Law (1992)	- Convention translated into Chinese	...

Agreement/Convention	Signature	Ratification	National action plan/programme	Resources allocated to implementation	
Ramsar Convention	...	31/03/92 (Ac)	- 30 sites designated as Ramsar sites, 4 of which are in Yunnan	...	
United Nations Convention to Combat Desertification (CCD)	14/10/94	18/02/97 (R)	- National Action Programme to Combat Desertification (1996, revised 2005)	...	
Stockholm Convention	23/05/01	13/08/04 (R)	- National Implementation Plan (2006)		
United Nations Convention on the Law of the Sea	10/12/82	07/06/96 (R)	...	...	

*Note: The status of ratification is denoted by: R (Ratification), Ac (Accession), Ap (Approval).
Sources: CCICCD (2006), Convention websites, Country submission, SEPA (2005).*

	Main areas of action covered by plan	Relevant national laws, decrees and directives	Public awareness	Constraints to implementation
	...	- Protection of Wildlife Law (1989, revised 2004) - Soil and Water Conservation Law (1991) - Environmental Protection Law (1989)	- Convention translated into Chinese	...
	Short-term objectives (2001–10): - 22 million ha of desertified land controlled - 1.7 million ha of forest shelterbelts established - 3.7 million ha of aeolian desertified land enclosed for protection Medium-term objectives (2011–20): - 20 million ha of desertified land controlled - 1.2 million ha of forest shelterbelts established - 11 million ha of sandy land enclosed for regeneration of vegetation Long-term objectives (2021–50): - 35 million ha desertified land controlled - 34 million ha of forests and grassland established - 1.8 million ha of forest shelterbelts established - 19 million ha of sandy land enclosed for regeneration of vegetation	- Desert Prevention and Transformation Law (2002) - Water Law (1988, revised 2002) - Sand Prevention and Control Law (2001) - Regulations for the Implementation of the Forest Law (2000) - Forest Law (1998) - Soil and Water Conservation Law (1991) - Environmental Protection Law (1989) - Grassland Law (1985, revised 2002)	- Convention translated into Chinese - National desertification information network established - Research findings and other information disseminated - Various events and activities organized, including tree planting campaigns - Science and Technology Popularization Law (2002) used to promote public awareness and motivation	- Lack of financial, human and technical resources - Lack of appropriate laws and policies - Weak law enforcement capacity
	- Halt the production and use of chlordane, mirex and DDT used in anti-dirt paint by 2010 - Safely dispose of electrical appliances containing persistent organic pollutants by 2015 - Halt the production and use of persistent organic pollutants in pesticides by 2015	- Clean Production Promotion Law (2003) - Environmental Protection Law (1989)	- Convention translated into Chinese	...
	...	- Administration of the Use of Sea Areas Law (2001) - Exclusive Economic Zone and the Continental Shelf Law (1998) - Environmental Protection Law (1989)	- Convention translated into Chinese	...

and sector line agencies and units in the provinces, poor coverage of baseline information and weak public participation.

Viet Nam is committed to a number of multilateral environmental agreements (see Table 12.5 above). It is also the largest recipient of multilateral and bilateral international donor aid in the GMS.

Viet Nam puts great stress on the role of communities in environmental protection. The role of public participation is explicitly recognised in the National Strategy for Environmental Protection, and in the National Vision 2020. Community-based organizations have been gaining increasing credibility. Sociopolitical organizations such as the Viet Nam Peasants' Association and the Viet Nam Women's Union have grassroots environmental linkages that have proved effective in mobilizing public opinion for environmental protection.

Yunnan

Environmental management in China is a provincial responsibility, conducted within a national framework of environmental laws. The provincial environmental protection bureaus, though guided technically by the State Environmental Protection Bureau, are agencies of provincial governments. Over the years, the Yunnan Provincial Environmental Protection Bureau has been given a greater say in economic development, the centre of gravity in provincial decision making, but its ability to place environmental safeguards on all economic decisions may have been weakened.

Following the 1979 Environment Protection Law, and the 1983 decision of China's State Council to make environmental protection a basic national policy, a period of intense legislative activity produced the bulk of China's natural resource protection legislation. The Environment Protection Law itself was revised in 1989. More legislative development followed in the 1990s, including laws on water and soil conservation, agriculture, forestry, energy use, land resource administration, clean production and EIA. Also introduced were regulations

on environmental protection in construction, water pollution, phasing out the use of leaded gasoline, management of solid and hazardous wastes, and pollution prevention and control in the livestock and poultry sectors.

A number of provincial or local regulations and laws have been formulated, including the Environmental Protection Statute of Yunnan, the Agricultural Environment Protection Statute of Yunnan, Rules for Scientific and Technical Planning of Environmental Protection Projects, and environmental rules for key water bodies.

In terms of policy development, in all of China and its provinces five-year plans for ecological rehabilitation and environmental protection supplement five-year plans for socio-economic development. In Yunnan, the provincial government is currently guided by the Eleventh Five-Year Plan for Ecological Rehabilitation and Environmental Protection (2006–10). Under the previous Plan (2001–05), a budget of roughly US\$960 million was earmarked for 26 projects. The budget was dominated by Dianchi Lake, one of the most severely polluted lakes in China, and by pollution control in general.

The traditional approach to environmental management in China has been one of command and control. This remains an important component of policy and practice, but is increasingly being supplemented by a broader mix of regulatory and market-based instruments. These include resource pricing, taxes, pollution charges, subsidies and supervised trading of pollution entitlements. In Yunnan, the pollution levy has become an important tool of policy. Initially applied only to large industrial enterprises, its coverage was extended in 1996 to the increasingly important township and village enterprises. The application of the levy to Yunnan has contributed to improved environmental performance by enterprises and improvements in such areas as water quality and energy use. However, the reach and application of the system has not been enough to improve the quality of the most badly polluted lakes in the region.

Pollution permits, attention to pollution control throughout the life of enterprises, and EIA form the three pillars of environmental management in China. In Yunnan, all three have played a role. Between 1995 and 2003, the coverage of EIA was extended to practically all new or reconstruction projects in the province.

China recognises the importance of public participation in environmental protection, and environmental non-governmental organizations and the general public have begun to play a role. Several dozen non-governmental organizations—provincial, national and international—operate in Yunnan. They provide important support to Yunnan's responsibilities and activities under China's international environmental commitments (see Table 12.6 above). The Nature Conservancy, for example, is now assisting with a nationwide assessment of China's biodiversity that will result in a plan to protect the country's most important natural resources.

12.4 REGIONAL AND TRANSBOUNDARY ACTIONS

As the preceding sections shows, each member of the GMS has its own set of economic and environmental issues and responses. Some issues, however, call for transboundary cooperation, or are better dealt with jointly. The Mekong River and other shared river systems are an obvious example. Another is the trade in timber and wildlife resources, and, more generally, the conservation of ecoregions spanning national boundaries. Air pollution, though mainly a localized problem, poses a transboundary threat in the form of smoke haze from land and forest fires. A host of cross-border economic issues also offers opportunities for collective action.

Any development in the upper Mekong River basin in Yunnan can potentially affect—both positively and negatively—the four lower-basin countries of Cambodia, Lao PDR, Thailand and Viet Nam. As discussed, in 1995 these countries adopted an agreement transforming the Mekong Committee into the Mekong River

Commission. Myanmar and China are dialogue partners to this agreement (ADB 2006a). The MRC's mission is “to promote and coordinate sustainable management and development of water and related resources for the countries' mutual benefit and the people's well-being” (MRC 2006b).

The MRC aims to achieve its mission through an IWRM approach, which is defined as a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems” (GWP TAC Paper 4, cited by MRC 2006b). Under its new Strategic Plan for 2006–10, the MRC will implement this approach through an integrated programme structure comprising Flood Management and Mitigation; Drought Management; Agriculture, Irrigation and Forestry; Navigation; Hydropower; Fisheries and Tourism. These will focus initially on the four riparian countries of the lower Mekong basin, but it is to be hoped that China and Myanmar will eventually join the MRC as full members. In any case, to perform its roles effectively the MRC intends to—and must—forge links with other regional economic cooperation initiatives, including ASEAN, the GMS Program, and the emerging World Bank/ADB Mekong Water Resources Assistance Programme (MWRAP).

Cross-border trade in forest products has a major impact on biodiversity in the GMS, but it is mostly unregulated and unmanaged. Unilateral policy decisions by one country, such as a ban or restrictions on logging, may merely shift the pressure of harvesting to neighbouring countries. Bilateral cooperation in illegal logging and trade issues is slowly increasing, but an urgent need exists for a coordinated sub-regional approach.

Protected area systems have been instituted across the GMS, but the habitats and species they aim to protect may not fall neatly within national boundaries. Effective conservation of such ecoregions as the Annamite Range rain

forests along the Lao PDR-Viet Nam border may require the creation of transboundary protected areas. Furthermore, the ecological and economic value of existing protected areas—national and transboundary—can be enhanced by linking them with corridors of suitable habitat. Several sub-regional initiatives are taking this approach, including the Biodiversity Conservation Corridors Initiative of the GMS Program (see Chapter 6).

Smoke haze from land and forest fires regularly causes large economic losses in parts of the region. As discussed in Chapter 3, the threat from haze provided the impetus for the adoption of a Regional Haze Action Plan by ASEAN in 1997 (which covers every country in the GMS except China). This was later formalised by the 2002 ASEAN Agreement on Transboundary Haze Pollution. ASEAN countries in the GMS have recently proposed forming a sub-regional group to intensify cooperation in implementing the Agreement.

Economic integration leads to greater trade and investment, which lead, in turn, to faster economic growth. Closer integration is a major goal for the GMS, but it presents a variety of challenges. A key integration strategy is the development of economic corridors. These are analogous to biodiversity corridors in that they aim to enhance connectivity, efficiency and economies of scale. They typically begin as transport corridors, which form along major transport routes. As they develop into economic corridors, areas of economic growth start to emerge along the corridor route. In later stages of development, policies, institutions, regional agreements and integrated infrastructure act as a spur to further economic growth (ADB 2004b).

Besides transport and economic corridors, telecommunications and power transmission links offer opportunities to enhance the impact of development. The GMS has a high hydroelectric power potential. Most of this, however, is in Yunnan, Lao PDR and Myanmar, whereas the demand for power is largely concentrated in Thailand and Viet Nam (ADB 2004b). Cooperation through regional power trading would ensure that power resources are allocated efficiently.

Enhanced economic cooperation raises important social and environmental concerns. The potential impacts of hydropower dam development and other interventions in river systems, for example, have already been noted. The growth of transport and economic corridors has implications for the distribution of population and population centres. The urban centres of the GMS are growing rapidly, thanks in part to high rates of rural-urban migration. Economic corridors, by virtue of their rapid development, are likely to see high rates of immigration and population growth. This growth will put heavy pressure on infrastructure and basic services (ADB 2004b).

One emerging response to the environmental challenges posed by integrated economic development is the transboundary EIA. The MRC is currently developing guidelines for such an EIA, drawing on the draft North American Agreement on Environmental Assessment in a Transboundary Context, and the United Nations' 1991 Transboundary EIA Convention, or "Espoo" Convention (Sukraroeck 2005). The guidelines, known as TBEIA, or The Basin-Wide and Transboundary Environmental Impact Assessment Guidelines, will be used as a tool to assess the impact of interventions or development projects on the river environment, including the cumulative impacts of development projects.

12.5 RECOMMENDATIONS

The environmental outlook for the GMS is uncertain. Greater economic growth and affluence can be forecast with certainty, but their effects on environmental quality, and on the status and livelihoods of the region's rural poor, are uncertain. The spread of environmental awareness across the region, and each country's increasing efforts to integrate environmental concerns into economic decision making, offer grounds for cautious optimism, but serious questions remain about the ability of governments to finance and implement ambitious environmental programmes, or their willingness to take the difficult and possibly unpopular decisions that may be needed.

A key weakness is that the GMS still lacks a genuinely sub-regional body with the mandate to develop and implement a shared vision of sustainable development. Hence ensuring close and active cooperation by all six GMS countries in a well-structured and clearly mandated development programme presents a serious challenge. But this is only one of several constraints and challenges to effective regional cooperation. Others include (ADB 2006a):

- **Weak legislative framework:** Obstacles to broad participation, particularly at the grassroots level, include the lack of enabling legislation and consistent practice, limited capacity and past experience of suppression and civil strife.

- **Congestion of regional initiatives:** Co-ordinating the many entities and initiatives active in the sub-region remains a challenge.

- **Role of donor community and civil society:** Donors, non-governmental organizations and civil society groups may be able to exert some influence in improving cooperation. Constructive engagement by international institutions needs to be encouraged and formalised.

- **Role of sub-regional scientific community:** The scientific and research community needs to play a more active role in developing an integrated scientific perspective and consensus to support decision making in the region.

It is possible that these challenges could be tackled through existing regional bodies such as the MRC or GMS Program. The MRC is a possible candidate given its long history and wide experience, but it currently excludes China and Myanmar. Bringing these countries into the organization as full members must therefore be a key long-term goal for MRC. Even so, some reports suggest that China may not favour the MRC as its vehicle for participating in the region (Hirsch and Jensen 2006). It is also unclear what role Guangxi, the newest member of the GMS, might play in the MRC.

Other candidates for the lead regional institution are the ASEAN Working Group on

Water Resources Management, and the ADB-financed GMS Program. Each has its strengths. As already noted, Sunchindah (2005), believes that the AWGWRM “could very well serve as the champion and spearhead for addressing some of the upstream-downstream riparian issues [in the Mekong basin]”. The GMS Program also has wide political support, including from China.

Ultimately, the best option may not be an existing initiative, but a completely new body. Since 1992, the United Nations has been calling on countries to pursue strategic and coordinated action for sustainable development through the creation of national sustainable development strategies (NSDSs). Most recently, the 2002 WSSD called on countries to take immediate steps to develop and implement NSDSs. The WSSD also encouraged countries to develop regional and sub-regional sustainable development strategies reflecting both national and regional priorities.

In Asia and the GMS, UNEP and the Norwegian government are supporting the formulation of NSDSs and their related action plans. Together with ADB, they are also supporting a parallel process to prepare a sub-regional sustainable development strategy for the GMS. Once complete, implementation of the strategy will be guided by a regional co-ordinating structure for sustainable development. This could be an existing structure, but it is more likely to be a new structure. Its role would be to develop a regional vision of sustainable development, keep sustainability a key regional priority, facilitate strategy implementation, provide policy advice to governments, enable broad-based partnerships, promote public awareness, and so on.

It is possible that the sub-regional sustainable development strategy, and the coordinating structure established to see the strategy into fruition, will furnish the GMS with the strong, credible body it needs to coordinate the region's response to the challenges of environment and development. ■

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⁸ Vientiane, Lao PDR, 26–27 October 2006.

GLOSSARY

ACCESSION

The act whereby a state that has not signed a treaty expresses its consent to become a party to that treaty by depositing an instrument of accession. Accession has the same legal effect as approval, acceptance or ratification (q.v.).

AEOLIAN DESERTIFICATION

A form of land degradation characterized by wind erosion resulting mainly from human activities. Now mostly a problem in arid and semi-arid regions of northern China.

ALGAL BLOOM

A sudden spurt of algal growth, which can reduce water quality and may indicate potentially hazardous changes in local water chemistry.

ALIEN SPECIES

A species or subspecies occurring in an area outside its known natural range as a result of intentional or accidental dispersal by human activities.

BIOCHEMICAL OXYGEN DEMAND (BOD)

The amount of oxygen consumed in the biological processes that break down organic matter (q.v.) in water. The greater the BOD, the greater the degree of organic pollution.

BIOLOGICAL DIVERSITY (BIODIVERSITY)

The variety and variability of living organisms and the ecological complexes in which they occur. It is usually considered at three levels: genetic diversity, species diversity and ecosystem diversity.

CARBON INTENSITY

The ratio of CO₂ emissions to activity or output. At the national level, carbon intensity is shown as CO₂ emissions per unit GDP (q.v.).

CHEMICAL OXYGEN DEMAND (COD)

A measure of the oxygen required to oxidize all compounds, both organic and inorganic, in water.

CHLOROFLUOROCARBONS (CFC)

A family of inert, non-toxic and easily liquefied chemicals used in refrigeration, air conditioning, packaging, insulation, or as solvents and aerosol propellants. Because CFCs are not destroyed in the lower atmosphere, they drift into the upper atmosphere where their chlorine components destroy ozone.

DESERTIFICATION

Land degradation in arid, semi-arid and dry sub-humid areas, resulting from such factors as climatic variations and human activities.

ECOREGION

A relatively large unit of land or water containing a geographically distinct assemblage of natural communities sharing a large majority of their species, dynamics and environmental conditions.

ECOSYSTEM

The interacting system of a biological community and its non-living environmental surroundings.

ENDEMIC

Restricted to a specific region or locality.

EUTROPHICATION

Excessive enrichment of a lake or other waterbody with nutrients, and the associated adverse biological effects.

EXOTIC SPECIES

See alien species.

GROSS DOMESTIC PRODUCT (GDP)

An aggregate measure of production equal to the sum of the final uses of goods and services (all uses except intermediate consumption), less the value of imports of goods and services.

HOTSPOT

A biogeographic region that is both a significant reservoir of biodiversity and threatened with widespread habitat loss.

HUMAN DEVELOPMENT INDEX (HDI)

A composite index based on life expectancy at birth, adult literacy rate, gross enrolment ratio and GDP per capita. A higher HDI value generally indicates a higher level of human well-being.

INCOME POVERTY LINE

An income level that is considered minimally sufficient to sustain a family in terms of food, housing, clothing, medical needs, and so on.

IN-SITU CONSERVATION

Conserving species within their natural habitat.

INTRODUCED SPECIES

See alien species

INVASIVE SPECIES

An alien species which colonizes natural or semi-natural ecosystems, is an agent of change, and can threaten native biodiversity.

KARST

A kind of terrain with characteristics of relief and drainage arising from a high degree of rock solubility. The majority of karst conditions occur in limestone areas, but karst may also occur in areas of dolomite, gypsum or salt deposits.

LAND DEGRADATION

The temporary or permanent lowering of the productive capacity of land. It is a complex, multidimensional process covering the various forms of soil erosion, adverse human impacts on water resources, deforestation and lowering of the productive capacity of rangelands.

MALNUTRITION

An imbalance between the supply of nutrients and energy, and the body's demand for them to ensure growth, maintenance and specific functions. The term protein-energy malnutrition refers to a group of related disorders that include kwashiorkor.

MORBIDITY

The number of sick persons or cases of disease in relationship to a specific population.

MORTALITY

The death rate; the ratio of the number of deaths per year to a given population.

MORTALITY STRATUM

Member countries of WHO are divided into five mortality strata, or groups, based on levels of mortality in children under 5 and in males aged 15–59.

NATIVE (INDIGENOUS) SPECIES

A species or subspecies occurring within its natural range (past or present) and dispersal potential (the range it occupies naturally or could occupy without direct or indirect introduction or care by humans).

ORGANIC MATTER

Carbonaceous waste contained in plant or animal matter and originating from domestic or industrial sources.

PARTICULATE MATTER

A collective name for fine solid or liquid particles added to the atmosphere by processes at the earth's surface. Particulate matter includes dust, smoke, soot, pollen and soil particles.

PROTECTED AREA

Geographically defined area which is designated or regulated and managed to achieve specific conservation objectives.

PURCHASING POWER PARITY (PPP)

The rate of currency conversion that equalizes the purchasing power of different currencies by eliminating the differences in price levels between countries.

RATIFICATION

Ratification, acceptance and approval all refer to the act whereby a state establishes its consent to be bound by a treaty.

SOIL ALKALIZATION

See soil salinization.

SOIL SALINIZATION

The accumulation of soluble mineral salts near the surface of soil. The accumulation of exchangeable sodium (with or without soluble salts) is referred to as soil alkalization. Both processes can interfere with the growth of most crop plants.

THREATENED

A species or community that is vulnerable, endangered or presumed extinct.

TOTAL FINAL ENERGY CONSUMPTION (TFC)

The sum of consumption by different energy end-users. TFC is broken down into energy demand in the following sectors: industry, transport, other (including agriculture, residential, commercial and public services) and non-energy use.

UNDERNOURISHMENT

A level of food intake with an energy content that consistently fails to meet the dietary energy requirements of a person.

Sources: Dinerstein, Powell, Olson, Wikramanayake, Abell, Loucks, Underwood, Allnut, Wettengel, Ricketts, Strand, O'Connor, Burgess and Mobley (1999), EPA Terms of Environment (<http://www.epa.gov/OCEPAterms>), European Environment Agency Glossary (<http://glossary.eea.europa.eu/EEAGlossary>), FAO (1985), IEA (2005), OECD Glossary of Statistical Terms (<http://stats.oecd.org/glossary/index.htm>), UN (1992), UNEP (1992), United Nations Treaty Handbook (<http://untreaty.un.org/English/TreatyHandbook/hbframeset.htm>), WHO (2004d).

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