

Environmental Setting and Priority Areas for Environmental Action

Transboundary Issues

Riparian states historically shared the resources of the Mekong River Basin, however, subsistence based use of resources were sustainable from an ecological standpoint and led to few conflicts of resource exploitation affecting the welfare of another. Presently, with new technologies and production systems, imperatives of economic growth combined with globalization and population growth, have profound social, environmental and economic implications for the subregion.

Although the level of economic development differs among the four countries, a number of environmental issues are common to all or some of them. Critical among these are issues relating to deforestation, loss of biodiversity, degradation of water resources, and coastal resources. The geographical and geopolitical significance of these issues vary from local, national, and subregional vantage points. As part of a regional river basin, the countries share some of the resource concerns that, being transborder in nature, may be geopolitically sensitive.

On the subregional scale, utilizing the water resources of the Mekong River could emerge as a dominant issue in the new millennium.

The past decade of the Mekong Basin development has been marked by the conflicting and disintegrated interests of riparian states. The promise of hydroelectricity exports has prompted the Government of the Lao PDR to set as a goal the completion of 23 dams by year 2010, to generate over 18,000 megawatts (MW) of hydropower. The Asian economic crisis has adversely effected Mekong development projects since struggling Asian

countries especially Thailand's pivotal role became constrained. Thailand's per capita income is roughly ten times that of the other countries. Further upstream, the People's Republic of China (PRC) has its own plans to construct six large dams along the River and another nine along its tributaries to generate a total of 20,000 MW of electricity for Yunan province. The dams are being built for hydro-power rather than irrigation purposes, implying continuous release of water. Thailand also had plans to build dams along the lower reaches of the Mekong, although the plans have been stalled by NGO opposition. Meanwhile the four other Lower Basin States are concerned about the reduction of flow these dams could cause during the dry season. Concern has also been expressed that existing and proposed water diversion and hydropower dam projects will alter the Mekong Basin's hydrologic cycle permanently.

Each of the downstream countries have their own special concerns. The environmental consequences of the projects are being borne not only by local inhabitants but also by those living and farming downstream in the Mekong Delta. Viet Nam is concerned that reduced water flow could lead to saltwater intrusion farther up the Mekong delta during the dry season, which could threaten its rice production. Cambodia is concerned about increased sedimentation of the Tonle Sap. For the Lao PDR, the Mekong is a "navigational backbone;" in addition, hydropower earns for this country nearly a quarter of its total foreign exchange revenues through its sale of electricity to Thailand. Given its low potential for export-oriented industries because of a lean and generally unskilled labor force, the lack of economies of scale for commercial manufacturing, also the inadequacy of existing communication infrastructure (including the lack of a seaport), hydropower is likely to remain its major source of export revenue, with the Mekong as its life source.

The Mekong River Commission (MRC) has completed preparing an overall framework Water Utilization Program (WUP) for this communal resource, as specified in the Agreement of Riparian States (MRC 1998). The WUP was conceived as a long-term program to plan, develop and implement rules for the rational utilization of the Mekong River and procedures and processes in support of implementation. The program covers planning and modeling and monitoring and management of the river basin.

A subregional strategy for Cambodia, Lao PDR, Thailand, and Viet Nam, given striking similarities in culture, ecology, and status of economic development of these countries, may effectively promote developing a multi-country biodiversity protection program with emphasis on developing human resources and transboundary reserves, and establishing collaborative biological inventories and monitoring systems. In this respect, Thailand could share its knowledge base with its neighbors. However, its biodiversity is fast disappearing and its log ban policy is threatening the biological resources of its better endowed neighbors.

Assessment and monitoring of development impacts on natural resources, especially of transboundary nature, require quality baseline data of which very little is available in Cambodia, Lao PDR, Thailand and Viet Nam. A diagnostic study for the river basin area conducted by the Mekong River Commission (MRC 1997) found data to support basin river planning and management on the whole inadequate, fragmented and outdated, and this has put considerable constraints to any analysis including environmental assessments.

ADB's Regional Assistance Initiatives

Concerted efforts have been made by ADB to identify and support subregional initiatives. The establishment of the Working Group on the Environment marked an important initiative on the part of ADB's Greater Mekong Subregion (GMS) program to establish an informal forum to promote and facilitate subregional cooperation in environment among the participating countries including Cambodia, Lao PDR, Thailand and Viet Nam. The potential for subregional cooperation in the Mekong countries led ADB to formulate the GMS program in 1992/93. Although the program's initial emphasis was on improving physical linkages among the GMS countries, other transboundary concerns have since been included into the program's scope. Under its

Table 2: Environmental Regional Technical Assistance (Greater Mekong Subregion) Program

Project	Approval Date	Structure of Financing (\$ million)
RETA 5622: Subregional Environmental Monitoring and Information System (SEMIS)	February 1995	ADB (JSF): 1.0 UNEP: 1.0 GMS govts. (in kind): 2.0
RETA 5684: Subregional Environmental 0.80 Training and Institutional Strengthening in the GMS (SETIS)	May 1996	ADB (JSF): Norway: 0.75 Finland: 0.10 GMS govts (in kind): 0.7
RETA 5771: Poverty Reduction and Environmental Management in Remote GMS Watersheds	December 1997	ADB (JSF): 1.0 Finland: 2.2 GMS govts. (in kind): 0.6
RETA 5783: Strategic Environmental Framework for the Greater Mekong Subregion	March 1998	ADB (JSF): 0.6 Switzerland: 1.0 UNEP (in kind): 0.03 GMS govts. (in kind): 0.27
RETA 5822: Protection and Management of Critical Wetlands in the Lower Mekong Basin	December 1998	ADB (JSF): 1.0 Finland: 0.65 GMS govts. (in kind): 0.4

GMS - Greater Mekong subregion, JSF - Japan Special Fund, RETA - regional technical assistance, UNEP - United Nations Environment Programme

environmental component, five regional technical assistance (RETA) projects have been, or are being implemented (see Table 2).

Assistance on a subregional level to strengthening environmental monitoring and information (Regional technical assistance [RETA] 5622) and providing environmental training and institutional strengthening in the GMS (RETA 5864), two projects just completed, have contributed to building the capacity of the environment agencies. Besides technical assistance to GMS countries, other non-GMS assistance (Coastal and Marine Environmental Management in the South China Sea, RETA Nos. 5552 and 5712), implemented in two phases between 1995 and 1999, have substantially expanded the number of participating countries and ADB's

understanding of the major management and policy issues in the coastal zone. It also laid the framework for possible investment activities.

In an evaluation study of the GMS environment program by ADB, it was noted that the environmental component has created increased environmental awareness between individual GMS countries. The thrust of the program has been in developing mechanisms for data sharing and developing subregional environmental standards. The major transboundary investment potentials of GMS has propelled the program's environmental component to a position of considerable importance. Though not central to the GMS program, the environmental component has become its essential supporting element. It succeeded best in facilitating professional contacts and creating a common environmental language across the subregion. The financial cost of this achievement may have been high but the benefits of institutional goodwill and a more efficient debate across the subregional boundaries have been commensurate to the cost. As the GMS environmental efforts moves in the direction of environmental management, it will be handicapped by the absence of reliable data. There is a need to find ways of collecting, assembling and exchanging critical *original* data rather than dealing mainly with the manipulation of secondary data. For a program aiming to address transboundary impacts, it should be a source of concern that neither the GMS governments nor the donors have a good idea of the magnitude of transboundary flows of goods, people, wildlife, etc. The gap between the sophisticated aims of the GMS environmental component and the field reality must not get any bigger, and ideally, should start getting smaller.

Forests and their Utilization

Cambodia

By comparison with its neighbors, Cambodia remains well endowed in forest resources. The economic and environmental consequences of massive deforestation elsewhere in Southeast Asia served to turn the attention of the development community to the risk of the same happening in Cambodia as the country set about liberalizing its economy. To this was added the concern with areas leased out for logging to the private sector, and the declining fiscal contribution of forestry that coincided, paradoxically, with an expansion of forest concession hold-

ers during 1994-1996. Forest revenues that accounted for 14 percent of total government revenues in 1994 generated less than 5 percent by 1996. The apparent mismanagement of the sector and the dissipation of its revenue spurred a review of the entire sector's governance by IMF, World Bank, Food and Agriculture Organization (FAO) and the United Nations Development Programme (UNDP) in 1995 and 1996. A subsequent series of measures have created breathing space and a genuine prospect of a better regulation of the sector, especially its industrial component. However, the causes of deforestation and forest depletion in Cambodia extend well beyond a flawed forest concession policy and it would be ingenuous to expect recent policy changes to be a cure-all.

Much has been said about the decline of Cambodia's forest reserves since the beginning of the decade (World Bank 1996, ARD Inc. 1998). Official data and best estimates present the picture in Table 3.

Policy discussion has been handicapped by the continued absence of reliable data on the extent and composition of standing forests, a reflection of, among other things, problems of access until recently to areas under conflict without which remotely sensed data (of which there are many) cannot be unambiguously interpreted.

Equally uncertain are estimates of forestry output. From well below 1 million cubic meters (mm³) per annum (p.a.) in the 1980s, industrial log production increased to over 4 mm³ in 1997, of which over half were exported either as logs or sawn wood, mainly to Thailand and Viet Nam, much of the exports illegal. These figures contrast with the annual allowable cut in 1969 of only 0.6 mm³ or estimates of aggregate sustainable cut of around 1.0 mm³ p.a. used at the time of the Forest Policy Review (FPR). There can be little doubt about the seriousness of overcutting that has been done in the mid-1990s. Behind countrywide aggregates, however, lies a more complex

Table 3: Forest Cover in Cambodia, 1969-1997

Year	Estimated Forest Cover (million ha)	Source
1969	13.4	Institut de la Recherche Forestiere, based on forest inventory, quoted in Chanrithy (1997)
1991	12.3	Mekong Secretariat and Ministry of Agriculture, Forestry and Fisheries
1993	11.2	Mekong Secretariat, based on Landsat imagery
1997	10.6	ARD Inc. (1998) best estimates

MAFF - Ministry of Agriculture, Forestry and Fisheries.

reality of spatial differentiation in forest quality and the extent of mismanagement. The production and exports registered a marked decline in 1998 and 1999 following a more determined enforcement of the log export ban and a number of other developments.

Total production of fuelwood, sold as such or as charcoal, in the mid-1990s was estimated at about 6 mm³ equivalent p.a. (World Bank 1996), of which about half was estimated to have come from forest areas, the balance coming from nonforest areas and household lots. Fuelwood production has been the main cause of deforestation in some locations, including the environmentally crucial ones such as the inundated forest of Tonle Sap.

Deforestation and its causes

The loss of forest cover in Cambodia is the result of a number of factors, most of which echo the deforestation experience elsewhere in Asia. The causes include the continued practice of shifting cultivation by a growing number of upland dwellers (especially in the northeast of the country), clearing of forest for agriculture, often after opening of forest areas for industrial logging, indiscriminate logging by industrial and small-scale operators, and persistently high demand for fuelwood met under a de facto open access management regime. The remedies to deforestation are as complex as its causes, a lesson ADB has learnt over the years, but one that deserves to be restated.

Policy developments

Government policies governing access to forest resources, especially by industrial operators, have claimed the lion's share of attention because they offer the greatest prospect of short-term effectiveness. By contrast, activities directed at a large number of individuals and families whose daily subsistence and commercial activities, too, affect the overall condition of the country's forests, are much less responsive to policy change, especially in the short run.

The FPR has been the principal engine of policy change in Cambodia. Its outcome has been a temporary suspension of new forest concession awards, repeal of a number of concession agreements entered into during 1994-1997, formulation of a new policy of more transparent and efficient system of concession allocation, enactment of a program of monitoring and illegal log control, and legislative redrafts, all accompanied by sustained dialogue between funding agencies and the Government and near-exemplary coordination among agencies. A full and detailed analysis of these developments is available (e.g., ARD Inc., 1998) and little point would be served by repeating it here.

Among the less fully developed components of the FPR package is the management of forests by communities and the corresponding institutional, regulatory, and training prerequisites. Apart from other problems, communities with the traditional right of access (as well as those lacking them) are faced with unclear rights under industrial forest concessions. The framework for community forestry needs to be created in tandem with reform of industrial forestry on the one hand, and with policies on rural development on the other. Herein lies the main difficulty. The FPR has made recommendations for environmentally more sound management of concession areas but has said relatively little about the operating regimes suitable for forest areas adjacent to protected areas.

On the institutional side, some progress has been made in clarifying the protection mandates of the Department of Forestry and Wildlife (DF&W) and the Ministry of Environment. With the creation of the protected area system in 1993, a seemingly simple solution was to make MOE responsible for protected areas while retaining DF&W's responsibility over other forest areas. However, in the poorly supervised field conditions of Cambodia, logging as well as wildlife poaching often cross the boundaries between the two jurisdictions. Furthermore, of the two branches of government, DF&W has greater access to funding and stronger field presence. As a result, enforcement of environmental provisions in protected areas often relies on the goodwill (and staff) of DF&W. The complex nature of the interdependence between the two branches is recognized and a promising start has been made recently in creating joint DF&W and MOE task forces to deal with control of illegal logging (RGC 1999). Despite recent progress, much more clarity is needed.

Lao PDR

The Lao PDR suffers from a number of environmental problems, the most important of which are related to deforestation. Expanding commercial exploitation of forests, plans for additional hydroelectric facilities, foreign demand for wild animals and nontimber forest products (NTFPs) for food and traditional medicine, and a growing population, all place increasing pressure on Lao's forest resources.

To meet these challenges, the Department of Forestry (DOF) has prepared a "Forestry Vision to 2020" document that sets forth the strategies and measures for sustainable forest management. Also related to forest management, DOF staff is formulating forestland

use and management plans in consultation with village communities, in which the villagers have been trained by DOF to guide forest concessionaires in logging operations. A total of 47 forest management plans will be prepared by 2000. Some villagers have already earned income from implementing these forest management plans.

Status

Most of the Lao PDR was once forested. MacKinnon & MacKinnon (1986) estimated 68 percent comprised evergreen forest, 23 percent mixed deciduous, and 7 percent dry dipterocarp. By 1992, coverage of these forest types were 5 percent, 35 percent, and 5 percent, respectively, revealing a dramatic decline in evergreen forest. (Berkmuller et al. 1995) An estimated 85 percent of the Lao PDR is covered by vegetation not currently under active management, much of which is secondary. The remaining 15 percent comprise urban areas, permanent agriculture, and active shifting cultivation.

Less than 50 percent of the total forest area has good quality forest. The remaining forest area with a crown density above 20 percent is distributed among different regions of the country (Table 4). Through its forestland allocation program, the Government is attempting to settle people on arable land to encourage livelihoods from permanent agricultural activities. The Government has a goal of retaining 17 million hectares under forest cover.

The central and southern regions retain some of the highest proportions of forest cover in Asia. However, much of the remaining natural forest is degraded and under shifting cultivation.

The following are the main forest types today:

- dry evergreen: northern Lao PDR
- tropical montane evergreen: along highland areas of the Annamite Mountains and Bolovens Plateau
- lowland semievergreen dipterocarp: the Mekong River Plain
- tropical montane deciduous: scattered areas in the north
- dry dipterocarp: southern Lao PDR

- mixed deciduous: southern Lao PDR
 - forest on limestone: small areas in the Annamite Mountains
 - pine forest: small areas in the Annamite Mountains
 - subtropical montane: small areas in northern Lao PDR
- All forestland is classified as one of five forestland use types established by the Forestry Law, namely,
- protection forest: for protecting watersheds and preventing soil erosion;
 - conservation forest: for protecting and conserving biodiversity, as well as historical, cultural, tourism, educational, and scientific research;
 - production forest: for satisfying economic and social development needs, meeting people's livelihood requirements for timber and other forest products on a sustainable basis and without significant negative environmental impacts;
 - regeneration forest: young fallow forest for regeneration and maintenance, for increasing the total area of mature forest; and
 - degraded forestland or barren land: land without forest or areas of heavily damaged forest, classified for tree planting, permanent agriculture, livestock production, or other purposes, according to national economic development plans.

Deforestation rates

Population growth, slash-and-burn cultivation, and overexploitation of forest products are becoming increasingly unsustainable. This syndrome, combined with uncontrolled logging, forest fires, and the effects of wartime bombing and chemical defoliation, has greatly reduced both the forested area and also the quality of much of the remaining forest.

In the 1940s, 70 percent of the land area was under forest cover. In the forest inventory of 1989, forest cover had declined to 47 percent. The most recent forest cover estimate is 40-41 percent (unofficial), which was prepared in 1999 based on satellite imagery and other data from 1997. The total area of forests is approximately 8.5 million ha, while another 8.2 million ha represents poor growth areas, less dense wood, and shrub land (Stibig 1997).

A 1996 analysis suggests that "mature" forests—defined as areas with at least 20 percent canopy cover and a 30 meter canopy—cover an estimated 40-41 percent of land although the official figure remains at 47 percent. This is based on an estimate of forest cover in 1989 using similar methodology. Thus, the national forest estate seems to be contracting at about 0.5-0.7 percent per year. Under this definition, there is very little "mature" forest

Table 4: Regional Distribution of Forests in Lao PDR

Item	North	Central	South	Total Area
Total land area (million ha)	9,821	7,229	6,630	23,680
Total forest area (million ha)	3,563	3,739	3,866	11,168
Forest cover (percent)	36%	52%	58%	47%

Source: Forest Inventory, 1989..

north of 19°30'N (about the latitude of Xieng Khouang town). The largest and least disturbed blocks of forest remaining are all in or south of the Nam Theun catchment (DOF 1999). Over the past 50 years, forest cover has declined from about 70 percent of the land area to the current official figure.

Deforestation not only destroyed at least 150,000–160,000 ha of valuable forest annually in the 1980s, but also caused erosion—leading to siltation of reservoirs, navigation channels, and irrigation systems downstream—and reduced groundwater levels.

Causes of Deforestation

Logging

Most of the logging that takes place in the Lao PDR is not based on systematic management, planning, and careful inventories. In many areas where logging takes place, the forest is not regenerated. Overexploitation is caused both by legal and illegal operations. At present, most of the valuable forest is located inside protected areas, where commercial harvesting is naturally not allowed. Consequently, the remaining production forest areas are under heavy pressure from loggers (Forestry Law Lao PDR 1996)

For logging and forest produce utilization, the Department of Forestry (DOF) provides the following general instructions (*Country Economic Review*, ADB 1998).

- logging is allowed only in areas with forest management plans,
- clear cutting is allowed only if necessary,
- replanting and/or good maintenance of logging areas,
- efficient harvesting methods and minimizing of logging residues through maximum use of cut trees, and
- collection of NTFPs is regulated by specific regulations of agencies concerned.

Logging quotas

Commercial wood harvesting in the Lao PDR is based on annual logging quotas. These quotas set the limits for volumes that may be logged in the country and are based on assessment by individual provinces, the Ministry of Agriculture and Forestry (MAF), the Tourism Authority of the Lao PDR, the Ministry of Finance, and the Office of the Prime Minister. MAF issues logging quotas and distributes them to the provinces as provincial quotas. This comprises the requisite provincial logging plan. In reservoir areas of hydropower dams, logging also is limited by quotas

(ADB Regional Technical Assistance [RETA 5771], 1998).

Timber royalties formed 13.9 percent of government revenues in FY1997 (Lao: Country Economic Review, 1998) and are a major part of the domestic revenue collection for the Government. Despite the vital role of logging revenue, the setting of quotas is not transparent and actual criteria are not disclosed. A recent examination of the decision-making process revealed that quotas are based on fiscal needs of the Government and the needs of state-owned enterprises (SOEs) in terms of supply contracts and available logging capacity. Provincial authorities play a role in granting provincial quotas by allocating logging sites. They are prone to be influenced by powerful logging firms and do not possess adequate information on which to base the selection of sites. Thus, the commercially most attractive logging sites are selected with little or no consideration of sustainability issues. The whole quota allocation process is not clearly understood even by officials involved and is characterized by covert influence and bargaining among various public sector institutions. The final quota is decided by the Office of the Prime Minister and not by forestry authorities (ADB RETA 5771, 1998).

The official volume harvested in FY1997 was 661,700 m³ and the quota for FY1999 is 450,000 m³, with significant volumes (an estimated 50 percent) being derived from hydroelectric development sites rather than designated production forests. The logging of dam sites is financially attractive since no regeneration of forests is required (ADB RETA 5771, 1998).

As a result of the inadequate resources available for forest inventory, the central role played by SOEs, and large-scale logging in hydroelectric development sites, DOF does not have final control over utilization of forest resources in the Lao PDR. In essence, DOF has been marginalized in some segments of the logging policy process in the country (ADB RETA 5771, 1998).

Shifting cultivation

The Government's desire to preserve valuable hardwoods for commercial extraction and to protect the forest environment, and the international concern about environmental degradation and the loss of many wildlife species unique to the Lao PDR, have motivated efforts to prohibit shifting cultivation throughout the country. This policy affects significantly the livelihoods of upland villagers dependent on cultivation of upland rice. Traditional patterns of village livelihood rely on forest products as a food reserve during years of poor rice harvest and as a regular source of fruits and vegetables. The

Government has restricted the clearing of forestland for shifting agriculture since the late 1980s and is attempting to resettle upland farming villages in lowland locations where paddy rice cultivation is possible. However, both the Government's inability to ensure compliance with the measures and the attraction of Thai money for forest products inhibit implementation of the restrictions.

Rural households (an estimated 85 percent of all households are in rural areas) remain highly dependent on forest products for their livelihoods and much forestland is being used for shifting cultivation. An estimated 6 percent of the Lao population practices shifting cultivation, a traditional form of agriculture, predominantly in the mountainous regions of the country (ADB Country Assistance Plan 1999) for their subsistence. Population density in the upper watersheds has progressively increased as people have been forced to relocate and expand agricultural cultivation into forested land due to armed conflicts, population pressure, and land degradation in indigenous areas.

Thailand

Through the middle of the twentieth century, Thailand was a heavily forested country. However, deforestation has progressed in recent years at a rate faster than any other country in the region except Nepal. By official estimates, forest cover decreased an average of 400,000 ha per year (Ministry of Science, Technology and Environment [MOSTE] 1997), from 53.3 percent forest cover in 1961 to 25 percent in 1998. These figures fail to include the degradation of remaining forest areas—where the most valuable timber, wildlife, and other forest products may have been exploited, but sufficient trees remain to count for survey purposes.

In 1989, following a major landslide and flooding disaster in the south of Thailand, believed to have been exacerbated by the denudation of forests, a complete logging ban was imposed by the Cabinet. This was unprecedented anywhere in the world. The ban has helped slow the rate of forest destruction, but has not stopped it. Illegal logging continues, along with encroachment by farmers. Forest fires, usually started to clear areas for cultivation, are also a problem; in 1994, they affected some 784,000 ha, equivalent to 5.6 percent of the total forest area. The rate of deforestation slowed from 0.9 percent per year, pre-1989, to 0.4 percent per year just after the ban, and was down to 0.2 percent per year between 1995 and 1998, averaging 400,000 ha per year over the four decades (NSO 1998).

The forests in northern Thailand have been most severely affected, with forest cover decreasing by nearly 6 percent there between 1985 and 1995. Nationwide, some 1.3 million households in 12,360 villages have been surveyed within National Forest Reserves, occupying nearly 13 million ha (Royal Forestry Department [RFD] 1993). Thus somewhere between 8 and 16 percent of the population, or 5-10 million people, illegally occupy forestlands (statement of the Director-General, RFD, before the Foreign Correspondents Club of Thailand, 1999).

Policies and Programs

The National Forest Policy sets a target of 40 percent of total land area. Of this amount, 15 percent would be conservation forest and the remaining 25 percent commercial or productive forests. Approximately 13.6 million ha have been classified as national parks or wildlife sanctuaries (RFD Director-General, 1999). Although reforestation programs are being implemented, the rate of reforestation—currently approximately 18,162 ha per year (RFD, 1998 official contract)—is only about 6 percent of annual deforestation, which during the 1990s has averaged about 320,000 ha per year. To reach the target goal of 40 percent therefore will require a significant increase in investment and effort. No target date has been set.

The Royal Forest Department (RFD) was established in 1896 by King Rama V to ensure that teak and other valuable forest products would be well managed. During the early days of its operations, RFD depended on concessionaires to undertake forest management and utilization, including logging, natural regeneration, reforestation and protection. Forests not under concession were protected by controlling their utilization and by punitive actions as defined in forestry laws (Forest Act, 1941 and the National Forest Reserve Act, 1964). RFD expanded its operations and administrative functions over time, as technical aspects of forestry development expanded. Its organizational structure evolved in response to changes in administrative requirements and conditions, such as the 1989 ban on logging concessions and its reorientation toward forest conservation. RFD has five technical bureaus, several administrative sections, and 21 regional forestry offices. At the local level, RFD has 75 provincial forestry offices and over 500 district forestry offices. In 1995, 8,687 officers and 8,073 permanent employees staffed RFD. The Wild Animals Reservation and Protection Act of 1992 (originally promulgated in 1960) and the National Parks Act of 1961 are currently perceived to be the most effective laws available for forest protection.

Today, however, the agency is heavily criticized from both within and without. Other agencies have stepped in to fill some of its mandates. For example, the Watershed Classification System was introduced, surveyed, and promoted through the Cabinet by the Ministry of Science and Technology's Office of Environmental Policy and Planning (MOSTE-OEPP). Currently, the Fisheries Department is pushing to take responsibility for national parks on islands and in coastal areas. Within the Ministry of Agriculture and Cooperatives (MOAC) itself, a new generation of leadership is emerging and attempting serious reforms. Of particular importance for forestry management, a Natural Resources and Biodiversity Institute (NAREBI) has recently been established to operate as an independent agency within MOAC to facilitate and coordinate natural resource management programs among all of its line agencies and to serve as the principal contact point for other government agencies concerned with natural resource management issues.

Viet Nam

Over 60 percent of Viet Nam's land area, some 19 million ha, is classified as forestland, mostly in the upland and mountainous areas located in the west and north of the country. Yet, of this area only 8.3 million ha or 25 percent of the country is natural forest, about 1 million ha or 3 percent is plantation, and the remaining "forestland" is "bare" (covered with shrub or grasses). The northwest is the most severely affected, although all regions have large areas of treeless land. Thirty percent of Viet Nam is classified as "bare" land and less than 1 percent has original forest cover.

Forest loss

Deforestation has been widespread for several decades, with 50 percent of the forest cover lost during the 40-year period 1943-1983. Loss of natural forest cover during the period 1976-1990 averaged about 190,000 ha per year across the whole country, but this rate may have declined over the current decade.

Forest loss has been rapid in the northern and southern regions and is proceeding at an increasing rate in the central highlands. Natural forests are mainly concentrated in the highlands (Tay Nguyen), in central and southeastern Viet Nam. The Northwest and the Northeast regions have suffered particularly severe forest loss. In these mountain areas, the forest cover is only 13.5 percent and 16.8 percent, respectively, with some provinces losing almost all their forest cover. Son La has only 9.8 percent forest cover and Cao Bang only 11.2 percent.

The declining diversity of forest systems

Despite these serious losses, Viet Nam still has a diverse forest flora due to its wide range of climatic and topographic conditions. The main forest types are shown in Table 5.

For administrative purposes, forestland is divided into three categories: production forests, protection forests, and special use forests. Production forests are earmarked for use according to approved management plans. Protection forests are designated to protect land and water resources in critical areas and their use is restricted. Special use forests are mostly nature reserves and national parks managed for biodiversity and conservation. They include sites of cultural, historic, and scenic importance. In each of these categories, tree cover is seriously depleted (Table 6).

Forest uses

Forestry accounts for about 2 percent of GDP in Viet Nam. This figure understates the importance of forestry and forestlands in the rural economy. Forests meet much of the energy needs of the rural population, with some 15 million cubic meters of fuelwood harvested every year. Natural forests in particular provide a wide range of

Table 5. Classification of Natural Forests in Viet Nam

Forest Type	Area (ha)
Closed broad-leaved tropical evergreen and semi-deciduous	5,648,600
Closed broad-leaved deciduous lowland and sub-alpine tropical	935,000
Closed tropical conifer, conifer and conifer-broad leaf mixture	155,100
Closed tropical bamboo and bamboo-broad leaf mixture	1,464,800
Mangrove	34,700
Melaleuca	13,600
Total natural forest	8,251,800
Plantation	1,050,000
Total forest cover	9,301,800

Source: FIPI (1995); MARD (1997).

Table 6. Categories of Forestland, 1995 (million hectares)

Forest Class	With Forest Cover	Without Forest Cover	Total
Special Use Forest	0.7	0.2	0.9
Protection Forest	2.4	3.3	5.7
Production Forest	6.2	6.2	12.4
Total	9.3	9.7	19.0

Source: Forest Inventory and Planning Institute (FIPI), (1995).

nonwood products, ranging from bamboo to medicinal plants. About 20 million people live in or around forests in Viet Nam and derive a substantial part of their food and income from forestland. In addition, the economic implications of forest loss to soil erosion, sedimentation, maintenance of water quality and availability, and to biodiversity loss are not reflected in national accounts. It is the pivotal natural resource for the maintenance of ecosystems on which overall development depends.

In the past, state forestry enterprises were responsible for forest management and logging and paid little attention to sustainable management and regeneration. Ethnic minorities living in the forest areas and migrant farmers from the delta areas also contributed to deforestation. Strategies of effective forest management need to consider both the underlying and immediate causes of forest loss and degradation which include:

- *Poverty*: Rural poverty forces the poor to overuse forest resources for subsistence and marketing;
- *A lack of arable land*: Viet Nam has reached the limit of land suitable for cultivation;
- *Limited government capacity*: the Ministry of Agriculture and Rural Development and provincial and district Forest Services do not have the capacity to manage and protect forests; and
- *Limited local rights over forests*: the ability of local populations to manage forestland responsibly is constrained by an inadequate system of land use planning and land tenure in forest areas.

The following lead to most of the more immediate causes of forest loss and degradation:

Migration of people to forested regions associated with clearing and encroachment for agriculture. Direct environmental impacts include reduced forest area, loss of topsoil, watershed degradation, loss of plant and animal species, and loss in natural water regulation. Indirect effects include the sedimentation of rivers, lakes, dams, and coastal waters as well as the loss of carbon sequestration capabilities of the forest.

Fuelwood collection degrades forests and limits regeneration. If converted to area equivalents, fuelwood harvesting would account for six times as much forest harvesting as commercial logging (World Bank, 1995).

Logging and illegal harvesting of forest products. Mismanagement of commercial operations degrades forests and opens the way for illegal activities, immigration, and conversion to agriculture of production, special use, and protection forest.

Fires. During the dry season of 1997-1998, a record 1,681 fires throughout the country degraded 19,819 ha of

forestland. Of this area, 6,293 ha were natural forests, 7,888 ha were plantation forests, 494 ha were bamboo forests, and 5,123 ha were grass and shrubs. Between 20,000 and 30,000 ha of forest are burned each year, with up to 100,000 ha being burned in certain years (San and Gilmour 1999).

Infrastructure development. As much as 30,000 ha of forests are lost each year with the creation of reservoirs for hydroelectricity and irrigation (World Bank 1995). The construction of power lines and major roads has also resulted in forest losses.

War. Bombs, herbicides, and use of heavy machinery destroyed about 4.5 million ha of forests during the war of 1961-1975 (World Bank 1995).

Institutional challenges

In the early 1990s, the Government of Viet Nam recognized the decline of natural forests as threatening its rural development objectives. A major spending program was devised to reverse the impacts on downstream agricultural water and, to a lesser extent, on fisheries. In 1993, the Government launched the "Re-greening the Barren Hills Program (327)". The program identified reforestation and watershed protection as primary objectives, implemented through land allocation to smallholders under Resolution No. 10 NQ.TW.

As of end of 1997, the Government had spent some \$137 million on Program 327. Yet it had difficulties achieving its goals, largely due to institutional constraints including

- a top-down, bureaucratic approach;
- constantly changing program objectives;
- stalled land allocation processes that had failed to involve local people;
- insufficient and untimely funding;
- poor technical capacity;
- failure to recognize the wider development aims of resource-poor households who need an overall integrated development approach; and
- scarce land resources.

In 1998, the Government introduced the "Five Million Hectare Program" that seeks to continue Program 327 with some modifications. To the year 2010, \$2.5 billion has been earmarked for the program, which aims to increase forest cover to 43 percent and focuses on reforestation through natural forest regeneration. In the past, reforestation of bare land had been conducted with limited success through plantations. Plantations continue to be a key objective, but the "Five Million Hectare Program" has taken a first step in recognizing the benefits of better natural forest management. By controlling

the serious environmental degradation caused by forest loss and mismanagement, the Government hopes that rural development objectives across the country can be put back on track. Institutional constraints remain (UNDP/MPI 1999).

Biodiversity and Protected Areas

Cambodia

Ashwell (1997) has described Cambodia's biological heritage elegantly:

"Cambodia possesses many features of international significance. It retains one of the highest proportions of land as natural habitats (forest and wetlands) in the world, and one of the least disturbed coastlines in continental Asia. Currently, over 45 habitat types have been characterized and mapped for the country.

The landscapes of Cambodia have provided the Cambodian people with a wealth of natural resources for many centuries. The maintenance of these landscapes has ensured the stability of Cambodian society and culture through the protection of soil, the regulation of hydrological regimes, and the provision of a vast range of natural products. These resources remain of fundamental importance to the subsistence of Cambodia's predominantly rural population, and to the future development of the nation.

The extent of dependence upon plant resources is one illustration.... Of the 2,300 species of plants described in Cambodia, approximately 40 percent have a traditional use, primarily as food and medicine. Over 220 of these species are major components of the 45 habitats of the country. They provide opportunities for sustained income through community participation in natural resource management, especially in protected area and buffer zone management."

In addition, the country is believed to have over 130 mammal and more than 500 bird species. A substantial number of these are of international conservation significance.¹ Some 300 species of freshwater fish have been identified, of which 215 are in the Tonle Sap. This biological heritage, however, is threatened by the loss of habitats through commercial and community uses. Deforestation, as always, is the most common threat.

Wildlife capture is common in most parts of Cambodia, regardless of the management status of the areas involved. Wildlife trade with Thailand and Viet Nam has been a major concern for years. In several instances, especially in the southwest of the country, the loss of biodiversity is exacerbated by immigration from densely populated eastern provinces.

Protected Areas System

From the ecological viewpoint, Cambodia can be divided into seven relatively homogeneous biodiversity regions, namely (i) southwestern coastal ranges and marine waters, (ii) northern lowlands, (iii) northeastern forests, (iv) Kompong Cham, (v) Mekong Delta region, (vi) Tonle Sap floodplains, and (vii) northwestern region.² Of these, regions (i), (iii), and (vi) are considered of higher priority for conservation action than the rest.

Protection of habitats is not new in Cambodia. Prior to 1957, about one third of the country had been subjected to some form of inventory and classified into 173 forest reserves and six wildlife reserves. Many sites recently declared protected areas were well known to Cambodian society as places of recreation and nature conservation early in the century. A 10,800-hectare area around Angkor temples was declared a national park in 1925, the first in Southeast Asia.

In 1993, King Norodom Sihanouk decreed a new National Protected Area System, giving the Ministry of Environment authority to supervise, develop, and manage an area of 3,327,200 ha in cooperation with the Ministry of Agriculture. The new system designates seven national parks, nine wildlife sanctuaries, three protected landscapes, and three multiple-use management areas (World Bank, 1997). The 1993 Royal Decree 126 on "The Creation and Designation of Protected Areas" designates 23 areas of fragile and critical habitats constituting a total of 19 percent of the country. Four management categories were distinguished, namely (i) national parks, (ii) wildlife sanctuaries, (iii) protected landscapes, and (iv) multiple-use management areas. This framework is the basis for developing a national protected system in Cambodia.

¹ Cambodia signed the Biodiversity Convention in 1994, the Convention on International Trade in Endangered Species (CITES) convention in 1977, and the Ramsar Convention in 1999. The three Ramsar sites exist in Cambodia: Koh Kopit in Koh Kong, the Mekong River north of Stung Treng, and Boeng Chhmar. The Tonle Sap itself is classified as an international biosphere reserve.

² Of these, regions (iv), (v) and (vi) have a high or moderately high population density and have been the geographic focus of ADB's interventions until now.

Constraints to biodiversity protection

The promulgation of the decree was a major achievement. It has ensured, for instance, that no logging concessions have been issued in protected areas although it could not prevent illegal logging from taking place there. Not unexpectedly, a number of problems remain. These are briefly described below.

The selection and delineation of protected areas embodied in the decree was based on information available in the early 1990s. That information was incomplete and uncertain. As a result, adjustments of boundaries or additions are now necessary that would better represent the existing natural habitats.

The system of protected areas that emerged in 1993 was largely administrative; the ability of the State to effectively manage these areas emerging much more slowly. The first national park to be inaugurated was Ream, in 1995. The preparation of management plans and formal adoption of national parks for management continues to be dependent on foreign funding and to date, only about 20 percent of the total area designated as protected is under some form of active management.

The State's inability so far to manage protected areas has not been countered (with the exception of the Angkor ecocultural site) by innovative ways of financing the protected area system. The potential for making protected areas an engine for economic development in buffer zones is yet to be realized even if much preliminary thinking along these lines has taken place. The concept requires that the protected area of interest be made a part of a wider zone and a wider complex of resources to be managed. This often allows the benefits of conservation activities to be captured by linked activities and partly "recycled." For instance, where protecting a classified watershed safeguards the hydroelectric potential of a nearby facility, an opportunity is created for some of the electricity revenue to be recovered by the area's "conservationists." This logic leads to favoring development of clusters (either clusters of protected areas or clusters of protected and nonprotected areas). However, it also demands considerable planning and coordination capacity at the local level that, for now, is missing.

Lao PDR

Accidents of geography have endowed the Lao PDR with unusually rich biological diversity. The country is highly mountainous, which creates wide variations in climate, soils, and ecological niches, leading to locally adapted and diverse biota.

Primary forest provides a substantial natural habitat for a wide variety of flora and fauna. Some 9,000 to 10,000

species of mammals, reptiles, amphibians, birds, freshwater fish, butterflies, and vascular plants are believed to inhabit the forested areas. According to the International Union for the Conservation of Nature (IUCN) in Southeast Asia, the Lao PDR is second to Cambodia in species density, and ranks fourth, after Thailand, Myanmar, and Viet Nam in species endemism. The Lao PDR has been identified as home to 25 species of endangered mammals and birds. The Kouprey and the Javan rhinoceros, both among the most seriously threatened large mammals in the world, are thought to survive in the southern part of the country. Wetland surveys reveal that some of the country's more than 25 wetland areas support populations of endangered species such as the Siamese crocodile (*Crocodylus siamensis*) and the eastern form of the Sarus Crane (*Grus antigone*) (Claridge 1993).

In terms of faunal biodiversity, the *Wildlife in the Lao PDR: 1999 Status Report* (Duckworth, *et. al.*) produced by IUCN, Wildlife Conservation Society (WCS), and the Center for Protected Areas and Watershed Management (CPAWN), states that a total of 319 out of 1,140 species included in the review are of national or global conservation significance: 67 percent of the large mammals, 53 percent of the bats, 6 percent of the insectivora, 14 percent of the murid rodents, 22 percent of the birds, 25 percent of the reptiles, and 2 percent of the amphibians.

Biodiversity conservation efforts are of recent origin in the Lao PDR. The CPAWN was established by DOF in 1986 to undertake surveys of wildlife and their habitats. Recognition of the program by the National Forestry Action Plan prepared in 1990-1991 enhanced the CPAWN's importance as part of the forestry management and conservation program implemented during the 1990s. Field studies operated through the CPAWN helped to identify the best remaining forest areas and wildlife populations, and also led to the discovery of several new species of mammals during the 1990s, such as the saola and large-antlered muntjac.

Protected areas system

Biodiversity is being protected through the establishment of 20 protected areas (referred to by most people in DOF as National Biodiversity Conservation Areas—NBCAs) based on criteria developed by the IUCN, comprising 12-14 percent of the land area, of which 12 areas currently are receiving international funding support. An integrated conservation and development (ICAD) approach is being used to manage several of the protected areas—an approach that is reported to be frequently in conflict with government policies. The ICAD approach is being implemented as a pilot under the World Bank/

Global Environment Facility (WB/GEF) project in four protected areas. Donor funding is being used to support preparation of protected area management plans, technical assistance, rapid biodiversity appraisal, zoning of protected areas (including land use classification), training of DOF protected areas management staff, and infrastructure and civil works.

In addition to the centrally designated protected areas, large areas have been designated as protection or conservation forests at the provincial and district levels, some of which will be upgraded to official protected area status in the future. Together, the protected areas and the provincial and district conservation and protection forests cover 8 million ha or 76 percent of the land in the forestry sector.

Sustainability of the protected area system: Assessment and adaptability

Almost all of the Lao protected areas have had some form of faunal biodiversity assessment over the past six years (that is, in addition to the original survey work that identified priority areas pre-1993). However, there is still a major information gap in relation to knowledge of the detailed botanical aspects of biodiversity, not only in the NBCAs but also throughout the country in general. The most recent botanical overview of the country dates to 1960. Enhanced knowledge through further biodiversity assessments will assist management of individual protected areas and also contribute to refinement of the system. There is already sufficient knowledge of some areas, such as Nam Et NBCA in Houaphan Province, to indicate that there may be justification in reducing the size of the areas. Conversely, in other areas it may be necessary to expand existing boundaries as a result of further survey work or other factors. However, if the viability of the Government's biodiversity conservation strategy (yet to be comprehensively defined in the forthcoming Biodiversity Strategy and Action Plan) is to be maintained, other mechanisms need to be considered.

Where NBCAs are identified for potential expansion because of biodiversity factors, other mechanisms should also be considered. These include declaration of biological "corridors" as well as "biosphere reserves." The biological corridor concept is particularly important to conserve stretches of habitat between NBCAs, enabling movement of wildlife from one area to another. This approach has been recommended by IUCN in the case of Nakai-Nam NBCA (1997/98), with corridors linking Phou Hin Boun (Khammouane Limestone) and Hin Nam No NBCAs in Khammouane Province. In

general, there is considerable potential for the formation of corridors not only between NBCAs but also between NBCAs and provincial conservation forests, and to recognize provincial reserves as the second tier of the national protected area system. With respect to biosphere reserves, there is certainly scope for their creation in some parts of the Lao PDR, potentially linked to establishing of Natural World Heritage Sites. Likely candidates include the Nakai-Nam Theun-Phou Hin Boun-Hin Nam No NBCA complex in Khammouane Province, and the Xe Pian NBCA-Siphandon Wetlands-Dong Kanthung complex in Champassak Province. However, the national capacity to implement even basic planning and resource management is extremely limited. Long-term capacity developments will therefore have to go "hand-in-hand" with other protected area support initiatives.

Although many of the ethnic groups in the Lao PDR have traditionally used and exploited the biological resources that surround them, the increasing intensity of exploitation in recent decades is having a severe impact on the country's biodiversity, especially the faunal diversity. Instances of traditional conservation resource management can still be found (e.g., protection or prohibition on consumption of certain species, maintenance of sacred forests) and people are aware of a decline in previously abundant resources.

Protected areas, or NBCAs, did not exist prior to October 1993. The communities in the areas declared under Prime Minister's Decree 164 suddenly were living in areas where restrictions on many of their livelihood practices would have to become the norm: clearing of forest and hunting of protected species. Unlike protected areas in many countries, there is no involuntary resettlement of communities in the Lao PDR. There is recognition that sustainable use of specific natural resources can continue and that people from these communities can and should participate in managing the NBCAs. There remains a very large gap between these principles and reality—largely because of the impoverishment of the people on the one hand, and the inability of the Government at central and provincial levels to deliver the kind of development support that is required, on the other. However, forging the links between conservation objectives and local development needs and mechanisms is one of the most challenging aspects of biodiversity conservation in the Lao PDR. All donor and multilateral projects have highlighted the long-term requirements of biodiversity conservation through protected area establishment and management, training of protected area staff, and modest development support to specific NBCAs.

Constraints to biodiversity protection

The Lao PDR has until recently been sheltered from many of the forces acting to reduce biodiversity. Examples of these forces include improved commercial rice varieties, commercial logging that destroys habitat, large-scale resource development, and agro-industry. However, as the economy of the Lao PDR opens up to the outside world, all this is beginning to change rapidly, and threats to the country's biodiversity resources are emerging. Specific constraints to the protection of biodiversity in the Lao PDR include the following:

Forest management

The Government has taken steps to enforce controls to conserve forestry resources. However, anecdotal evidence and observation in various parts of the country suggest that government policy and regulations are difficult to enforce. Decentralization of power to provincial governments and the semi-autonomous operations of regional military development companies make communication of policy and enforcement of regulations by central authorities difficult.

As one of the last countries in Asia with substantial reserves of high value timber, the Lao PDR is attracting considerable interest from other countries in the region, in particular Republic of Korea, Malaysia, Taipei, China, Thailand, and Viet Nam. Large, well-financed companies from some of these countries are granted timber concessions without demonstrating the ability or willingness to ensure that sound forest management is implemented, such as effective codes of logging practice; and that land use planning is used in resource allocation.

Agricultural impacts

Impacts of agricultural land use on biodiversity result from a number of often interrelated factors: changing patterns of traditional land and resource use, subsistence and income supplementation by farmers through use of NTFPs, and commercialization of agriculture. Until recently the Government had committed itself to a policy of ending shifting cultivation by the year 2000; however, the time frame to achieve this objective was clearly unrealistic and a moderated approach is being considered to dealing with the issue. Most recently the Government has indicated that the year 2020 is a more realistic target date (DOF officials, as quoted, July 1999).

The implication for conservation could be a greater impact on natural resources adjacent to the settlement areas as families both intensify and broaden their harvest of forest and wetland products to raise

income to supplement their rice production and replace NTFPs, or for direct alternative subsistence purposes. Where this occurs near or within protected areas, the integrity of the areas' conservation values will be severely compromised.

Large-scale agroforestry investments by foreign firms have also resulted in the clearing of several hundred hectares of secondary forests on the Bolovens Plateau in Champassak near Paksong outside the protected area. Large-scale activity of this nature that alienates local communities from their traditional resources is likely to increase pressure on the resources of nearby conservation forests.

Agricultural pesticide use will have an increasing impact on natural systems unless controls are enforced. Although banned in the Lao PDR, the organophosphate methyl parathion is produced in Thailand and sold illegally in the Lao PDR to farmers and villagers (I. Baird, personal communication to Claridge). DDT is also used by rice farmers (Claridge 1996). These toxic chemicals are not only used, with a lack of training and protection, on crops but also to poison aquatic resources as a harvesting method. In many villages cropland is physically adjacent to or linked through food chains to water resources, forests, and other natural ecosystems (especially wetlands), so the continuing use of these chemicals poses a serious threat to biodiversity values as well as human health.

Hunting and wild products harvesting and trade

Despite the retention of extensive forest habitat and the discovery of new species of large mammals, biological resources generally are under threat, and wildlife in particular is subject to intense pressure even with a relatively low overall human population density. There is a long tradition of hunting in the Lao PDR, and rural communities are also dependent on hunting and harvesting of wild products to supplement seasonal rice harvests, especially those communities dependent upon the vagaries of climate to support upland rice production. There seem to be few if any tax of wild vertebrates not used by at least some (and in many cases, many) ethnic groups, be it for food, medicine or in trade.

Commercialization and trade in wildlife products has also increased as prices have risen and access to previously remote areas improved. Wildlife survey teams that come to the Lao PDR are, unfortunately, always impressed by the paucity of wildlife in otherwise apparently intact forests.

Wetlands

Wetlands in the Lao PDR play an extremely important role in the subsistence and commercial economy of the country. Although wetland resources are important in all parts of the Lao PDR, including the mountain rivers and streams, it is in the lowlands where their value is particularly high, since much of the lowland forests have been cleared for agricultural use. As with NTFPs in forested areas, the availability of wetland resources provides an important social security or welfare mechanism in times of rice deficit as well as an ongoing source of plant products and protein (fish, crustaceans, turtles, frogs, and insects). The biodiversity of wetlands plays a critical role in supporting human development. As well as biological values, wetlands also have essential roles in transportation, flood amelioration, hydropower generation, and provision of potable water. For this reason the management of wetlands is usually complex and subject to the involvement of a number of government sectoral agencies as well as local communities. Wetland conservation efforts have included cooperative management arrangements with local people, such as the approach being implemented by the Lao Community Fisheries and Dolphin Protection Project in Khong District in Champassak Province (Baird 1996).

The biological resources of wetlands come under the same kinds of pressure as terrestrial resources, to which they are usually ecologically linked. Claridge (1998) reports a number of critical issues affecting wetlands and the resources that they support:

- unsustainable fishing practices—use of gill nets, blast fishing, fishing with poisons, pumping out of wetlands (a move away from traditional practices in small wetlands to use of large irrigation pumps in large wetland areas), inappropriate use of wing traps, impacts on migratory fish species;
 - introduction of exotic fish species (carp and *Tilapia*) into natural wetlands;
 - hunting of wildlife and migratory waterbirds;
 - trading in wetland wildlife (turtles, tortoises, native fish species, Siamese Crocodiles) with Thailand and Viet Nam acting as both pipelines for other countries, including PRC, as well as directly absorbing some of the trade itself;
 - the impact of dams, for example: drying out of overflow wetlands which are important fish breeding and nursery areas, decrease in or loss of fish stocks through blocking migration or changing water quality, possibility of increased vector-borne diseases such as malaria and liver fluke, impacts on rice production;
- weed infestation, such as the large-scale invasion by *Mimosa pigra* in Savannakhet;
 - abuse of DDT, methyl parathion, and other pesticides, including their use as tool for harvesting aquatic fauna;
 - the increasing threat of pollution as more industrial development is established in the Lao PDR, especially in major urban centers along the Mekong River, and inadequate water quality standards implemented, if they are implemented at all;
 - a range of concerns related to irrigation projects, including: soil-related physio-chemical issues (salinization, alkalinization, water logging, sedimentation, and erosion); loss of fauna and flora in wetlands deprived of water by irrigation reservoirs; impacts resulting from the use of agrochemicals associated with the production of irrigated crops; and socioeconomic aspects, such as relocation of people in or out of affected areas;
 - increasing sedimentation of rivers, streams, and reservoirs, with poor forestry practices associated with commercial logging and slash-and-burn agriculture the most likely cause.

Fish and other aquatic resources

The Government acknowledges the importance of fish as the primary source of protein in the diet of the Lao people, particularly in rural areas. The annual consumption of aquatic animal protein was estimated in the mid-1980s to be approximately 10 kg per capita. The ecosystems of the wetlands of the Mekong River Basin are very productive, providing wide-scale fisheries and many other aquatic flora and fauna, and also supporting populations of rare and endangered species of waterfowl, mammals, fish, reptiles, and amphibians. Mekong River Commission (MRC) studies indicate that the basin's wetlands provide critical habitats for many endemic fish and other wildlife species, making their protection a key issue in biodiversity maintenance. A Living Aquatic Resources Research Center (LARREC) has been established in Vientiane with Danish Government support, under the National Agricultural and Forestry Research Institute, to further basic research initiated by the MRC on the identification of fish resources of the Lao PDR.

Preliminary studies suggest that many or most of the mountain tributaries of the Mekong River contain their own endemic fish fauna that could be endangered by logging operations and hydropower development. There is anecdotal evidence that fish catches are declining. The most common explanations offered by villagers for depletion of fisheries include: (i) overfishing, due to

increasing numbers of visitors from urban centers; (ii) changes in river flow, caused by watershed deforestation and an increase in obstructions for small-scale irrigation schemes; and (iii) reduced water quality (usually increased turbidity), attributed mostly to the introduction of upland cash crops and road-building projects. No scientific data appear to be available to confirm catch reductions or alleged causes, but the allegations appear to be reasonable (MAFF 1999).

The Nam Ngum is one of the major tributaries of the Mekong River. Construction of the Nam Ngum 1 hydropower project blocked the migration of native fish species and the subsequent reservoir has been stocked regularly with freshwater fish species. A total of 130 species have been recorded in the Nam Ngum reservoir that annually yields an estimated 1.4 million tons of fish, of which some 800,000 tons are commercially marketed, generating a cash value of \$800,000. Biodiversity studies in the Nam Ngum 2 and 3 hydropower sites have recorded 19 species of indigenous river fish fauna in the Nam Ngum River north of the reservoir. Of this number, seven species have been frequently recorded. Construction of the Nam Ngum 2 and 3 hydropower projects will further impact on natural fish migration and adversely affect species density and distribution. The greatest potential for fisheries development in the Nam Ngum watershed following hydropower development will be through aquaculture, primarily in the upper watershed. (Lao Agricultural Strategy Study, ADB 1999).

Thailand

Thailand straddles the land gate linking the Asian continent and the Indo-Malayan biogeographical regions, and itself contains 15 distinctive terrestrial biomes as well as a diversity of freshwater and marine habitats, so it is richly endowed with flora and fauna species. Seventeen different ecosystems, including mountain forests, limestone forests, peat swamps, teak, bamboo, and mangrove forests are found in Thailand. These habitats contain an estimated 10,000-13,000 vascular plants and 86,000 animal species, of which 5,000 are vertebrates.

Given the tremendous changes in use of land, coastal, and water resources—including the loss of two-thirds of forest cover in just 40 years—significant loss of species diversity and quantity is inevitable. A number of endemic species—species that occur nowhere else in the world—have already become extinct, including three species of shrimp, one fish, one reptile, eight birds, and two mammals. Some 100 species of plants are considered endangered, 600 rare, and 300 vulnerable. Endangered species

of animals include 20 freshwater and 9 marine fishes, 2 amphibians, 10 reptiles, 39 birds, and 39 mammals (MOSTE 1992). RFD has taken measures to conserve the biodiversity by establishing protected areas. Two acts have formed the basis of Thailand's conservation strategy: the Wild Animals Reservation and Protection Act of 1960, and the National Park Act, 1961 (TDR 1995). The first national park was established in 1962 under the Act in 1961 and presently there are 77 national parks covering an area of 39,283 sq km.

Viet Nam

While covering less than one percent of the earth's surface, 10 percent of the world's mammal, bird, and fish species are found in Viet Nam. Forty percent of the 12,000 local plant species are endemic. Viet Nam's forests contain the highest avian and primate diversity in mainland Southeast Asia. The recent discovery of four new species of large mammals in the provinces of Nghe An and Quang Binh reinforce the global significance of the country's rich biodiversity; only three other new mammal species have been discovered on the earth this century.

While the country's species diversity is exceptional at around 23,000 terrestrial and aquatic species in all, so, too, is the rate of species and habitat loss, currently the highest in the region. Of all of Viet Nam's endemic species, 28 percent of mammals, 10 percent of birds, and 21 percent of reptile and amphibian species are endangered (GOV 1994). Species loss is an indicator of overall degradation of ecosystem and genetic diversity.

Deforestation is the main cause of biodiversity loss in Viet Nam

As forest habitats are degraded, the complex fabric of species associations that they support unravels to the point where the decline of many species to extinction becomes irreversible.

While most forest types have experienced significant decline in area, some of the less well represented types have suffered particularly severe losses. For example, Melaleuca forests have lost 72 percent of their 1976 area (Table 7). Mangrove forests have diminished by 63 percent over the same period. Already, for some terrestrial and aquatic species, this extent of habitat loss and other continuing pressures of exploitation are the end.

Threats to biodiversity include agricultural encroachment on natural forests, logging, hunting, and fishing, the collection of nontimber forest products (fuelwood collection, for example, is the main threat to biodiversity in many forest areas), inappropriate land uses, pollution,

Table 7. Changes in Forest Cover of Main Forest Types from 1976-1995 (Unit: 1,000 ha)

Type of forest	1976	Year		Increase/Decrease		
		1990	1995	1976-90	1991-95	1976-95
Natural forests	11,108	8,431	8,252	-2,677	-178	-2,855
Evergreen broad-leaf and semi-deciduous forests	8,331	5,759	5,649	-2,573	-111	-2,682
Deciduous forests	796	847	935	+51	+88	+14
Conifer forests	181	135	155	-46	+20	-26
Mangrove forests	91	73	35	-18	-39	-57
Melaleuca on sulphate soils	48	34	14	-14	-20	-34
Bamboo forests	1,174	1,048	846	-126	-202	-328
Mixed woody & bamboo forests	429	499	619	+70	+120	+190
Orchard forests	27	35	1	+8	-34	-26
Planted forests	93	745	1,050	+652	+305	+957

Source: FIPI (1995). (-): decrease, (+): increase

and trade in wildlife. The devastating effects of wildlife trade are only beginning to be appreciated. In one year to June 1977, the Government reported that 69,000 animals of different species were sold in Viet Nam or abroad. That record of confiscation represents only 5-10 percent of the total trade, indicating more than 700,000 individual animals being taken from their natural environment each year (UNDP/MPI 1999).

A wide variety of endemic agricultural species of plants and animals are threatened through shifts to monoculture. Farming on land better suited for other purposes is one of the most serious growing threats to biodiversity, for example, shrimp ponds in mangroves; rice cultivation in highly acid sulfate soils and wetland systems; and upland crops on steep watersheds or biodiversity rich forests.

Declining economic benefits from biodiversity

About 5,000 plant and 1,000 fauna species in Viet Nam have economic uses. The wider gene pool is also of great economic value and has the potential to make a more important contribution through research and production of medicines, essential oils derived from plants, and other products. Yet, biodiversity contributes most to the nation's economic development through "free ecosystem services," including watershed, soil and coastal protection, climate and water regulation, environmental stability, and carbon sequestration.

All those existing or potential economic benefits of biodiversity resources are declining, most before their full value has been appreciated.

The three main government initiatives to safeguard biodiversity resources are:

- *better forest management*: reforesting and rehabilitating forestland to reestablish its economic and ecological functions;
- *better water management*: introducing integrated planning structures and approaches to watershed management; and
- *better management of protected areas*: identifying important terrestrial, coastal, and wetland ecosystems to be protected.

Policies relating to the first two measures were outlined in previous sections. In each of these two sectors—forests and water-effective management of protected areas and their buffer zones is of mounting importance to the maintenance and sustainable use of biodiversity resources.

Protected areas

In 1997, the Government undertook to increase the number of terrestrial protected areas from 87 to 101 and to increase the size of most units. This initiative would increase the total area from 1.1 to 2.2 million hectares, amounting to 6 percent of the country. A tentative list of the 101 proposed protected areas is under review, including the closure of 21 existing areas that are considered to retain few biodiversity values, and the expansion of more than 60 others of significance.

Viet Nam has made progress in protected area management. Management boards have been established for 10 national parks and, over the past 10 years, management plans for parks have increased from 20 to 44. Once a plan is prepared, a government budget is allocated for implementation. Staffing of protected areas has increased and, since 1994, more than 900 rangers have received training. Three training centers have been established

for the purpose. Biodiversity assessments have been undertaken for 11 national parks and more than 40 other protected areas, and reviews of Viet Nam's threatened and endangered species have led to the publication of species Red Books as an essential framework of indicators for monitoring the health of the country's natural systems (IUCN/MOSTE 1999).

Despite these investments, most protected areas are under increasing pressure from illegal forest exploitation—encroachment, logging, grazing, and non-timber products gathering. Biodiversity is declining in all parks due to heavy human use.

Biodiversity regions

When so much needs to be done with few resources, strict priorities must be set. On the recommendation of the 1994 Biodiversity Action Plan, the UNDP/MPI 1999 review of aid to the environment facilitated a process to define biodiversity regions throughout the country, then to set priorities for action within each region and between regions according to agreed criteria.

Based on original vegetation cover, species composition and distribution, and a number of other biophysical characteristics, 19 biodiversity regions—10 terrestrial and 9 coastal and marine, were identified. Regions in most urgent need of conservation action were selected according to

- level of biodiversity wealth,
- level of threats to conservation of biodiversity resources, and
- feasibility of taking conservation actions (including time frame and resources required).

In order of priority, the four top ranking terrestrial biodiversity regions that require attention from Government (as described in the UNDP/MPI 1999 review) are the following:

North Central. A typical feature of the region is the long but narrow band between Truong Son range and the sea. Rich forest still covers a long strip of Truong Son range, near the Lao border. The varied relief explains the rich biodiversity of the region. A number of endemic and endangered species, such as Blue pheasant with white tail *Lophura hatinhensis* and Hatinh monkey *Trachypithecus francoisi hatinhensis* are found in the region. Over the past five years, two new mammal species, sao la *Pseudoryx nghetinhensis* and the large muntjac *Megamunticus vuquangensis* have also been discovered in the region.

Plateau Tay Nguyen. The region lies at the Indochinese junction between Viet Nam, the Lao PDR, and Cambodia and is biodiversity-rich. In the region can

be found many large mammals including elephant, tiger, panther, wild buffalo, and kouprey and rare plant species, for example, Ginseng, Ngoc Linh, and the Dipterocarpaceae.

Northeast. The region's diverse ecosystems range from limestone mountains to low hills and narrow coastal plains and includes many picturesque sites of important heritage value: Ha Long Bay area, Cat Ba Island, and Ba Ba Lake area. Fauna and flora of the region are very rich. A number of rare endemic species exist only here, such as musk deer *Moschus caobanghensis* and snub-nose monkey *Trachypithecus avunculus*. Forest cover was once around 50 percent but has been seriously depleted due to shifting agriculture and illegal logging.

Northwest. Although not extensive, the forests of this region represent well-defined ecosystems at different altitudes. Biodiversity has been seriously depleted but 38 rare animal species and some precious plant species such as ginseng and *Fokienia hodginsii* remain.

The two biodiversity regions given highest priority for action fall within Viet Nam's central economic region.

Institutional constraints

In the 1998 review of the Biodiversity Action Plan, the Ministry of Planning and Investment reported "a considerable gap between awareness and action. This can be attributed partially to a lack of coordination and unified action and management on biodiversity conservation issues. Conceptually, ecologically sustainable development and biodiversity conservation have not been integrated into sectoral economic development plans and are considered only in a fragmentary manner. Scientific research is often unrelated to investment and policy making (and vice versa), and additionally, environmental issues are often the last consideration in investment decisions. Typically, this results in environmental issues being manifested as problems after the decisions have been made" (IUCN/MOSTE 1999).

Water Resources

Cambodia

Tonle Sap and fisheries

Water and its use define Cambodia: the Mekong River, the Tonle Sap River, and the Tonle Sap lake support agriculture, fisheries, and transportation. Besides being the largest permanent freshwater lake in Southeast Asia, the Great Lake (or Beung Tonle Sap in Khmer) plays crucial economic and environmental roles in Cambodia and

beyond.³ In a unique fashion, the lake is connected to the Mekong River and the ecosystem of the Mekong basin. The Tonle Sap River, about 120 km long, provides the physical link. Through it, the lake receives water during the Mekong's high flow and, conversely, returns water into the Mekong once its flow recedes. The same link is vital to the migration of fish. Fish migrations from the Tonle Sap into the Mekong River help restock fisheries as far upstream as Yunan Province in the PRC and many tributary rivers along the way (Dennis and Woodsworth 1992). During the rainy season, the Mekong is estimated to supply approximately two thirds of the lake's total volume, the balance being supplied by other rivers that flow into the lake from a total drainage area of about 67,000 sq km. Because of the flat topography of the area, fluctuations in the volume of water stored in the lake result in large variations of the flooded surface area (from about 2,600 sq km during the dry season to 9,000-14,000 sq km during the rainy season). The area, temporarily flooded, and its management is at the heart of attempts to safeguard the lake and its productivity as explained below.

Although estimates of the Tonle Sap fish catch are surprisingly inaccurate and conflicting—varying from less than 40,000 tons per annum to a figure twice as large, the difference accounted for mainly by undeclared catch by small fishermen—it is widely believed that the lake provides about two thirds of fish consumed in Cambodia (see Table 8). About a million people (15 percent of Cambodia's population), are said to depend on the lake's fisheries for their livelihood (Savath and Chanrithy 1999). The lake provides much more than fish; it is a reservoir of biological diversity that includes—besides fish species—birds and a number of wild animals. Many migratory species move back and forth within the Mekong-Tonle Sap floodplain. This makes the management of Tonle Sap an issue of regional as well as national importance. The lake has the status of an international biosphere reserve.

The areas periodically flooded play a key role in maintaining and renewing the lake's productivity.⁴ Traditionally under forest, inundated during the rainy season, and exposed during the rest of the year, these areas are the breeding and feeding habitat for fish and other forms of life. The productivity of the lake is among the highest in the world due to a combination of high water temperature, annual flooding, and the supporting role of the inundated forest in stimulating the development of micro-organisms and phyto- and zooplankton. A significant loss of the inundated forest is, therefore, a direct threat to the lake's productivity.

Table 8: Selected Estimates of Cambodia's Freshwater Fisheries

Year	Total Inland Catch (tons)	Source	Registered Tonle Sap Catch (tons)
1940	120,000	Chevey and Le Poulin (1949)	n.a.
1957	130,000	Bardach (1959)	n.a.
1960	138,000	Department of Fisheries	n.a.
1970	100,000	Department of Fisheries	n.a.
1982	66,000	Department of Fisheries	40,070
1991	75,000	Department of Fisheries	41,200
1994	65,000	Department of Fisheries	38,550
1998	111,000	Van Zalinge (1997)	n.a.
	200,000	FAO/MRC informal estimates	

Source: Savath and Chanrithy (1999), NEAP (1998), FAO/MRC (1998).

Fishing in the lake and the management of the entire inundated area are regulated by the Department of Fisheries (DOF) under the Ministry of Agriculture, Forestry and Fisheries (MAFF). Since Royal Decree 126 in 1993, the whole of the Tonle Sap has been designated as a marine protected area. Fishing in the lake is seasonal (from October to May) and regulated. Table 9 shows the three main management categories.

Review of main management and policy issues

The inundated forests have come under increasing seasonal pressure in recent years for at least three different reasons. First, the demand for fuelwood for households and artisan production, especially bricks, has continued to grow. Second, the riparian communities, traditionally dependent on fishing, have been increasingly marginalized as areas of open access have diminished at the expense of fishing-lot operations. Third, the absence of income-earning opportunities in areas away from the lake has been at the root of increasing seasonal migration towards the lake and conversion of inundated forest to farming. Apart from the loss of forest cover, so vital to maintaining the productivity of Tonle Sap, the

³The link of the Tonle Sap with the World Heritage site of Angkor are well beyond the scope of this report. Nevertheless, two points may be of relevance: First, the Tonle Sap has a significant eco-tourism potential because it complements the Angkor complex. Second, integrated management of the Angkor complex has proven possible, with the creation of APSARA Foundation and the adoption of a Government-endorsed zoning plan. UNESCO acts as a secretariat of the International Committee for the Safeguard of Angkor. The legislative and regulatory coordination experience in the case of Angkor is directly relevant to future efforts to manage the Tonle Sap in an integrated manner.

⁴The annual flooding of the Tonle Sap area is the most remarkable among the more general occurrence of annual flooding in many other parts of Cambodia. The total area of permanent wetlands in Cambodia and areas annually flooded exceeds 3 million hectares. Wetlands management in areas other than Tonle Sap is clearly important. Several organizations are involved in various aspects of wetlands management.

Table 9: Current System of Fisheries Management in the Tonle Sap Area

Category of Fishing Operators	Area Where Fishing Allowed	Condition of Access
Large scale (industrial)	Within designated fishing concessions	License required Two-year permits allocated via auction
Medium scale (artisanal)	Mainly in open access areas; Also in demarcated areas	License required Certain administratively determined taxes payable
Small scale (family)	In open access areas only	Unregulated

spread of farming in the inundated forest zone has brought with it a serious risk of fertilizer and pesticide runoff that could devastate the lake's fishing potential.

By contrast, the sedimentation of the lake, often at the forefront of public discussion, is largely the result of seasonal flows of the Mekong and therefore outside the control of Cambodian authorities. There is even continued uncertainty about the rate of sedimentation and its changes. Despite occasional calls for dredging of portions of the lake or the Tonle Sap River, most technicians agree that such an approach would not be effective, let alone efficient. While subregional dialogue addressing the much bigger issue of basin-wide rate of soil erosion must continue, the answers to the Tonle Sap management challenge lie in domestic and local policies.⁵

A number of initiatives have been undertaken to coordinate and integrate approaches to the management of Tonle Sap. Notable among them is the creation of the Tonle Sap Coordination Unit within the Ministry of Environment (MOE) and the formulation of the National Wetlands Action Plan by the Ministry of Agriculture, Forestry and Fisheries (MAFF) and MOE. Several initiatives assisted by funding agencies, notably by the Food and Agriculture Organization (FAO),⁶ have aimed at safeguarding the inundated forest zone by a combination of measures that include forest regeneration, controlled farming, and a more secure access of lakeshore communities to fishing. Institutional conflict, mainly involving MAFF and MOE, remain, however. Absence of a decision-making body pursuing a consistent approach to the management of the lake's resources is among the chief drawbacks.

Notably missing from the policy and investment initiatives around Tonle Sap has been the fisheries' regulatory framework and practices. Although the policy of extending areas under commercial management has

much to recommending it in efficiency terms, there are doubts about how truly competitive the auction process, used to allocate fishing lots, has been. With the annual value of the fisheries output placed at between \$100-\$200 million, potential losses of revenue for the Government could be very large. Information is insufficient on several important aspects of revenue collection by the Fisheries Department. Also, limited official attention has been given to the wider ramifications of an emphasis on revenue generation, in particular on the link between reduced access to family fishing enterprises and the livelihood patterns around the lake. Finally, there is evidence that harmful fishing practices are increasingly used by both large and small operators (RGC 1996b).

Irrigation and catchment management

The country's history is intimately related to the development of irrigation and remains a central concern to this day. While water resource planning and utilization is of major national concern, more recently, water use in Cambodia has acquired a subregional dimension as certain water utilization schemes, having basin-wide repercussions, require unanimous approval of the member countries of the MRC. The sector, especially its rural component (both irrigation and non-irrigation), has seen major involvement by NGOs in the 1990s complementing, and in many cases pointing to the directions for activities of development agencies.

ADB has been involved in Cambodia's water resources, right from the resumption of lending in 1992. Among other things, a Special Rehabilitation Assistance Loan addressed the most pressing among irrigation subsector rehabilitation needs. A water sector and irrigation review was undertaken as part of the 1993 Technical Assistance Review of Agricultural Development Options. In the same year, an assessment was undertaken of water supply and sanitation needs. Since then, investment projects in urban environmental improvement (heavily focused on water), community irrigation rehabilitation, and water resource development have been formulated under a project preparatory technical assistance (TA). An advisory TA is under preparation for institutional support for water resource management. Taken together, these initiatives add up to a substantial sectoral portfolio that requires certain unifying themes and a review of broader water resource utilization issues and rural aspects of water use.

⁵ A case in point is the runoff from gem-mining operations in Pailin, Samlot, and Tasang that ultimately ends up in the lake.

⁶ Participatory Natural Resource Management in the Tonle Sap Region, Project GCP/CMB/002/BEL, initiated in 1995.

ADB-commissioned⁷ and other studies⁸ present the following broad picture: In 1993, there were 920 irrigation schemes in Cambodia covering a total of 310,000 ha. The area has expanded somewhat since then. Most new irrigation projects (storage systems and canals) are considered not economically viable and are of interest only in the longer term when other lower cost means of increasing agricultural output have been exhausted. Possible exceptions are Stung Mongkol Borey, Stung Chinit, and Prek Thnot. Rehabilitation of existing systems is more attractive. Low-lift pumps and shallow tubewells, and individual rather than collective management are seen by many as the best irrigation solution for many years. In a number of cases, the legacy of technically unsound irrigation structures built during 1975-1979 has increased the cost of rehabilitation. While rehabilitation remains preferable to expansion of capacity, an even greater need is to ensure that existing facilities are well managed and maintained. This requires a fundamental change of approach, explicit targets for financial management, and creation of viable user groups.

Information regarding groundwater resources remains inadequate and views conflicting. Some assessments (e.g., ADB 1993) argue that no groundwater sources of sufficient potential for large-scale irrigation exist while other reports (e.g., FAO 1999) take a much more optimistic view of the groundwater potential. The environmental repercussions of the spontaneous emergence of groundwater extraction for irrigation in parts of Cambodia (e.g., Battambang) have not been assessed.

There is a critical need for a water resource development plan that would set the framework for the optimal use of water resources and reconcile possible conflicts of interest. With the creation of the Ministry of Water Resources and Meteorology (MOWREM) in 1998, a single agency now exists that is expected to become responsible for the preparation of a national long-term water resource development plan. Apart from its planning and resource allocation value, the availability of such a document would strengthen the position of the Cambodian National Mekong Committee vis-à-vis those of the other riparian countries in discussions over basin-wide development priorities.

The technical and supervisory capacity of the Ministry of Agriculture, Forestry and Fisheries (MAFF) to manage and implement irrigation development projects is weak, a weakness magnified by the nonexistence, until now, of cost recovery in irrigation.

That situation is set to change with the expected adoption in 1999 of an irrigation policy subdecree. Implementing the subdecree will be the greatest short-term challenge facing the new MOWREM. This is institutionally complex to implement, with the involvement of several ministries, most notably the Ministry of Industry, Mines and Energy (MIME) in water supply provision and sanitation, the Ministry of Rural Development (MRD) in rural water supply, and the MOE, the latter particularly concerned by an increase in water pollution from nonpoint agricultural sources and its monitoring.

Coordination among funding agencies in the sector has not been adequate. Cambodia has remained unable to profit from potential synergies between the work of MRC and development agencies, as well as see the best lessons of NGO experience incorporated into routine programs of development agencies.

Rural water supply and sanitation

The majority of Cambodians will continue to live in rural areas well into the next century, but their water supply and sanitation needs have attracted only modest funding by development agencies, including ADB. Important work has been undertaken by international NGOs.

Lao PDR

The Lao PDR has Asia's largest per capita volume of renewable water. At 66,000 m³/person, it is 20 times the regional average. Current use of 228 m³/person is only a small fraction of the supply. Agriculture is estimated to consume 82 percent of the total withdrawal, followed by domestic use (10 percent), and the industry sector (8 percent).

Irrigation

By international standards, irrigation schemes in the Lao PDR are small. Six irrigation command areas have a service capacity of 1,000 ha or more. The largest scheme services only 4,500 ha. As of 1997, 15,500 irrigation schemes were operational, with a wet season service capacity of 164,273 ha, or 20 percent of the country's 800,000 ha of land cultivated annually (see Table 10). (Lao Agricultural Strategy Study, ADB 1999).

⁷ See, for instance, *Water Resources and Irrigation*, a component of Phase I of the Agricultural Development Options Review (1994). Although based on the situation at the end of 1993, much of the report retains its relevance.

⁸ A 1994 inventory (by WATCO of the Netherlands) listed 230 studies in the region, and identified 67 of relevance to Cambodia (including those with transboundary implications). See also MRC's *Rehabilitation and Development of the Hydrological Network* (1992) and the UNDP-funded *Irrigation Rehabilitation Study* (1994).

Table 10: Cultivated and Irrigated Areas by Type, 1997

Type of Area	Size of Area (ha)
annually cultivated land	800,000
irrigated area, dry season	44,141
irrigated area, wet season	164,272

Source: Department of Irrigation 1997.

Six types of irrigation systems were identified in the ADB Irrigation Subsector Review (ARCADIS 1998), namely:

Type of Irrigation Scheme	Size
small-scale weirs	less than 100 ha
medium-scale weirs	100 to 1,000 ha
small- to medium-scale reservoirs	100 to 1,000 ha
medium and large reservoirs	greater than 1,000 ha
small-scale pumping	up to 100 ha
medium and large-scale pumping	greater than 100 ha

A breakdown by type of irrigation scheme is found on Table 11, as reported by the Department of Irrigation in 1997.

A breakdown by elevation region, upland versus lowland based on data from 1995, is presented on Table 12. Since 1995, relative percentages have not changed significantly.

The Government's strategy for increasing the number of irrigation command areas is to use gravity and pump schemes to increase water supply and irrigate more land during the dry season (Vissia 1998), and to shift away from large, capital-intensive schemes and move away from government-managed toward farmer-managed systems. ADB support to this strategy is being provided through the Community Managed Irrigation Systems Project and

Table 11: Distribution of Irrigation Command Area by Type of System, 1997

Type of System	No. of Systems	Wet Season Irrigated Area (ha)	Percent of Total Area
Small dam	521	38,957	24
Storage reservoir	263	16,304	9
Pumping	292	46,157	28
Watergate	60	4,325	3
Traditional weir	14,331	57,374	35
Stone weir	33	1,156	1
Total	15,500	164,273	100

Source: Department of Irrigation (1997).

Table 12: Geographic Distribution of Irrigation Command Area, 1995

Geographic Location	Size of Area (ha)	Percent of Total Wet Season Area
Total Irrigated Wet Season Area	150,000	100 percent
Lowland Irrigated Area	27,000	17 percent
Upland Irrigated Area	123,000	83 percent

Source: World Bank (1997)

ADB technical assistance (TA No 1764-LAO), Strengthening and Restructuring of Irrigation Development Project. The objectives of these projects are to assist the Department of Irrigation to improve scheme efficiency, cost recovery, and sustainability. Creation of water user associations and the promulgation of the 1997 Water Resources Law that provides the legal framework for the associations are important steps toward giving these groups financial autonomy, thus enabling them to achieve sustainability (Agriculture Strategy Study, ADB 1998).

Thailand

About 90 percent of Thailand's water use today is for irrigation; domestic use is 7 percent, and industrial just 3.5 percent. From 1980 to 1990, use of water doubled from 20,530 million cubic meters (mm^3) to 43,000 mm^3 , and has nearly doubled again during the 1990s. Despite considerable government investment in development of surface waters, supply has not kept up with demand. By official estimates, 50 percent of all villages lack sufficient water for domestic consumption (*Bangkok Post* 1998); and in the fertile lower Chao Phraya basin, only 35 percent of the irrigable area receives sufficient water for dry season irrigation. In the Bangkok Metropolitan Region (BMR), current groundwater pumping of 1.5 mm^3 per day is nearly double the estimated sustainable yield of 800,000 mm^3 per day from the aquifer. Yet the groundwater is being developed further with government support; in the drought year of 1994 an estimated 50,000 irrigation wells were dug in the lower Chao Phraya basin alone.

The 1993-1994 dry season brought a severe nationwide drought. The water shortage became severe, especially in the central basin where the Chao Phraya and Phitsanulok Irrigation Projects are located. In response, the Royal Irrigation Department (RID) established guidelines to allocate emergency water use within the Chao Phraya basin. Solutions included diverting the flow from Mae Khlong watershed to the Tha Chin river, temporarily closing a dam to prevent saltwater intrusion,

expanding pumping for irrigation, boring shallow wells, and dredging ponds. The situation was alleviated in early 1994, when unseasonal rain occurred in the northern, northeastern, and central regions.

Policy and programs

Water resources administration in Thailand is supervised by eight different ministries, with the National Economic and Social Development (NESDB) responsible for policy formulation and coordination at the national level. The National Water Resources Committee (NWRC) and a Small-Scale Water Resources Development Subcommittee assist NESDB. In 1996, NWRC was established to coordinate water resource management activities. NWRC has drafted a new basic Water Law, which is essentially complete, but has yet to be submitted to the Cabinet for approval. The draft law calls for the establishment of river basin organizations to facilitate management of water within hydrological boundaries of major river basins.

In 1997, the Government completed a comprehensive Chao Phraya Basin Water Management Strategy that supports the early establishment of a Chao Phraya River Basin Organization. Given the dominating significance—and management complexity—of the Chao Phraya, this would necessarily be a broad umbrella organization. There is equal or greater need to establish effective river basin organizations for all the main rivers of the country, including for the Ping, Wang, Yom, and Nan rivers, the major component tributaries of Chao Phraya itself.

Despite the creation of NWRC, there remains a significant overlapping of duties and responsibilities, with agencies frequently competing or simply following their own set of rules and regulations. Often, these mandates are contradictory. For example, the Department of Fisheries (DOF) constructs fishponds in irrigation command areas, including areas prone to salinity, which are managed by the RID. The concentration of fishponds causes underground water tables to rise during the dry season, thus worsening the salinity problem.

Competition and conflicts over water consumption between agriculture, industry, services sectors, and urban and household consumptions are increasing. Water is becoming increasingly scarce, and the Government faces both supply-and-demand side challenges. There is general agreement on the need to promote management at the basin level through increased participation of local users, to protect key watersheds, and to improve collection of water consumption fees based on real costs—and use this revenue for the maintenance and conservation of water resources.

Viet Nam

Viet Nam's water resources are coming under stress, an anomaly, given that on an annual basis it has abundant water. The country receives about 2,000 mm of rain each year, with parts of the central highlands reaching 3,300 mm per annum. The mean annual runoff totals 880 billion m³ and exploitable groundwater is estimated at 6-7 billion m³ a year. Currently, about 36 billion m³, or 90 percent of the total water withdrawals each year goes to agriculture, with 10 billion m³ or 10 percent abstracted to meet municipal and industrial demand (World Bank 1996).

Rainfall is highly variable throughout the year, causing floods, then drought of increasing severity. Rainfall occurs in the six months from May to October, but about 75 percent of the annual flow is generated in 3-4 months with 30 percent in one peak month. Water is abundant in the wet season but is becoming scarcer in the dry season. Water quality is rapidly deteriorating in both rural and urban areas.

Causes of diminishing accessibility and quality of water

Surface water availability is uncertain. The Mekong and Red River carry 75 percent of annual runoff. Yet, more than 90 percent of the Mekong basin lies outside of Viet Nam and 90 percent of its flow is generated outside the country. More than half of the Red River basin lies outside the country and 35 percent of its flow originates in PRC. Water availability in these systems is beyond Viet Nam's control and upstream countries are withdrawing increasing amounts particularly during the dry season (World Bank 1996). Limited domestic storage capacity makes Viet Nam especially susceptible to the water use patterns of others.

Natural water regulation is being lost. Forest and water resources are directly linked in natural systems. The loss of forests disrupts natural processes of water regulation and reduces the water storage capacity of river catchments. More than 50 percent of the seasonal fluctuation in rice production is related to increasingly volatile water flow due to upstream forest loss. More rapid runoff and less water retention results in more pronounced seasonal peaks and troughs in flow. Removal of forest cover in the watersheds of the Ba and Se San basins, for example, has resulted in peak flow rate increases of 45-50 times, and a corresponding soil erosion increase of 100 times (MWR 1994).

Watersheds are degrading. Forest loss, cultivation on steep slopes, and associated soil erosion have wide implications for water quality and availability. Increasing

sedimentation reduces the life of storage reservoirs, raises river and stream beds and increases flooding, reduces water available for irrigation and navigation and reduces the quality and accessibility of water for municipal and industrial uses. It also damages freshwater and marine ecosystems, reducing and eliminating habitat and economic species.

Wetlands are degrading. Water resources and wetlands are inextricably linked. The quality and maintenance of one is essential to the other. Wetlands play a critical role in water regulation. Without them flooding and drought can become more extreme. Without them, quality is lost, with water becoming acid and saline and unsuitable for human use. The ecological well-being of wetland systems underpins a large part of the country's economy. Yet, they are converted to agricultural land or simply ignored in planning processes. They are being polluted by urban expansion, by chemical and fertilizer use from increasingly intensive agricultural practices, and by rapidly increasing industrial development. They are being over-used and disturbed by destructive fishing techniques and cleared for timber and shrimp ponds. Hydroelectric power schemes in upland areas threaten downstream wetland communities by disrupting natural river flow levels.

Water quality is deteriorating. Heavy silt loads reduce water quality for many uses. Soil entering rivers and other water bodies is the most universal cause of diminishing surface water quality in Viet Nam. Untreated sewage is the second most serious pollutant. Throughout Viet Nam, the bulk of human wastes directly or indirectly enter the water stream untreated. This is especially a problem around urban areas where human wastes comprise 70-90 percent total organic load in river systems and water bodies. Industrial pollutants also enter surface and groundwaters untreated and are a problem where there are large plants or industrial concentrations. There has been a trend from organic and degradable industrial wastes to those that are more toxic and persistent. Only five of the industrial zones throughout the country have central wastewater treatment.

Saltwater intrusion is increasing. Another cause of reduced water quality is mounting salinity in some coastal areas, particularly in the south, and around large cities where groundwater is being overused. Salinity becomes worse during dry seasons when there is insufficient flow to prevent backflow of seawater. Strong tides cause intrusion up to 70 km inland and now affect some 2 million ha, damaging crops, limiting other economic uses of water, and degrading wetland ecosystems.

Future water demand will escalate. The pressure on water resources will increase and associated problems

could become serious impediments to development. The situation is becoming worse because of:

Mounting population: Currently growing at about 2 percent yearly, a doubling of the population over the next 35 years will more than treble demand for water due to an increase in per capita income, agricultural intensification, enhanced water and sanitation services, and associated increases in food and energy consumption.

A growing economy: The 1997 growth in real GDP averaged close to 8 percent annually. Despite a drop in 1998, to 3.5 or 5.8 percent due to the Asian financial crisis (depending on the source: UNDP 1999), the outlook over the next few decades remains good for the economy of Viet Nam. Growth in industry and the services sector is expected to range from 7 to 10 percent with the agriculture sector continuing to expand from 2.5 to 3.5 percent. Agriculture will remain the main user of water, but by 2030 its share will drop to 75 percent with industrial and domestic consumption increasing to six times its current rate.

Growing economic importance of the industry sector: Rapid growth in the industry sector requires increased use of natural resources, particularly water as the key resource underlying most industrial activities and as the principal sink for wastes. Increased production, use of energy, and more transportation and other infrastructure services all result in more wastes and more pollution. Already, water pollution is serious throughout Viet Nam, especially in rivers and canals near urban centers. Most industrial wastewater is discharged without proper treatment. Water pollution can affect both ecosystems and human health. Hazardous wastes are generated by the fastest-growing sectors such as steel, electronics, and chemicals. There are no systems in place for the handling, storage, or treatment of hazardous wastes in Viet Nam.

Institutional challenges

The water sector in Viet Nam is characterized by (i) many agencies with a limited mandate; (ii) fragmented planning, development, and management; (iii) a lack of regulation; and (iv) an absence of well-defined responsibilities for water resource management and water service delivery among the agencies concerned. In May 1998, the Government enacted a Water Resources Law to address these problems. The Law establishes specific institutions and instruments for comprehensive water resource management. These include (i) a National Water Resources Council (NWRC) as a high-level advisory body with a role in conflict resolution; (ii) river basin organizations for water resources planning on the basis of river basins; (iii) a system of water allocation through licenses;

(iii) a system of wastewater discharge permits; and (iv) an inspection system for the safety of dams and other hydraulic works (ADB 1999).

Coastal and Marine Resources Management

Cambodia

Current situation

The environment of the coastal areas is the result of a complex interplay of activities in the hinterland affecting coastal rivers, and those along the shore, be they mangrove forests, or beaches, including coral reefs, or seagrass beds. Cambodia's coastal resources and their management have attracted substantial foreign funding, including that by ADB (RETAs 5552 and 5712).

Apart from about 435 km of shoreline, 52 offshore islands can be found in Cambodian waters, most of them uninhabited, some fringed by coral reefs and considered potential tourist or eco-tourism destinations. Cambodia also has remarkable mangrove forests covering nearly 60,000 ha. Despite heavy and indiscriminate logging in the Cardamom Mountains and other adjacent inland areas throughout the 1990s, Cambodia is the sole place in mainland Southeast Asia where tropical forest still reaches all the way to the seashore (as it does in the vicinity of Koh Kong). Coastal wildlife is believed to be still abundant but, despite several years of external technical assistance, still poorly documented. Over one million ha of land within and close to the coast have some degree of protection status (Table 13). The International Union for the Conservation of Nature (IUCN) is assisting the Government in developing a management plan for the Ream National Park. The Australian People for Health, Education and Development Abroad (APHEDA) is funding mangrove replanting in selected villages.

Among the principal environmental problems encountered are increased river and coastal sedimentation linked to logging in hinterland areas (including the Botum Sakor, Ream, and Bokor National Parks), and persistent pressure on coastal mangroves as a source of charcoal, or poorly regulated sites for shrimp aquaculture or salt farming. Significant beach pollution occurs in the vicinity of Sihanoukville and Kep, both important tourist destinations. The conditions of coral reefs and seagrass beds are only partly known. Dynamite fishing is practiced on an undetermined scale. There are, for now, few industries for industrial pollution to be of major concern, but this situation could rapidly

Table 13: Protected Areas within or Affecting Cambodia's Coastal Zones

Type of Protected Area	Location (ha)	Province	Area
National Park	Kirirom	Koh Kong	35,000
	Botum Sakor	Koh Kong	171,250
	Phnom Bokor	Kampot	140,000
	Kep	Kampot	5,000
	Ream	Kampot	150,000W
Wildlife Sanctuary	Phnom Aural	Koh Kong	253,750
	Peam Krasaop	Koh Kong	23,750
	Phnom Samkos	Koh Kong	333,750
	Multiple Use Area	Dong Peng Koh Kong	27,700

Source: Adapted from RGC (1998b).

change. Oil and gas exploration in the offshore areas has recently started, without fanfare but in earnest.

The problem of depletion of coastal fisheries is complex, partly because it is linked to illegal fishing by foreign boats.⁹ In general, the productivity of Cambodian coastal waters is believed to be in the decline, especially in terms of output per unit of effort (RGC, 1998), and at least one foreign-financed fish-processing plant is said to have closed on account of insufficient catch. However, a generally weak infrastructure (roads, refrigeration facilities, etc.) is undoubtedly a contributing factor. Not unlike logging in the mid-1990s, the fisheries sector is characterized by a large number of illegal operators and illegal operating practices.¹⁰ As in most other parts of Southeast Asia, small-scale fishing is increasingly being threatened by larger-scale operators.

Even more than in the case of Tonle Sap inland fisheries, the statistics of output are perfunctory. All available estimates are based on crude extrapolations.¹¹ Poverty in coastal areas is believed to be widespread (Nelson 1999). What may be good for the environmental status, namely, the absence of a good coastal road, contributes to the economic stagnation of the coastal area.

⁹ The delineation of the exclusive economic zone (EEZ) remains a subject of territorial disputes with Viet Nam and Thailand. Pending the resolution of these disputes, the management of EEZ is fundamentally handicapped.

¹⁰ RCH (1998b) estimates that about half of fishing boats in Cambodia do not have permits and routinely use illegal fishing gear.

¹¹ The total output of Cambodia's coastal fisheries was officially put at 30,000 tons p.a., i.e., about a third of total Cambodian fish catch. Informally, the actual catch is estimated to be substantially higher (NEAP 1998). Besides, it is not clear whether these amounts refer to the landings in Cambodia or to total catch. Some documents (RGC 1998b) estimate that no more than 20 per cent of the total catch is used for local consumption.

The policy aspects of coastal zone management

If problems of jurisdiction and allocation of responsibilities between some line ministries (e.g., MAFF and MOE) are complex, the institutional complexity is even greater in the case of coastal zone management where no overall management framework yet exists. All main ministries have some role to play. However, coordinating mechanisms and information exchange are being developed with some success. Several foreign-funded projects in the coastal area have relied on provincial working groups consisting of directors and deputy directors of the provincial departments of MOE, Ministry of Public Works and Transport (MPWT), MAFF (especially the fisheries office), MRD, Ministry of Tourism, and Ministry of Industry, Mines and Energy (MIME). These working groups have proved that cooperation and coordination in coastal zone management are possible. Three central-level coordinating bodies now exist. They are (i) the National Committee for Land Management Urbanization and Construction, created in 1997 to regulate construction activity based on a zoning plan; and (ii) the National Steering Committee for Coastal Zone Management under MOE. Set up in 1997, the committee comprises line ministry representatives, provincial staff, and NGOs active in the coastal zone to deliberate on various management issues requiring coordinated response; and (iii) the Coastal Coordinating Unit within MOE, one of several such units created to deal with a distinct environmental problem.¹² Most day-to-day management in the coastal zone is performed by MAFF, especially the Department of Fisheries. The jurisdictional overlap between MOE and MAFF, mentioned in the context of forestry, is present also in coastal area management.

Thailand

Thailand's 3,220 km coastline is highly diverse and naturally productive. Twenty-three of Thailand's 76 provinces border the coastline. Islands, estuaries, coral reefs, seagrass beds, mangrove swamps, and sandy beaches have supported some of the world's most intensive traditional fisheries, and much of Thailand's modern tourism boom. It is fair to say that exhausted resources at home spurred the Thai fishing fleet to expand into deep-sea, international fishing in a big way, making Thailand one of the top ten fishing countries in the world.

This intensive growth has come about through excessive and inappropriate expansion of capture fishing, shrimp aquaculture, industry, tourism, and harbors at the

expense of mangrove forests, beaches, coral reefs, and marine resources which have been seriously degraded and depleted.¹³ About 90 percent of mangrove wood is exploited for making charcoal. Virtually no sustainable management practices are currently in place or being implemented.

The Gulf of Thailand is one of the most productive areas in the world, owing to its shallow depth and complex circulation patterns that create numerous localized areas of upwelling and submergence. Fisheries catch and production increased at 4.3 percent annually from 2.0 million tons in 1981 to 3.6 million tons in 1995. Most of this growth came from a dramatic increase in coastal aquaculture and freshwater culture fish production of 11.8 percent per year. In 1995, 79 percent of fish production came from marine capture, 10 percent from coastal aquaculture, and 5 percent each from inland capture and freshwater culture. By 1995, however, marine capture contributed less than 47 percent of the total Baht (B) 96 million value of fish production, while coastal aquaculture contributed 43 percent, and the inland capture and freshwater aquaculture subsectors each contributed about 5 percent.

Despite the boom in aquaculture, the trend is downward for fisheries as a sector of the GDP. In 1997, fisheries GDP was B49.16 billion, or 14.7 percent of agricultural GDP, and 1.4 percent of national GDP. Export earnings from the fisheries sector was B166.60 billion in 1995. In 1995, the number of coastal fishery households in Thailand totaled 53,112; the number of fishing boats was 54,538; and catch and production of marine fisheries was reported at 2.83 million tons. The value of Thai shrimp and aquaculture exports totaled more than B54 billion in 1997, up from B3.4 billion in 1985, and equal to 4.2 percent of the total value of all exports. Fish resources have been overexploited, so that catch per unit of effort has fallen from 265 kilograms per hour (kg/hr) in the early 1970s to 25 kg/hr at present. More than 40 percent of marine capture consists of juvenile fish.

More than half (54 percent) of Thailand's extensive mangrove forests, which provide natural nursery areas for many species of fish and other aquatic life, were lost between 1960 and 1986.¹⁴ From a high of approximately 13,000 ha/year of mangrove forest lost nationwide between 1979 and 1986, the rate of decline slowed to 2,600 ha per year between 1991 and 1993, and about 1,000 ha

¹² Other technical coordination units (TCUs) within MOE exist, e.g., the TCU for the Tonle Sap.

¹³ Office of Agricultural Economics, 1995.

¹⁴ TDRI 1987. Thailand Natural Resources Profile.

per year between 1993-1996. Currently, only 167,000 ha remain.¹⁵ Remote sensing data indicate two-thirds (66 percent) of this decline was due to the combined effect of clear-felling for timber, firewood, and charcoal; clearing for aquaculture; salt evaporation ponds; road and port development; and mining.¹⁶ The single largest end use (32 percent) was shrimp farm development. This high percentage may be an understatement of shrimp farming, many ponds are developed from former mangrove areas already cleared for other purposes.

Policy and programs

The Department of Fisheries (DOF), founded in 1947 under the Fisheries Act, has traditionally focused on development and promotion and only very recently have DOF programs emphasized management and conservation. The rapid development of aquaculture was led by the private sector, principally small farmers with inputs from major livestock feed producers. There has been little intervention or oversight on aquaculture by DOF or other agencies.

The Royal Forestry Department (RFD) is responsible for managing the island and coastal parks and sanctuaries—marine protected areas (MPAs). An estimated 60 percent of Thailand's coral reef areas and other important marine habitats such as seagrass beds, marine turtle nesting sites, and mangrove forests are located within the 18 designated MPAs. Capture fisheries and even aquaculture continue to encroach on these protected areas, but tourism also does serious damage, especially to coral reefs.

Viet Nam

Viet Nam has 29 coastal provinces (out of a total of 63 provinces) with 3,200 km of coastline dominated by the Red River Delta to the north and the Mekong River Delta to the south. The coastal zone extends 10 km or more inland, up to the point of the tidal influence on rivers, streams, and wetlands. Some 300,000 ha of tidal marshes associated with the delta are mangrove forests. Viet Nam generally has four mangrove zones with highly diverse plant formations. They are found in the northeast around Hai Phong (39,400 ha), along the coast of the Red River Delta (7,000 ha), in the coastal zone of central Viet Nam, the northern mangrove forests of the Red River Delta (46,400 ha), and the mangroves of Vung Tau (14,300 ha).

A significant level of economic activity occurs in these coastal and marine areas. Many of Viet Nam's valuable wetland resources—on which much of its agriculture and fisheries activities depend—occur in the coastal zone.

More than 50 percent of the protein intake of the Vietnamese comes from fish harvest of more than one million ton each year; around 70 percent of that comes from the sea. 'Capture' fisheries production has decreased, yet there is considerable potential for increased aquaculture production as currently only half of the suitable areas are being used for the purpose (World Bank 1998). A rapidly increasing urban population in search of jobs live along the coast where many industrial zones are located. Coastal and marine areas are also key attractions of the country's tourism industry and, with the development of new deep-sea ports they provide the main transport facilities for regional and global trade.

Viet Nam's 29 coastal provinces are uniformly experiencing a decrease in productive coastal and marine natural resources. A 1999 survey by ADB of coastal communities revealed decreasing biological resource base in areas inhabited by coastal households. In 22 provinces the decline is severe, with an increasing number of species extinction and declining trends in local and national coastal biodiversity. And more disputes have also been reported within and among communes over access to shrinking resources (ADB *Outlook*, 1999b).

Nearshore fisheries are heavily exploited and are harvested at unsustainable levels, while inshore fish stocks have collapsed and catch per unit effort is also decreasing. Overfishing has degraded marine ecosystems and significantly reduced biodiversity in Viet Nam. The situation is aggravated by destructive fishing methods, including the use of poisons and chemicals, which have destroyed breeding grounds in coastal zones and inhibited the capacity of fisheries stocks to regenerate.

Aquaculture could replace natural capture as a principal source of protein. Yet, degradation of coastal marine habitats, especially of wetlands and mangrove forests caused by unsustainable aquaculture practices, threatens even this potential. Mangrove deforestation, construction of poorly planned water management systems, saline intrusion, and outbreaks of disease in ponds all undermine coastal marine resources and viable economic uses of the zone. Industrial and urban development and pollution, fisheries, agriculture, forestry, mineral exploitation, energy development, shipping, and tourism are in varied ways contributing to degrading the natural coastal and marine systems on which much of these activities depend. And

¹⁵ Royal Forest Department, 1996. *Forest Statistics of Thailand, 1996*.

¹⁶ Conclusion reached by Joint Working Committee of RFD, DOF, DLD and NRC.

Viet Nam has no integrated policy or institutional framework to manage these impacts at the present time.

Resource use zoning

Unlike the mainland, the marine areas of Viet Nam are not zoned according to function, activity, and level of protection. Technical assistance provided by ADB for Coastal and Marine Environmental Management in the South China Sea has arrived at the observation that the open access nature of fisheries and the declining marine biological resources tends to create a chaotic “free for all” environment that encourages complete lack of restraint in marine resource harvesting. Traditional fishing grounds and methods have been overrun by those able to afford more advanced harvesting equipment (ADB 1999c). Similarly, critical coastal habitats are ill-defined and overrun by ad hoc and opportunistic uses. Some shipping routes and proposed protected areas are an exception to the open access “rule.”

Integrated area wide planning

Administrative jurisdiction over marine areas are not well defined in Viet Nam. There are no laws setting out maritime responsibilities or marine areas covered by coastal provinces and no formal recognition of marine customary rights or roles of local communes in managing coastal marine resources. Planning and management of maritime areas is a central government function that continues to operate on an uncoordinated sectoral basis. Fisheries, transport, tourism, and energy sectors, for example, often operate with conflicting objectives. Setting priorities between them becomes an arbitrary process.

Enforcement of existing laws

Destructive fishing methods along with the inability of authorities to control their operation have been identified as key issues in 21 of Viet Nam’s 29 coastal provinces, and as a major source of community conflict. Staff, budgets, and equipment are insufficient to conduct surveillance and enforcement functions. In addition, fines and other measures taken against violators of fisheries regulations are not punitive enough and do not serve as sufficient deterrents. No effective controls over land-based sources of pollution have been noted.

Policy framework for marine protected areas

There are no laws providing for MPAs, even as extensions of terrestrial parks. Until 1999, the Ministries of

Science, Technology and Environment (MOSTE), Agriculture and Rural Development (MARD) and Fisheries (MOFI) were each responsible for aspects of marine resource management. The protection and management of areas of high biodiversity values was not a clear mandate of any of these Ministries, hence little was done along that area. The situation has improved somewhat as the MOFI has been given overarching responsibility for marine protected areas. National policies and an active program of protected areas planning and management remains lacking, however.

There are 20 existing coastal and marine protected areas in Viet Nam, covering 223,000 ha yet the level of resources and active management attention given to these areas are variable, piecemeal and often lack follow-through action. The 1998 Government review of ADB’s bank assistance plan (BAP) gave a high future priority to extending the system of marine and coastal wetland protected areas and buffer zones (IUCN/MOSTE 1999).

Viet Nam has nine coastal and marine biodiversity regions. Three have been identified for highest priority conservation action (UNDP/MPI 1999).

- ***Mong Cai to Do Son*** including Cat Ba, Halong Bay, and the Ton Kin archipelago in the northeast part of the country.
- ***Dai Lanh Capeto Vung Tau Cape***. The coastal zone offshore from Khanh Hoa and Ninh Thuan provinces in south central Viet Nam, consisting of capes, small deltas, small lagoons, and bays.
- ***Vung Tau Capeto Ca Mau Cape***. Including Con Dao island and the mangrove forests of the Mekong delta.

The MOFI and the National Environment Agency (NEA) are finalizing a proposal for the Government to establish an additional 15 marine and 64 coastal wetland protected areas with special emphasis on certain priority biodiversity regions. The proposal is being refined with support from ADB, to include the extensive upgrading of 21 highest priority protected areas, with nine new ones, through a host of actions that include biological and socioeconomic assessments, management plans, zoning, boundary demarcation, and infrastructure (ADB 1999).

This formal recognition by the Government of the importance of coastal and marine protected areas comes from a growing appreciation of the critical role of these areas in developing the coastal zone. There is little doubt as to the direct and indirect economic values of coastal and marine biodiversity to the national and local economies, but the key role of protected areas in safeguarding and managing these essential resources is only now beginning to be understood and to take shape.

Urban and Industrial Pollution

Cambodia

For over 30 years, very little investment has been poured into maintaining, let alone improving Cambodia's urban environment, once among the best in mainland South-east Asia. Since the country's political life more or less stabilized, private investment in home improvement and construction has easily outstripped investment in public infrastructure. Cambodia continues to live off inherited urban assets that are quickly deteriorating (if some of these are not already disintegrated), putting at risk both the health of people in the urban areas and discouraging foreign investment from a lack of support infrastructure.

The Land Law promoted by UNTAC in 1992 created legal basis for ownership and transfer of land and urban development. To facilitate urban planning, the Law on Land Management, Urbanization and Construction (CNATUC Law) was enacted in 1994, seeking to balance often competing demands of urban and rural development and to provide legal basis for construction activities. The law also seeks to promote tourism while protecting the natural environment.¹⁷ A series of hierarchical urban master plan structures are provided in each province under the Law, with oversight provided at the Central government level. Despite developments in legislation, however a number of weaknesses persist. With small exceptions, there is no comprehensive or equitable system of land registration in the urban or semi-urban areas and as a result, a potentially valuable enabling tool for urban financing is not available in Cambodia.

A relatively complex institutional structure exists for planning and implementation of urban projects. In general, administrative powers and responsibilities are divided imperfectly between line ministries, municipalities, and provincial governments; only rarely are these responsibilities devolved further, such as in instances where solid waste management has been placed under the jurisdiction of district town authorities. All maintenance, rehabilitation and development work within provincial urban areas are handled by the branch office of the line ministry. On the positive side, while funded by the central government ministry, the branch office typically liaises with the Provincial Governor who chairs multisectoral task forces and committees. Many provincial town activities reflect the broader consensus as a result. Institutional responsibilities in Cambodia are summarized in Table 14.

Table 14: Institutional Roles in Urban Environmental Management in Cambodia, 1999

Investment Area/ Policy Concern	Institutional Responsibility
Sanitation, drainage	Departments of the Ministry of Public Works and Transport (Drainage and Sewerage Division) in each province Municipality of Phnom Penh
Solid waste	Departments of the Ministry of Public Works and Transport (Waste Management Division) in each province Municipalities of Phnom Penh and Sihanoukville
Urban water supply	Unit of Potable Water Supply within the Ministry of Industry, Mines and Energy in selected towns other than Phnom Penh (Battambang, K. Cham, K. Thom, Sihanoukville, Takeo) Phnom Penh Water Supply Authority under the Ministry of Interior Urban Planning Comité National de l'Aménagement du Territoire, d'Urbanisme et de Construction Bureau des Affaires Urbaines
Urban development	Municipalities of Phnom Penh and Sihanoukville (Departments of Urbanisation and Construction) Provincial governments
Urban environmental monitoring	Ministry of Environment
Environmental awareness	Ministry of Education, Youth and Education and Sport Ministry of Environment

More important problems than fragmented institutional responsibilities are those relating to financial and operational management. Not only are the key institutions technically weak, virtually no mechanisms for cost recovery are in place to ensure sustainable urban environmental services.

The nature of environmental problems created by inadequate sanitation in Cambodia's towns and urban

¹⁷ The Ministry of Tourism has its own zoning strategy for Cambodia based on eight tourism development areas.

centers strike chords close to home in other urban centers of Asia and for this reason deserves some restatement for emphasis. The contamination of shallow groundwater sources, as in many cities of Asia, is the result of inadequate wastewater and solid waste disposal. Over 80 percent of existing sewage/stormwater drains in Cambodia's urban centers are no longer functioning (Chanrithy 1997).

Urban environmental problems are exacerbated by the continuing migration of populations to urban areas, especially Phnom Penh, despite continued under-investment in urban infrastructure. Sections of flood protection levees have been occupied by squatters, many of them migrants, degrading water banks at a time when the threat of flooding (which is related to deforestation of the upper catchments) is a distinct possibility. More people have occupied land over natural drainage paths and canals, restricting water flows and creating sanitation problems. This has aggravated problems of flooding and deteriorating sanitation which directly affect public health and the quality of urban life.

Unplanned settlements outside the main levee system in Phnom Penh threaten the system of natural drainage which has served as traditional environmental safeguard against floods for many years. To address this, important and relevant experience may be drawn from development projects on low-cost improvements in urban neighborhoods (involving CARE and AusAID, for example), which provide models that prove major urban improvements need not be prohibitively expensive.

In all provincial towns, most existing infrastructure—already limited to begin with—are in urgent need of rehabilitation. Urban planning is practically nonexistent and very little knowledge goes around on the causes and effects of environmental degradation although awareness of deterioration is very much felt. In small towns a substantial number of people occupy unsuitable areas and aggravate environmental and sanitation problems. With the partial exception of Sihanoukville, Kompong Thom, Kompong Cham, and Battambang, no more than elementary systems of water supply and sewerage exist.¹⁸

Solid waste management

The situation in Cambodia resembles that in a number of other developing countries. With the exception of Phnom Penh, Sihanoukville, and Battambang, solid waste collection is extremely patchy in all other urban areas in Cambodia and usually only limited to public

market areas. Waste disposal is far from comprehensive and adequately organized. Dumpsites are chosen opportunistically with little regard for their management. Solid waste services have been privatized in Phnom Penh and Battambang, with mixed success in Phnom Penh. The subdecree on solid waste management has just been issued in April 1999, but is already considered flawed and requiring amendments and operating guidelines to allow it to be applied by Cambodian municipalities.

Hazardous waste management

The widely publicized case of hazardous waste dumping by a foreign company on Cambodian territory in 1997 is indicative of the virtual absence then of regulatory provisions and enforcement capability to deal with the problem of hazardous waste. Possible stockpiling of toxic materials, for example, pesticides, is probably a more serious problem at present than generation of hazardous waste which are now largely limited to metallic sludge from electroplating, certain dyestuffs, oil residues, and batteries.

Industrial and mobile source emissions

Limited industrial pollution abatement has taken place in Cambodia. Since there are few industries, the situation is not as urgent with the exception of how to deal with hazardous wastes. The situation is beginning to change, even if municipal discharges continue to dwarf industries in terms of pollution load. A subdecree on water pollution control was issued in April 1999.

Among new developments has been the growing problem of air pollution in Phnom Penh, linked mainly to the rapidly increasing volume of traffic. The Pollution Control Department of the Ministry of Energy (MOE) is weak and inadequate to deal with this problem which, in addition, requires effective coordination among several government agencies.

No inventory of pollution discharges is currently available, making it difficult to calibrate regulatory priorities. On the surface, the relatively small number of establishments classified as industrial (108, as of 1997) makes it easier to gain headway through direct regulation. However, if the experience of other countries is to serve as some sort of basis, the combined pollution load of establishments classified as family-owned or handcrafts may be a more significant contributor of pollution yet a more difficult one to manage by direct monitoring and enforcement.

¹⁸A wastewater treatment plant has been renovated in Rottenberg in 1995 with assistance from the European Union and could serve as a model for other urban areas.

Mining

The field conditions, let alone the environmental repercussions of gem-mining operations around Pailin, have not been assessed technically even if much anecdotal evidence suggests serious environmental impacts caused by sediment transport into the Tonle Sap.¹⁹ With the re-establishment of government control over the area, the environmental dimensions of mining operations—patterns of impact, scope for modification of existing practices, rehabilitation possibilities, among others—ought to be assessed in addition to revenue and employment these mining activities generate. Environmental provisions of the Mineral Resource Law need to be strengthened and the respective roles of the Ministries of Environment (MOE) and Industry, Mines and Energy (MIME) in regulating and supervising the mining industry will have to be more fully elaborated.

Lao PDR

Deteriorating urban conditions in the Lao PDR as a result of economic and physical growth is sufficient reason for concern. The population of the Lao PDR's urban areas is rapidly growing, at rates higher than the national average. The capital, Vientiane, is growing at 3.9 percent per year and that of Savannakhet, the country's second largest urban center, has doubled from 30,000 to 100,000 between 1975 and 1995, an annual growth rate of about 3.5 percent (National Statistical Center 1998). Present development trends point to increased urbanization, rural-to-urban migration and expanding industrial and tourism sectors, which are anticipated to lead to exponential increases in solid waste-related environmental problems for the country in the immediate future.

Solid waste

The Ministry of Communications, Transport, Post and Construction (MCTPC) is the government agency directly responsible for solid waste management at the national level. MCTPC is represented at the provincial level by the Department of Communications, Transport, Post and Construction (DCTPC). Administrative arrangements differ for each province and individual districts may be designated implementing agencies in some cases. Although municipalities do not exist officially, urban areas create de facto municipalities, recognized as having special needs managed through a municipal committee chaired by the provincial governor. This committee designates an implementing agency for waste management issues. In Luang Prabang, Thakhek, and Pakse, the implementing agency is the district. In Savannakhet it is the DCTPC, (UNDP 1996).

Legislative basis for solid waste management in each town is enforced by a provincial decree. The decree assigns a responsible agency or committee and a general scope of work and sets rates to be collected from households, government offices, and commercial enterprises for the collection of wastes.

Common problems associated with solid waste management in Vientiane and secondary towns manifest themselves at three levels (UNDP 1996):

- degradation of the quality of urban surroundings that impedes the functioning of the physical environment and induces people into accepting deteriorated conditions as normal; and
- lack of a sound financial and material resource base in municipalities and districts, including a sufficient stock of essential equipment and human resources with the capacity to manage solid wastes.

Solid Waste Generation: Average urban waste production is 0.7 kg per capita per day, consisting of approximately 30 percent organic material, 30 percent plastic, 15 percent paper, and 25 percent glass, cans and other metals. Hazardous and toxic wastes such as batteries, old paint cans, aerosols, and other refuse also are mixed with these wastes. No waste segregation is required, the low organic material content in municipal solid waste reflects the efficiency of an agricultural lifestyle where even in the urban areas large fractions of food wastes are used as animal feed.

Solid Waste Collection: Domestic and commercial wastes are collected from various premises and placed in bins along main roads for pick-up by the responsible government agency or by a private waste collection company specially subcontracted for the purpose. These wastes usually have the same composition. The waste is then transported to a designated dump site located between 2 and 20 km from an urban area. Collection services charge anywhere between 200 and 500 kip per month (1996), with progressively higher collection rates for commercial enterprises. Collection services generally reach only 10 percent of all urban households for a number of reasons:

- services are underfinanced;
- residents are reluctant to pay the monthly collection charge and thus dump indiscriminately or incinerate the wastes, even if such methods are unsanitary;
- collection services are unreliable, usually due to insufficient stock of necessary equipment and poor maintenance of existing equipment; and

¹⁹ Other areas where mining has potentially serious environmental implications are several sites in Ratanakiri province.

- a general lack of public awareness of the need for proper waste disposal, particularly in urban areas. (UNDP 1996).

Solid Waste Disposal: Three principal methods are used to dispose of solid wastes: they are either dumped in municipal landfills, openly burned, or indiscriminately dumped, usually into a body of water where they are eventually washed away by the tide, or dumped on vacant low lying land. The most prevalent practice is the traditional practice of indiscriminate dumping, which has resulted in negative environmental impacts including pollutive smoke and fumes, contaminated wastes, and leachate, which contaminates drinking and groundwater and agricultural land and produces methane, a greenhouse gas (UNDP 1996).

Recycling of Solid Wastes: Vientiane is the only urban area where recycling has been adopted as a commercial venture. Local markets in secondary towns are not highly developed and volumes of waste generated are neither sufficiently large to warrant transport costs nor interest foreign buyers of recycled wastes in Thailand and Viet Nam.

Sanitation and health

An estimated 50 percent of the Lao PDR's population of five million live below the poverty line. Infant and under-five mortality rates (IMR and U5MR) have declined by 10 percent from 1990 to 1995, but the country's child survival indicators are still among the lowest in Southeast Asia. Maternal mortality ratio (MMR), estimated at 650 per 100,000 live births in 1990, is one of the highest in the region. Total fertility rate is very high, and birth spacing advice services underdeveloped. Thirty-five percent of the Lao PDR's child-bearing women suffer from anemia, and the problem is exacerbated by complications from malaria which strikes one million people each year, causing as many as 28,000 deaths. Although only 157 cases of HIV have been reported as of 1996, an increase of 24 percent has been noted over the previous year (UNICEF 1997).

UNICEF reports 50 percent of the population lack safe water and 65 percent have no access to adequate sanitation facilities. Poor environmental sanitation and the unsafe disposal of human and solid waste contribute to the high incidence of malaria, diarrhoeal diseases and dengue fever. In addition, difficult access to safe and clean water places a major additional work burden on women and girls who must fetch water for household needs.

The far-reaching socioeconomic reforms of the "New Economic Mechanism," launched in 1986, expanded economic opportunities for the population at-large, but also exposed vulnerable groups, especially ethnic minorities, the poor, women, girls, and young children, to greater security risks. Key health and social statistics are presented on Table 15.

Table 15: Key Health and Social Statistics

Factor	Data
Population density	19.4 persons/sq km
Population density in Vientiane municipality	135 persons/sq km
Population growth rate	2.76 percent/annum (1998 est.)
Fertility rate	5.66 children per mother (1998 est.)
Life expectancy at birth	53.7 years
Infant mortality rate (per 1,000 live births)	101
Under 5 mortality rate (per 1,000 live births)	140
Mean years of schooling	2.9 years
Adult literacy rate	43 percent
Access to safe water (percent of population)	39 percent
Physicians (per 1,000 people)	0.2
Hospital beds (per 1,000 people)	2.6

Sources: ADB, Lao PDR Country Assistance Strategy, 1999; UNICEF, 1999; & World Bank Development Indicators, 1999

Thailand

Air quality

Residents and visitors to Bangkok Metropolitan Region, the country's capital and leading city, are exposed daily to levels of air pollution that exceed World Health Organization standards of safety. On a positive note, Thailand has instituted mitigating measures gradually since 1990, and their effects are beginning to be realized. Since the introduction of unleaded gasoline in 1992, for example, average curbside concentrations of lead in Bangkok have been reduced tenfold, from 1.5 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) in 1991 to 0.12 $\mu\text{g}/\text{m}^3$ today. A 1994 World Bank study estimates a 20 percent reduction in lead concentrations to result in health benefits worth between \$300 million and \$1.5 billion in money terms. Such benefits have been more than realized (World Bank Thailand 1994).

Carbon monoxide (CO) levels have declined over the last decade despite an exponential increase in the number of vehicles. The one- and eight-hour average concen-

tration of curbside ambient CO now rarely exceeds, in less than one percent of observations, Pollution Control Department (PCD) standards. Fleet modernization, enforcement of emissions standards, less traffic congestion on account of more roads and highways, and fuel quality improvements, including requirements for oxygenates in gasoline, have cumulatively contributed to realizing these gains.

Despite these efforts, Bangkok's air pollution levels remain serious. Particulates and ozone are particularly problematic. Annual mean total suspended particulates (TSP) at curbside averaged 480 ug/m³ from 1988 to 1997, exceeding the annual average standard set by PCD of 330 ug/m³. In 1997, TSP levels at non-curbside monitoring sites averaged 120 ug/m³ while frequency in which daily TSP standards are exceeded is over 70 percent at curbside locations and only 2 percent at non-curbside sites. Total suspended particulates are generated largely (40 percent each) by diesel-fueled vehicles and by road dust, with the remainder from industry and other sources. A 1994 World Bank study on the urban environment estimates a 20 percent reduction in the concentration of suspended particulates could generate annual health benefits worth between \$400 million and \$1.6 billion in monetary terms (World Bank 1994).

Particulates of less than 2 microns are of special concern because of their ability to penetrate and remain deeply lodged in the human lungs; average particle levels of less than 10 microns diameter (PM¹⁰) at curbside sites have risen steadily since 1992. In 1997, the daily PCD standards for PM¹⁰ of 120 ug/m³ were exceeded 21 percent of the time at curbside monitors and 13 percent of the time at non-curbside sites.

Policies and programs. Four government departments—the PCD, the National Energy Policy Office (NEPO), the Land Transport Department (LTD), and the Bangkok Metropolitan Administration (BMA)—are involved in addressing Bangkok's air pollution problem. Current programs include:

- the construction of new roads and mass transit systems, and improvements in traffic management such as measures allowing reversible lanes, parking restrictions, enforcement of traffic laws, flexible working hours and requirement of catalytic converter for cars;
- improvements in fuel quality such as unleaded, oxygenates and gasoline reformulation, reduction of sulfur content, and reformulation of diesel and low smoke lube oil;
- improvements in emissions standards for new and in-use motor vehicles;
- improvement of vehicle inspection and maintenance systems and roadside inspection;

- fuel switching for private cars and *tuk-tuks*; and
- control of dust on the road and from construction activities.

Though air pollution is generally not yet a serious problem in urban areas outside of Bangkok, the PCD has nevertheless established a nationwide air pollution monitoring system focused on 10 key provinces.

Mae Moh is the site of a 13-mw power plant complex where large quantities of sulfur lignite are mined and burned at Thailand's largest single-generating operation (2,625 mw). The Mae Moh valley is surrounded by low mountains, during winter season atmospheric inversion conditions occasionally occur. The most severe sulfur dioxide episode in Thailand occurred in Mae Moh in 1992, causing widespread damage to crops, livestock, and human health. Following the incident and several government reviews, the Electricity Generating Authority of Thailand (EGAT) agreed to install scrubbers on all industries operating in the area although many of the units have yet to be completely installed.

In 1995, the maximum standards for sulfur dioxide emissions were exceeded for a total of 66 hours. Corresponding figures for 1992, 1993, and 1994 were 27, 31, and 29 hours, respectively. Unlike in previous years when surges in sulfur dioxide emissions were primarily the result of weather conditions, their large increases in 1995 were attributed mainly to high power production at Mae Moh to compensate for a temporary shutdown of the Bang Pakong plant near Bangkok during that time.

An unusual number of deaths from heart failures and high incidence of chronic respiratory ailments continues to keep Mae Moh in the news. In August 1998, some 400 local villagers were hospitalized for respiratory problems. Crop damage—and this is not the first this has happened—was also reported. Provincial health officials monitored local sulfur dioxide levels at 2,200 ug/m³ per hour, compared with the acceptable standard of 1,300 ug/m³.

Water quality

Status. The PCD conducted a nationwide survey of water quality in Thailand in 1997. Findings reflect 14 percent of surface water resources to be in good condition, suitable for aquatic animals and general human consumption; 49 percent are of average condition, safe for general consumption and agricultural uses; the remaining 37 percent appear to be of low quality (Channin and Johnson 1997). Daily per capita consumption of water ranges from 50 liters per person in the countryside to 250-500 liters in municipalities. Approximately 80 percent of water consumed ends up as wastewater, hence

domestic wastewater accounts for nearly 60 percent of total pollution load. Most of the country's domestic wastewater is treated by on-site septic systems which have little maintenance or control.

Pollution from domestic sewerage is a problem throughout the country, especially acute in central Thailand where population concentrations are highest. In addition to anxiety about high levels of coliform bacteria in water and biological oxygen demand, there is increasing concern about the rise in ammonium nitrates in surface and groundwater, most certainly coming from runoff sources of agricultural fertilizers. Industrial pollution is most severe in the BMR, especially in the Chao Phraya and Lower Thachin Rivers. The lower reaches of the Chao Phraya passing through Bangkok are always low in dissolved oxygen, averaging only 0.8 micrograms per liter (mg/l) compared with 5 mg/l which is the level suitable for consumption. The Tachin river estuary to the west of BMR is also significantly polluted, with average dissolved oxygen concentration of only about 0.5 mg/l. Indications are that groundwater quality is deteriorating although very limited actual monitoring has been conducted.

Deforestation, land development and reservoirs have altered the hydrology of major rivers in Thailand, generally exacerbating flow patterns and increasing runoff and sediment loads. Livestock raising, primarily of pig and poultry, and fish farming operations are expanding, introducing large new BOD into surface waterways. Increased agricultural and industrial activities are beginning to affect groundwater. In many areas including tourism zones such as Pattaya, the incidence of waterborne diseases is on the rise. There is widespread anecdotal evidence that many tourists are shying away from some of the most popular tourist beaches in the area because of concern over coliform bacteria and other pollutants.

Policies and programs. While Bangkok has a rudimentary sewer system, it was only in the 1990s that the city began constructing central wastewater collection and treatment systems. This has finally gained sufficient priority that, even with the economic crisis, the Government of Thailand committed \$550 million for wastewater collection and treatment systems in the Bangkok Metropolitan Area in 1998. Similar investments are under consideration for secondary cities and towns. Approximately 10 percent of municipalities nationwide currently have wastewater treatment facilities, another 30 percent have water treatment plants under construction, and 60 percent have no wastewater treatment systems underway. Almost everywhere, sewers combine with stormwater drainage, meaning annual overflows occur during flooding or heavy downpours.

Interagency cooperation remains weak and cost-recovery policies for wastewater collection and treatment and user charges are poorly designed, if at all implemented. As a result, existing facilities are often not maintained, or worse, not operated at all because of lack of funds. The Bangkok Post in 1998 reported that 25 of 26 wastewater treatments are not operating because of lack of operation and maintenance funds. Cost recovery for operation and maintenance remain serious constraints.

Solid and hazardous wastes

Status. Bangkok alone accounts for nearly one quarter of the 33,000 tons of solid waste generated daily (13 million tons a year) nationwide. Municipalities and sanitary districts generate a slightly greater amount, with the remaining half coming from rural areas and villages. Just before the recession, in 1996, estimates were that per capita generation of wastes was increasing by as much as 5 percent per year. For the year 2020, estimates of nationwide waste fall between 41,000 and 75,000 tons/days roughly a doubling of today's levels.

In Bangkok, collection efficiency has increased from 80 percent to over 95 percent in recent years. Bangkok is currently able to recycle 20 percent of its solid waste, nearly 35 percent are recyclable material of commercial value but which are just being thrown away.²⁰ However, in secondary towns and cities collection, levels are generally well under 80 percent and recycling and reuse programs are mainly through scavenging.

Medical waste from hospitals and clinics are also cause for concern. In Bangkok, at least 80 tons of medical waste are generated daily but BMA can properly handle only 20 tons/day for collection by special collection vehicles or for incineration. Hospitals and clinics in other cities generally dispose their wastes as municipal refuse.

Policies and programs. Bangkok and other key municipalities are giving garbage collection more importance, and this is evident in improvements in collection infrastructure and efficiency. Safe disposal nevertheless remains a major problem. In addition to household garbage, 1.5 million tons of industrial hazardous waste and 4,000 tons of health care waste were generated by Bangkok alone in 1995. No sanitary landfills are yet operating, wastes are disposed of in open dumps or landfills. Bangkok has two engineered landfills that process about half the waste generated, other cities do not have any landfills at all. The tourist city of Phuket constructed an incinerator but has discontinued its operation because

²⁰ Dr. Hansa Sanguanno, personal communication.

of high operating and maintenance costs. (But the Government, it has been reported, is stepping in to finance the operating costs of an incinerator.)

Chiang Mai, second largest city and tourist center in northern Thailand, has for the past decade faced increasingly serious waste disposal problems. The city's waste disposal site was filled beyond capacity in the early 1990s and faced with the most common garbage site problem: the not-in-my-backyard (NIMBY) syndrome. No community within reasonable distance was willing to host a new alternative dump site or landfill. The city has gone through several embarrassing periods of noncollection, in which wastes have festered on the streets for weeks at a time, causing considerable public nuisance and discouraging tourism.

A government-constructed but privately-operated hazardous waste treatment center was opened on the western half of Samut Prakarn in 1988, but it cannot process solvents containing wastes. In the meantime, the second of a nationwide series of waste treatment centers long planned by DIW in Rayong Province has yet to open. Both DIW and the PCD have pilot programs underway to encourage industry to adopt pollution prevention principles that will substantially reduce both hazardous and solid wastes. Most hazardous wastes are currently not being segregated from household or municipal waste streams and pose an increasingly worrisome threat to surface and groundwater supplies. Responsibility for collection and disposal of solid wastes, by law and tradition, rests in the local governments. Sewerage and wastewater treatment are, in contrast, functions of the central government.

The National Solid Waste Management Sector Plan, funded by ADB and completed in 1997 (PCD 1998a) provides a framework for establishing or upgrading waste collection, recycling and disposal facilities nationwide. The Overseas Economic Cooperation Fund (OECF) has offered support to both Bangkok and the central Government, but such assistance appears to be limited to OECF's current funding through the Environment Fund. Solid waste management is included under the World Bank's planned urban environmental loan program for Bangkok, but senior environment officials are confident that the Government's present efforts are adequate for the near term, and are more likely to seek international funding to address air and water quality issues (PCD 1998a).

In 1997, the PCD completed a solid waste management policy and planning report which sets guidelines for establishing preventive systems and action plans. The policy document recommends, among others, the setting of standard criteria and methods of solid waste reduction,

support for clean technology, investment promotion, and education and training to implement pollution prevention and control. The policy also includes developing the role and strengthening the capacity of local governments, private organizations and other sectors in environmental quality management, and recommending the establishment of an environmental auditing and reporting system. The Government has set as targets a 15 percent recycling of wastes, collection efficiency of 90 percent, promotion of private sector investment in waste management, the introduction of a "buy back" scheme for some packaging materials, and the application of the "Polluter Pays Principle."

Outside of Bangkok, local solid waste management planning programs are becoming an increasing focus of annual provincial environmental planning processes which could lead to funding for infrastructure from the Government's Environment Fund. A US Trade Development Agency (TDA) feasibility study was conducted during 1999 to develop waste management programs and facilities in the Thai western provinces of Rachburi, Petchburi, and Kanchanaburi. The program was initiated several years ago with the expectation of arriving at regionwide solutions. It appears that the TDA study will have to focus on province-by-province programs as some provinces appear unwilling to accept responsibility for disposal of solid waste from other provinces or areas (Nisakom, Kositra, personal communication).

Viet Nam

Viet Nam is dominated by the four large cities: Ho Chi Minh City (HCMC), Hanoi, Hai Phong, and Da Nang. The division is a result of the Government's policy of designating three areas of the country as industrial development zones, to receive the lion's share of foreign investment. Identified industrial development zones are: (i) Hanoi/Hai Phong/Quang Ninh, (ii) Quang Nam/Da Nang, and (iii) HCMC/Ba Ria-Vung Tau/Dong Nai. This land use allocation has created high migration rates to these cities, which have attained urbanization rates of about 7 percent. The projected urban share of the population is expected to grow by 2,000 to about 24 million. This population and economic trend is giving rise to a number of significant environmental issues.

Prolonged war effort and government investment policies were largely directed to industry and agriculture, leaving urban infrastructure a low priority. This has resulted in rapidly deteriorating living conditions in cities with issues discussed below as main features.

Water supply and sanitation

Investment in water supply and sanitation has been severely financially constrained in Viet Nam. Quality of urban water supply is generally poor, as a consequence of the discharge of untreated or partially treated wastes as well as domestic liquid wastes. In Hanoi, there is virtually no domestic or industrial liquid waste treatment, and—as the city holds a relatively large industrial base—industrial wastes are a significant source of water pollution. The National Environment Agency (NEA) estimates industrial wastewater discharges in HCMC to account for 20-30 percent of the total flows in Viet Nam's river systems, with major industrial contribution to water pollution coming from the oil refining, chemical, and food processing industries. Only 100 urban centers have piped water systems that deliver water to 47 percent of the urban population (1995). The remaining urban inhabitants use water from unprotected and most likely polluted shallow wells and the mortality and morbidity profile can be linked to waterborne diseases. Water pollution-related diseases are among the leading sources of morbidity, especially among children.

Groundwater

The quality of groundwater is generally good, except for elevated levels of iron and manganese in some areas, and seawater intrusion in coastal regions. At present, only 15 percent of exploitable groundwater reserves have been tapped, as surface water is generally plentiful and inexpensive. However, water demand is increasing in areas like Dong Nai, where surface water shortages are experienced.

Contamination of groundwater in urban areas, particularly in Hanoi, is becoming increasingly a critical issue, as virtually the entire population depends on groundwater for drinking and household use. There are also signs in Hanoi of high concentration of fecal contamination in water wells. Monitoring for toxic metals and other hazardous chemicals has been undertaken to a limited degree to assess impacts from industrial discharges.

For large segments of the population access to sewerage systems is largely nonexistent in the cities and most urban centers are served by various forms of open drainage such as ditches and street gutters. Maintenance of existing systems has not kept pace with the increasing influx of population. In addition, no city as yet has an operating plant for wastewater treatment of domestic sewerage in Viet Nam. This constitutes a major health hazard during periods of storm and flooding, when coliform

and fecal pollutants from human wastes are easily spread through contaminated floodwaters. It is estimated that wastewater discharge from households and commercial establishments is about 500,000 m³ per day. About 46 percent of the household wastes is discharged into septic tanks, and the remaining 54 percent is discharged untreated.

Air pollution is a burgeoning environmental problem in urban areas due to the combined emissions from both industrial and mobile sources. In Hanoi and Hai Phong, coal is the principal fuel for industrial boilers, cooking, and space heating in the winter months. Air pollution control devices are nonexistent in industrial facilities, which have aged, low-efficiency boilers. Due to rapid urban expansion, industrial estates that were previously located outside population centers are now within city zones and pose a serious threat to human health. Compounding the poor air quality is the profusion of low-efficiency two-stroke motorcycles and poorly maintained vehicles that run on leaded gasoline, generating high ambient levels of particulates, lead sulfur dioxide, and carbon monoxide. Air pollution is further exacerbated by increasing traffic congestion, reducing traffic speeds and increasing emissions per km traveled.

Solid waste

Less than half of the solid waste generated in Hanoi and HCMC is collected; the remaining uncollected waste is disposed of in lakes, streams, and vacant lots. The current disposal sites are not designed as sanitary landfills, are not properly sited or managed, and are expected to exceed their capacity in the near term. There are two composting plants with limited capacity, capable of receiving only about 3 percent of the 1,500 tons generated in HCMC (1995).

Industrial/hazardous waste

The industry sector in Viet Nam has become larger and more diverse with the reunification of the country. Based on government projections, industry will be four times larger by 2010, and most of the output will be from new industrial facilities. Foreign investment is increasing significantly; for example, 1996 figures show an increase of 23 percent over 1995. Viet Nam now has three major economic zones: north (Hanoi, Hai Phong, and Quang Ninh provinces), south (HCMC, Dong Nai, Vung Tau, and Ba Ria); and central (Quang Nam and Da Nang). The industry sector can be roughly divided into heavy industrial facilities (mostly located in the north) and a heterogeneous and medium-scale light industry sector

concentrated in the south. The large-scale heavy industries are state enterprises that generally employ inefficient technology and rely entirely on government support for capital investment, though these are isolated from international market forces.

The industry sector in Viet Nam is characterized by (i) obsolescent technology, resulting in inefficient use of raw materials with concomitant pollution; (ii) absence of effective pollution control facilities; (iii) industrial zones improperly planned; and (iv) improper siting.

Hazardous waste

In a recent ADB study related to hazardous waste management, it was estimated that 275,000 tons of hazardous waste are generated in the country, 30 percent emanate in the north, 10 percent in the central area, and 60 percent in the south. If industrial growth continues as envisaged by the Government, total quantity of hazardous wastes may increase to more than 1 million tons annually by 2010. The relative proportions of waste generated between the regions is not expected to change significantly.

ADB's study indicates that generally no segregation of wastes or systematic treatment or disposal of hazardous wastes, either at regionally based treatment facilities or at the production site, takes place. The general perception in Viet Nam is that hazardous waste management is not a major problem. A low level of understanding as to what constitutes hazardous waste also results in poor understanding of how much is currently being produced.

In addition, it was noted that industrial wastes, including hazardous wastes collected by the respective municipal services companies, are disposed of at poorly engineered landfill sites together with municipal wastes. Liquid hazardous waste from landfills, leachate, is generally discharged directly into streams or rivers that are used as a source for agricultural/aquacultural purposes or as a drinking water source by the local community.

Energy

Cambodia

Cambodia relies on two primary energy sources: biomass for about 85 percent of its total energy requirements, and petroleum products for about 14 percent. The balance is accounted for by a single small hydropower station (see Table 16). In the mid-1990s annual consumption of biomass was placed by the Ministry of Industry, Mines and Energy (MIME) at about 5.9 million tons, of which fuelwood accounts for about 5.5 million tons

Table 16: Structure of Energy Consumption, Cambodia, 1995

Energy Source	'000 TOE Equivalent	Percent of Total
Wood	1,850	82.2
Charcoal	26	1.2
Other Biomass and Dung	39	1.7
Petroleum Products	317	14.1
Fuel Oil	2	0.1
Diesel Oil	129	5.7
Kerosene	26	1.2
Jet Fuel	11	0.5
Gasoline	145	6.4
Liquefied Petroleum Gas	4	0.2
Electricity	20	0.9
Total	2,252	100.0

and charcoal and other biomass account for the rest. About two thirds of petroleum products were consumed by transport, 26 percent by electricity generation, and the balance was consumed by households (for lighting mainly in the countryside, and cooking in urban areas). The number of stoves using liquefied petroleum gas is believed to be increasing rapidly in Phnom Penh. Cambodia's fuel utilization efficiency for all fuels is comparatively low by international standards. Technical losses in electricity generation and distribution are 50 percent higher than in the more developed countries of Asia. Wood combustion efficiency is low and few biomass waste-utilization technologies are available. No significant effort has been exerted to reduce energy consumption despite economic losses and the somewhat less obvious environmental repercussions. The high and nondeclining consumption of wood-based energy has been an important contributor to localized deforestation and to environmental problems often associated with it. In the case of petroleum-based products and electricity, the primary environmental concerns are greenhouse gas emissions and the threat of worsening air pollution in Cambodia's urban areas. The Energy Efficiency Office within the Electricité du Cambodge (EdC) has been relatively ineffective until now.

A National Energy Conservation (NEC) being formulated under the World Bank's initiative to be implemented by MIME with broad participation (MOE, MAFF, EdC, MRD, Ministry of Women's Affairs) is the first of its kind in Cambodia. Its broad objective is to achieve a significant improvement in energy use practices over a five-year period (1999-2003). Among the more specific objectives are the establishment of a national energy conservation and efficiency office (as an NGO) and improvement of the effectiveness of EdC's Energy Efficiency Office.

Table 17: Consumption of Wood and Charcoal, 1995

Area	Wood (million tons)	Charcoal (‘000 tons)
Rural	5.0	8
Phnom Penh	0.1	34
Other urban	0.4	11
Total	5.6	53

Note: This table does not include “other biomass” sources (agricultural residues, etc.).
Source: MIME.

Wood-based and biomass energy

The annual consumption of wood and charcoal for 1995 is given in Table 17.

Household consumption accounts for almost all (97 percent) of wood-based energy. The pattern of household consumption is summarized in Table 18.

Households dominate wood-based energy consumption in Cambodia. The environmental impact of fuelwood and charcoal consumption is believed to be uneven and greater in areas more densely inhabited (broadly, the southeast) as well as those that supply charcoal to Phnom Penh.²¹

The FAO-funded Cambodia Fuelwood Saving Project, based in Kompong Chhnang province, demonstrated that efficiency improvements of up to 50 percent are attainable through improved design of household or specialized²² cooking stoves. Some agricultural residues (e.g., rice husks) find a ready market, while the use of other biomass residues has not been sufficiently explored. More efficient charcoal kilns are being introduced on a trial basis by an NGO, although the scheme is seen by some as an invitation to increase charcoal production rather than merely making it less wood-consuming. Taken together, considerable potential exists in improving the efficiency of fuelwood use. Improved stove efficiency could become a major positive force in areas such as the Tonle Sap, where deforestation is a serious issue. As in

Table 18: Household Consumption of Wood Energy 1995 (wood energy equivalents)

Area	Wood (percent)	Charcoal (percent)	Total (percent)
Rural	84.5	1.1	85.6
Phnom Penh	1.7	3.5	5.2
Other	7.2	1.0	8.2
Total	93.4	5.6	100.0

Source: MIME.

Table 19: Potential Hydropower Sites in Cambodia

Site Considered by MIME to have Potential for Short- to Medium Term Development	Maximum Installed Capacity (MW)	Site Considered by MIME to have Potential for Long Term Development	Maximum Installed Capacity (MW)
Kirirom I	11.0	Sambor	465
Prek Thnot	18.0	Lower Se San 1	900
Kamchay	127.5	Lower Se San 2	480
Bokor Plateau	28.0	Lower Se San 3	375
Stung Battambang II	36.0	Stung Metoek	180
Western Kirirom	13.0	Lower Russey Chrum	125
Stung Piphot	25.0	Chey Areng	269
Stung Atay	110.0		

the case of modern energy sources, demand management could be an attractive option in wood energy use, i.e., it could be cheaper to improve the stoves or charcoal kilns than expanding capacity (here, establishing and maintaining tree plantations). The question of charcoal production acquires a special environmental significance where it takes place in, or is close to, protected and other vulnerable areas such as the mangrove forests along Cambodia’s shores.

Hydropower

Hydroelectricity has been in the agenda of national and subregional planners in Cambodia, but only a single hydroelectricity installation is operational at present, a 1 MW plant in Ochum, Ratanakiri built in 1993; another two (Kirirom I, Prek Thnot) still await rehabilitation (see Table 19).

Pre-feasibility or feasibility studies for hydroelectric installations in Cambodia have been made by MRC ever since the latter’s establishment in 1957.²³ More recently, MOE has been involved in commenting on the feasibility studies of hydroelectric dams in Phnom Kamchay and Prek Thnot. MOE has expressed particular interest in obtaining funds for a reappraisal of the Sambor hydroelectricity project feasibility study.

Progress in bringing any of these schemes to fruition has been affected by a perception that despite hydrological and engineering appeal, the economics of these schemes are marginal, especially when compared with the return on investments in improved energy efficiency.

²¹ The UNDP/USAID/IDRC/CRDI Wood Energy Flow Study of Phnom Penh (1997) documented the pressure on forest resources linked to supplying Phnom Penh.

²² Among specialized uses, home-based agro-processing activities such as palm sugar distillation or fish processing predominate. Palm sugar distillation consumed almost a fifth of total fuelwood in Kompong Chhnang. Brick manufacture is among other important fuelwood-using rural or suburban activities.

²³ “Review and Assessment of Water Resources for Hydropower” (1991).

Also, the escalating cost of “negotiating” with a large number of widely dispersed foreign NGOs has fundamentally changed the economics of hydropower.

Lao PDR

The Lao PDR is endowed with significant indigenous energy sources. The tributaries of the Mekong River within the Lao PDR have few large-scale dams and reservoirs and hold a tremendous potential for hydropower development. The Ministry of Industry and Handicrafts (MIH) estimates the country’s hydropower potential at 18,000 MW. This promise of energy prompted the Lao PDR to set a goal 23 dams to be completed by the year 2010. The current installed capacity is 217 MW, of which 202 MW is based on hydropower, while the remaining 15 MW consists of diesel power generated electricity. Nationwide, 16 percent of the households are electrified with urban areas accounting for 90 percent of the electrification and about 95 percent of consumption. Domestic energy consumption is growing rapidly at 8-10 percent annually. Only 7 percent of the total electricity consumption takes place outside of Vientiane. At present, about 65 percent of the total output is exported to Thailand, earning 25 percent of the country’s foreign exchange.

Energy use in the Lao PDR is dominated by household consumption of traditional fuels, mainly wood and charcoal. The use of wood as fuel has been a major cause of deforestation and is likely to remain so in the near term.

There are major lignite deposits at Hongsa in north-west Lao PDR. These are proven reserves of about 810 million tons, of which over 530 million tons are deemed economically recoverable. Energy content is estimated at 8-10 megajoules per kilogram with a relatively low sulfur content of 0.7-1.1 percent.

Electricity sector

MIH is responsible for the energy sector, including the electricity subsector. Electricity generation is the responsibility of Electricite’ du Lao (EdL). EdL is responsible for the planning, design, and construction of its own facilities in generation, transmission and distribution, including both urban and rural electrification. MIH coordinates with EdL in planning and preparing large projects and managing the Government’s interest in joint venture companies run by EdL. The Science, Technology and Environmental Agency (STEA) in the Prime Minister’s Office is the main coordinating agency for environmental planning and management across all sectors and is responsible for the environmental review and

Table 20: Hydropower Plant in Operation

Name	Province	Capacity (MW)	Production in 1997 (GWh)
Nam Ngum -1	Vientiane	150	1055
Xeset	Salavan	45	136
Xelabam	Champassack	5	23
Nam Dong	Luang Prabang	1	4
Theun-Hinboun	Bolikhamxay	210	
		411	1218

Source: EDL

approval of hydropower projects. Since early 1977, the Department of Development and Promotion of Technology of STEA has also been assigned a role in research and development, information sharing, and promotion of renewable energy technologies.

Almost all the electricity generated in Lao PDR is from hydropower. In 1997, total electricity generation was 12,18.7 GWh, representing a decrease of 2.4 percent from the previous year. Electricity imported totaled 101.6 GWh, representing 8 percent of total production; 2 GWh was imported from Viet Nam to supply Houaphan province and 99.6 GWh from Thailand to supply the provinces of Khammouane, Savannakhet, Bolikhamxay, Bokeo, and Kenthao. Total energy sales in 1997 amounted to 1,144 GWh, of which domestic consumption totaled 434 GWh, while exports to Thailand amounted to 710 GWh.

There are five hydropower power plants in the Lao PDR (see Table 20). The Theun-Hinboun power plant is an independent power plant of 210 MW built to export electricity to Thailand. Two other hydropower plants are expected to come on line in 1999—Nam Leuk (60 MW) and Houay-Ho (150 MW). Nam Ngum, located near Vientiane and completed in late 1960s, has a total installed capacity of 150 MW and for many years generated most of the Lao PDR foreign earnings via hydropower sales to Thailand. The Xeset power station contributes 45 MW to the national grid and generation is mostly in the wet season since Xeset is a “run-of-river” type of facility.

Given the extensive development needs of the Lao PDR and the potential of dams to generate foreign currency, rapid development is tempting. However, difficulties in raising the required loans and a plethora of social and environmental problems beset potential projects. Quick development may upset delicate, natural hydrological and ecological balances upon which most Lao-tians depend for their subsistence livelihood. No overall

study of water resources has been carried out in the Lao PDR and if development plans are to be sustainable, they must be based on an extensive knowledge of the current physical and sociological characteristics of the localities being considered for development.

Rural electrification

The underdeveloped state of rural infrastructure in the Lao PDR is a major constraint to rural economic growth and poverty reduction. Only 8 percent of rural Lao households are connected to the electricity grid, compared with over 60 percent in Vientiane. Households which are not connected to the grid pay high prices for electricity, for example, electricity from automotive batteries cost at least \$2 per kilowatt-hour.

In many cases, rural areas are electrified by extending the electric power grid to the suburbs of urban perimeters. Rural electrification has, nevertheless, been an element of all major electrification projects in the past and has been a component of the five main electrification projects: (i) Vientiane Plain Rural Electrification 1986-1990 funded by ADB; (ii) Nam Ngum-Luang Power Transmission completed in 1997 funded by ADB; (iii) Southern Provinces Electrification completed in 1993 funded by World Bank; (iv) Provincial Grid Integration an ongoing World Bank project; and (v) Southern Provinces Rural Electrification (SPRE), also an ongoing World Bank project. As part of the SPRE loan, the World Bank has included a modest (\$610,000) off-grid electrification component. Through this component, technical assistance is being provided to EdL to design and implement diesel, solar photovoltaic, and micro hydropower off-grid electrification.

Due to long distances from sparsely populated and remote areas, connection to the regional grid is difficult to justify on economic grounds and inaccessibility and costs of fuel hamper use of diesel generators. The terrain and low population density in remote scattered communities makes off-grid electrification through renewable sources an attractive option. Barriers to surmount include budgetary constraints, lack of experience and qualified human capacity, and lack of information about technologies. Initiatives are underway to lay the foundation for larger future investments in this area by JICA, World Bank, and ADB to meet the Lao PDR's ambitious development objective of achieving 25 percent rural electrification by 2005.

Thailand

The 1990s was a period of declining oil prices and strong economic expansion, and Thailand's use of energy grew

rapidly. Annual commercial energy demand increased from 9.1 percent in 1992 to 12.4 percent in 1993, and the growth rate for electricity use was 12.3 percent. As is typical in an industrializing economy, these rates exceeded the economic growth rate, which averaged only 7.6—7.9 percent annually during 1992-1994. Peak demand in 1994 climbed to over 10,000 MW with reserve of about 25 percent at a 75-80 percent load factor, and the demand for new electricity generation was growing at 1,200—1,500 MW per year.

As the recession took hold in mid-1997, power demand went flat for the first time in over four decades. January 1998 saw a drop in electric consumption of 11.7 percent over the January 1997 level. Average consumption in January 1998 was equivalent to 1,031,145 barrels equivalent per day of crude oil (BOED). In 1999, Thailand's commercial consumption of raw energy began to rise again: by 2.2 percent in January over January 1998, or 1,053,905 BOED. This was an early signal that the recession had bottomed out.

Policy and program

The National Energy Conservation Program, coordinated by the NEPO and implemented largely through EGAT and the Metropolitan Energy Authority (MEA), has been a considerable success. It aims to reduce gross national energy consumption by at least 3 percent annually. It was funded at about Bt4 billion annually during the Seventh Plan period, and is expected to conserve Bt15 billion a year in energy costs.

Viet Nam

Viet Nam has one of the lowest levels of energy consumption in the world, although both production and consumption of energy are increasing rapidly. Power generation, transmission and distribution in Viet Nam, are under the exclusive aegis of Electricity of Viet Nam (EVN), which in turn operates under the umbrella of the Ministry of Industry (MoI). According to the MoI, Viet Nam's estimated demand for electricity to the year 2010 will grow annually at the rate of 13 to 15 percent corresponding to a need of adding 600–800 MW of new power capacity to be added to the overall grid annually.

Depending upon the area, Viet Nam is facing an increasing number of blackouts as demand for electricity surges beyond the capacity of existing power stations. Providing electricity to the larger cities and industry takes a precedence over smaller provinces and households in the countryside. It is expected that shortfalls will increase as large block industrial users such as production plants, industrial processing zones and satellite cities come on line.

Hydropower plants which contribute about 64 percent of Viet Nam's total electric supply have been adversely affected by the El Nino-induced drought of 1997 and early 1998. Industry experts claim that the current supply will be severely constrained with the growing population. In order to help alleviate the hydropower shortage, the state is planning to import energy sources from nearby Lao PDR and PRC.

A critical problem that needs to be urgently addressed is the deficient underlying transmission network. Poor operating substation and distribution equipment is the largest source of wastage with inadequate power grids accounting for a 20 percent loss each year.

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