

CAMBODIA ENVIRONMENT OUTLOOK



Ministry of Environment,
Kingdom of Cambodia



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Kingdom of Cambodia



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ISBN: 978-974-300-197-0

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Graphic, Layout and Printing: Thai Graphic and Print Co.,Ltd, Thailand
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ACKNOWLEDGEMENT

This is the first Cambodia Environment Outlook the Department of Natural Resources Assessment and Environmental Data Management (MoE/DoNRAEDAM) developed in conjunction with the UNEP RRC.AP under the capacity building project for integrated environmental assessment. It was evident that the data and information availability was a major challenge during the Report preparation process.

On behalf of the MoE/DoNRAEDAM and the national working team, we would like to express our gratitude to all the team members and experts who contributed to the completion of the report.

Our sincere appreciation is extended to those of concerned institutions who provided data, information, including supporting documents used for the analysis and assessment. We greatly recognized the internal coordination and collaboration within the Ministry of Environment in finalizing the report and inter-agency collaboration in giving the necessary assistance on timely basis. We also thankfully acknowledged reviewers and individual experts who provided constructive comments and assisted us in improving the quality of the report.

Finally, we would like to express our sincere thanks to H.E. Dr. Mok Mareth, Senior Minister and Minister of the Environment for giving us full support during the preparation process and the UNEP RRC.AP team for providing the technical guidance and financial assistance.

Special thanks are also extended to the MoE Team:

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The Process of developing Cambodia Environment Outlook was a great cooperation between the United Nations Environment Programme (UNEP) Assessment Programme and the Kingdom of Cambodia. The project aims at building capacity for integrated environmental assessment to foster scientific-based policy formulation and to support sustainable development in the country under the guidance of Ministry of Environment (MoE). Activities, including the national inception workshop and training, multi-stakeholders consultation and data collection had been organized and successfully strengthened the intra-agency coordination and built national technical capacity in integrated assessment of environmental issues.

Laid in the Greater Mekong Subregion, Cambodia is abundant in natural resources, a hydrological and healthy ecological system, and predominantly dependent on natural resources for socio-economic development such as forests, fertile soils, fisheries, water and mineral resources as well as biological diversity. Tonle Sap Great Lake connecting to the Mekong River at Chadomuk by the Tonle Sap river is the wetland rich in abundant natural resources like aquatic resource, biodiversity, water fowl, a variety of inundated forests, etc. referred to as the breath and heart of Cambodian people.

The population growth and increasing demands have exerted pressure on these natural resources. In this regard, Cambodia has been facing some developmental and environmental challenges. Over-exploitation of based natural resources could be the major threat and problem for sustainable development, if it is not well managed. This would cause destruction of the primitive forests, wetland habitats, fisheries and wilds leading to changes in ecological system, loss of both terrestrial and aquatic biodiversity, land degradation and top soil erosion. Amongst the national challenges to be dealt with, the significance and value of Tonle Sap Great Lake as a major source of livelihood/protein for millions of Cambodian, as a biosphere reserve and as a model for basin wide management approach for replication elsewhere need to be highlighted. So far, the Royal Government of Cambodia has developed relevant laws, policies, strategies and plans to cope with the protection and management of natural resources for development in a sustainable way to meet the people's demands and alleviate the people's poverty. This follows the economic policy agenda of the Political Platform and the "Rectangular Strategy for Growth, Employment, Equity and Efficiency in Cambodia".

Cambodia Environment Outlook is developed based on reliable data/information collected from key stakeholders of both state and non-state institutions. The ultimate goal is to update an environmental database consisted of available data on environmental conditions, trends and their significance, status of ecosystems, the effect of human activities and the implication. Anyway, the Report highlights five key environment issues in Cambodia: Land Degradation, Depletion of Biodiversity, Degradation of Inland Aquatic Resources, Coastal and Marine Resources Management, and Waste Management. It was evident that the availability of data and information was a limiting factor during the preparation process.

On behalf of the Cambodian Ministry of Environment and on my own behalf, I would like to take this opportunity to thank the UNEP regional team in Asia and the Pacific for both technical and financial assistance in preparing this report, which will serve as a valuable source to planners, policy- and decision-makers to develop sectoral plans and formulate policies for the sustainable development in Cambodia. Also, special acknowledgement and sincere thanks are given to those officials of the Department of Natural Resources Assessment and Environment Data Management, who had committed to the completion of the Project and took all the efforts in preparing this valuable report, or without their kind participation and assistance this report would not have come out. 

Senior Minister, 
Minister of the Environment



Dr. Mok Mareth

Executive Director United Nations Environment Programme

The United Nations Environment Programme (UNEP) is mandated to keep the state of the global environment under review. It does this through the Global Environment Outlook (GEO) process, producing a series of global, regional, sub-regional, national and even city-level assessments. Elaborated through a participatory and consultative process which gives them strong scientific credibility, GEO assessments provide information for environmental management and policy development to a wide target audience.



The capacity building programme of the GEO process was highlighted in the Bali Strategic Plan for Technology Support and Capacity Building, an intergovernmental framework for supporting developing countries and countries with economies in transition. The implementation of the Bali Strategic Plan is an important opportunity for UNEP to work with partners to strengthen national institutions, including developing environmental reporting as a basis for decision making.

The Cambodia Environment Outlook is one of the outputs of UNEP's capacity building programme. Cambodia is an agrarian nation that largely depends upon productive natural resources for food and income. Agriculture remains an important sector for economic development, employing much of the rural population. In the past ten years, more than 40 per cent of the national GDP has been derived from agriculture, fishery and forestry. Unsustainable use of natural resources has put increasing pressure on the environment. The country's forest cover declined from 73 per cent in 1965 to approximately 61 per cent in 2002. The total mangrove area decreased from 94,000 hectares in 1973 to 56,241 in 2002 as a result of intensive farming and charcoal production.

This report identifies key environmental issues including land degradation, depletion of biodiversity, degradation of inland aquatic resources, and the management of coastal and marine resources and waste. These issues have been prioritized and analyzed by various experts, including government officials, scientists, academics and civil society representatives, to determine their policy making implications. This broad-based participatory process brings national environmental issues to the attention of different stakeholders and the general public.

I hope this report will provide a sound basis for decision making for the Kingdom of Cambodia as it addresses environmental issues at the policy level and advances the sustainable development agenda. Finally, I would like to express my gratitude to the Ministry of Environment, line ministries and associated experts for the fruitful collaboration that made this report possible.

A handwritten signature in black ink, which appears to read 'Achim Steiner'. The signature is fluid and cursive, written in a professional style.

Achim Steiner
United Nations Under-Secretary-General and
Executive Director, United Nations Environment Programme
November 2008

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ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
APHEDA	Australian People for Health Education and Development Abroad
CBD	Convention on Biological Diversity
CBNRM	Community Based Natural Resource Management
CCC	Cooperation Committee for Cambodia
CCEAP	Climate Change Enabling Activity Project
CDRI	Cambodia Development Resource Institute
CFDo	Community Fisheries Development office
CIAP	Cambodia-IRRI-Australia Project
CMDG	Cambodia Millennium Development Goal
DANIDA	Danish International Development Agency
DFW	Department of Forestry and Wildlife
DoF	Department of Fisheries
EIA	Environment Impact Assessment
EPA	Environmental Performance Assessment
FA	Forestry Administration
FAO	Food and Agriculture organization
GEF	Global Environment Facility
GMS	Great Mekong Subregion
GPCC 98	General Population Census of Cambodia in 1998
IcLARM	International center for Living Aquatic Resource Management
IGES	Institute for Global Environmental Strategies
IPCC	Intergovernment Panel on Climate Change
JMP	Joint Management Program
LAc	Law on Administration of commune councils
LUcF	land use change and forestry
MAFF	Ministry of Agriculture, Forestry and Fisheries
MIME	Ministry of Industry, Mines and Energy
MLMUPc	Ministry of Land Management, Urban Planning and construction
MoE	Ministry of Environment
MoP	Ministry of Planning
MoWRAM	Ministry of Water Resources and Meteorology
MRC	Mekong River Commission
NAPCBD	National Action Plan on Conservation of Biological Diversity
NGo	Nongovernmental organization
NIES	National Institute for Environmental Studies
NRM	Natural Resource Management
PIP	Public Investment Program
PoP	Persistent organic Pollutants
PRASAC	Program for Agriculture Sector Assistance and Credit
RGC	Royal Government of Cambodia
SEDP	Socio-Economic Development Plan

SEDRP	Socio-Economic Development Requirements and Proposals
SEF	Strategic Environmental Framework
UN Habitat	United Nations Human Settlements Programme
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Framework Convention on Climate Change
UNITAR	United Nations Institute for Training and Research
WB	World Bank
WRI	World Resources Institute

PART I: EXECUTIVE SUMMARY

Cambodia is predominantly a low-lying country that occupies the central plains of the lower Mekong basin and is bordered on three sides by dense forested mountainous ranges. Forest in Cambodia tends to be located on the country's periphery while paddy cultivation is the norm to the lowland areas. Forest is one of the most important economic and environmental resources of the country and an important source of government revenue and employment for the local people. Cambodia's forests provide a variety of timber and non-timber products such as wildlife, fuel wood and medicinal plants. About a third of Cambodia's forests (all of it in the evergreen category) are considered commercially attractive (DFW, 2003). Cambodia's location in the tropical monsoon zone accounts for marked biological richness of the forests. Complex interrelationships exist between the country's forest cover and unique hydrological systems of the Mekong River and Tonle Sap Lake.

Cambodia remains a predominantly agricultural country. Agriculture and forestry contribute nearly 40% of the country's gross domestic product (GDP). The country's forest cover (under Cambodian definition) declined from 73% in 1965 to approximately 60% in 1997. A gradual reversal is observed from 1997 onwards. The Royal Government of Cambodia (RGC) cancelled a large number of forest concessions that brought the area under concession management down from 6.5 million ha in 1998 to 3.8 million ha in 2003 and reduced the pressure on the forest. Nonetheless, illegal logging has not been eliminated both in and outside the cancelled concessions, and shifting cultivation and agricultural expansion remain significant pressure factors. In response, the Government further increased the area of protected forest to a comparatively high 23.5% of the total land area by 2002.

Cambodia's natural habitats have been partly degraded in the course of the last three decades, resulting in additional pressure on the country's rich biodiversity. Despite this, biodiversity appears to be in better condition in Cambodia than in neighbouring countries. Since 1993, the government has been building up a system of protected areas. By now a relatively high total of 32% of Cambodia's territory has some form of protection status. It remains to be seen how effective the protection is in the face of continued and widespread pressures.

Fish accounts for three quarters of the animal protein intake of Cambodia's 13 million people and inland fisheries are essential for local livelihoods. Fish production has grown in recent years due mainly to greater production by small-scale and rice-field fisheries. The production by Tonle Sap appears not to have changed significantly in volume terms but there is evidence of changes in the composition of the catch towards smaller size fish, raising concerns about sustainability. Destructive fishing practices are widely used throughout Cambodia. The responses include support for community-based fisheries and reduction of commercial fishing lots in favor of community-based management. The change of policy direction is too recent to say whether it has resulted in more sustainable management of the fish resource.

As the country economy and population grows, the demand for safe drinking water increases. Access to safe water has improved in both urban and rural areas of Cambodia during the past decade but from an extremely low base. Cambodia has by far the lowest overall percentage of access to safe drinking water among the Greater Mekong Subregion (GMS) countries. The growth in rural population has increased also the demand for irrigation water. RGC's policy for the rural sector rests significantly on further expansion of irrigation and reduced dependence on rain-fed farming. The agricultural policy of increasing the percentage of irrigated lands in the cropland total from about 16% in the mid 1990s to 20% in 2003 have been achieved. There has been a significant decline in the per capita endowment of agricultural land from about 0.65 ha in 1961 to about 0.37 ha in 2003 due to a rapid growth of rural population and constraints placed on area expansion. Efficiency of land use has come to be an important policy consideration. Additional and special measures such as clearing land of unexploded ordinance have added to the stock of agricultural land (besides reducing risk to life).

Cambodia has the necessary suite of laws and regulations for environmental management, and MoE holds the responsibility for their implementation. However, improved institutional coordination with other development ministries and availability of better technical and financial resources is required to strengthen the institutional framework for environmental management in Cambodia.

Sustainable management of the country's natural resources and healthy environments for its population are important strategic priorities for Cambodia, as they are for the other countries of the Greater Mekong Sub-region. The challenges to Cambodian authorities and other national stakeholders in pursuing these priorities are many not least because of Cambodia's immature market economy and young regulatory frameworks. This report, is an attempt to present an overall picture of the progress made in reaching the goals of sustainable development and environmental health.

The central plains are mainly consisting of the alluvial plains of the Mekong River and the Tonle Sap Basin. The Cardamom and Elephant Mountain Ranges have the highest points between 1,500 m in the east and 1,800 m in the west (MRC, 1998). The Elephant Range runs toward south and southeast and rises to elevation of 500 m and 1,000 m. The Cardamom and Elephant Ranges are bordered on the west by a narrow coastal plain, facing the Gulf of Thailand. The northeastern border between Cambodia and Vietnam has altitude of few areas reaching over 400 m (MoE, UNDP and FAO, 2001).

The Dangrek mountain range, which forms a part of Cambodia-Thai border in the northwest, is a continuation of the Korat plateau and northeast plateau. Dangrek Mountain, at the northern rim of the Tonle Sap Basin consisting of a steep escarpment, marks the boundary between Thailand and Cambodia with an average elevation of about 500 m and the highest points reaching more than 700 m. Between Dangrek mountain ranges down to the Great Lake, the landscape is composed of numerous hills with altitude decreasing from 200 m near the chain to 40 m around the plain (MRC, 1998). The Lake with the flood plain around 18,000 km² is surrounded by the national road 5 and 6, which are located at 11 m above the sea level. The central plains are extremely flat with an elevation difference of only 5-10 m between the southern portion of the country and the upper reaches of the Lake in the northeast, and a distance of more than 300 km (IRRI and MAFF, 1997).

The Mekong River runs through Cambodia with a total length of 486 km. It flows south from the Lao PDR in the north, entering Cambodia at the Khone Falls, and then traverses Cambodia southward to the South China Sea through Mekong delta in Viet Nam. At Phnom Penh, with alternative arms, the Bassac River from the south and the Tonle Sap River, with a length of about 120 km linking with Great Lake Tonle Sap from the northwest, it continues further south-westward to its lower delta in Vietnam.

The Tonle Sap Great Lake is the largest freshwater lake in Southeast Asia with a size of about 2,600 km² in dry season and increase to 13,000 km² in wet season. The Tonle Sap Great Lake acts as a buffer of the Mekong River system floods. The Mekong River swells with water during the wet season and the water flow into the Tonle Sap Lake through the Tonle Sap River. During the dry season, the water flows out from the Tonle Sap Lake to the Mekong River and this specify of the Tonle Sap River makes it the only river with the return in the world.

Cambodia is naturally classified into four environmental regions, i.e. the plain, Tonle Sap, Coastal, and Plateau and Mountainous, which consist of twenty provinces and four municipalities. The falling-in provinces and municipalities are given in table 2.1.

Table 2.1: The Falling-in Province/Municipality, Land Area, Population and Density

Province/Municipality	Land Area (Km ²)	1998 Pop. Census ('000)	2003 Projected Pop. ('000)	Density (Pers/Km ²)	
				1998	2003
Cambodia-Total	181,035*	11,438	13,770	64	76
I. Plain Region	25,069	5,898.592	6,956	235	277.50
Phnom Penh (12)	267	1,000	1,283	3,745	4,805
Kandal (08)	3,591	1,075.13	1,257	299	350
Kampong Cham (03)	9,799	1,609	1,876	164	191
Svay Rieng (20)	2,966	478.252	551	161	186
Prey Veng (14)	4,883	946.042	1,077	194	221
Takeo (21)	3,563	790.168	912	222	256
II. Tonle Sap Lake Region	67,668	3,414.263	4,198	50.45	62
Kampong Thom (06)	13,814	569.06	673	41	49
Siem Reap (17)	15,271	696.164	843	46	55
Banteay Meanchey (01)	9,937	577.772	748	58	75
Battambang (02)	10,433	793.129	993	76	95
Pursat (15)	12,692	360.445	439	28	34.60
Kampong Chhnang (04)	5,521	417.693	502	76	91
III. Coastal Region	17,237	845	1,035	49	60
Sihanoukville (18)	868	155.690	204	179	235
Kampot (07)	5,209	528.405	611	101	117
Koh Kong (09)	11,160	132.106	182	12	16
Krong Kep (23)		28.66	38	na	na
IV. Plateau and Mountain Region	68,061	1,280	1,580	19	23
Kampong Speu (05)	7,017	598.882	717	85	102
Preah Vihear (13)	13,788	119.261	150	9	11
Stung Treng (19)	11,092	81.074	102	7	9
Rattanak Kiri (16)	10,782	94.243	120	9	11
Mondul Kiri (11)	14,288	32.407	42	2	3
Kratie (10)	11,094	263.175	319	24	29
Otdar Mean Chey (22)		68.279	98	na	na
Krong Pailin (24)		22.906	32	na	na

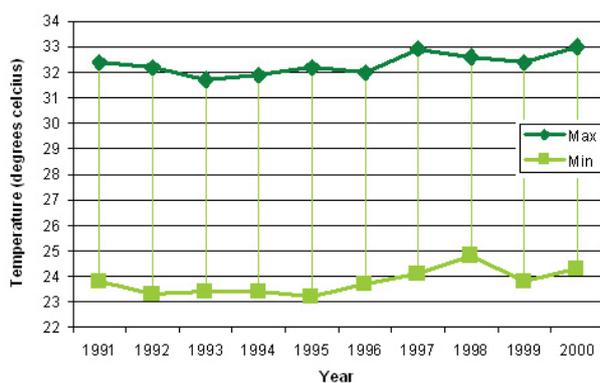
Source: General Population Census of Cambodia, 1998 (GPCC, 98) and Statistical Yearbook 2003, NIS/MoP

Notes: (nb) Provincial/Municipal Code Number

(*) Includes 3,000 km² of Tonle Sap Lake Area

(na) Data Not Available

Cambodia's climate is tropical monsoon. There are two distinct seasons – the dry season from November to April and the rainy from May to November. The northwest monsoon (wet) brings 90% of the rainfall, which varies generally between 1,200 and 2,000 mm per year across the country. Rainfall in the central area covering the Tonle Sap Basin-Lower Mekong Valley averages between 1,200 and 1,900 mm annually. The heaviest rainfall, over 3,000 mm per year, occurs along the coastal lowlands in the west. The northeast monsoon results in dry weather in the period of December to April. In any particular location, rainfall varies significantly from year to year, even in June and July periods of up to 15 days without rain are not uncommon. Relative humidity ranges from 65-70% in January and February to 85-90% in August and September

Figure 2.1: Mean Annual Average Temperatures

Source: Ministry of Water Resource and Meteorology, 2001

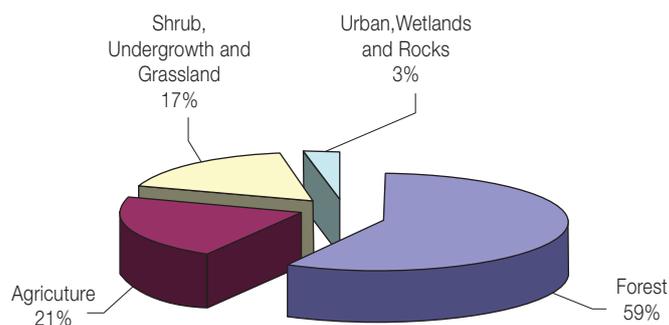
The temperature changes regionally and seasonally. The warmest month is April, when temperature can rise above 38°C, and the coldest of about 22°C is January. The average annual temperature is 27°C. Figure 2.1 illustrates the average annual temperature in Cambodia from 1991 to 2000.

Mean wind speed in Cambodia is low in the order of 2 m per second. December is known as the month of strong steady wind from the north. Typhoons, which often devastate coastal Vietnam, rarely cause damage in Cambodia. Annual evaporation is of the order of 2,000 to 2,200 mm, being highest in March and April at 200 mm to 240 mm, and lowest in September-October at 120 mm to 150 mm.

2.1.2 Land Resources

Land resources are finite, fragile and non-renewable. They include soil, land cover and landscapes. Soil is mainly important for agriculture in Cambodia. It is divided into three different types: (i) old alluvial and/or colluvial plains or terraces, (ii) in-situ from weathering of underlying parent material, and (iii) floodplains of rivers and lakes that are experiencing active alluviation. Old alluvial terraces occur in all rice-growing provinces of Cambodia and are former river, lake or marine floodplains that no longer experience regular flooding. Colluvial/alluvial plains result from erosion of surrounding hills and the movement of the eroded materials to the lower land initially forming a fan. Soil developed in-situ are developed from two main rock types in Cambodia, Palaeozoic sandstones and shale, which underlie much of the surrounding mountains, and igneous rock.

The land use classification data are available for 1992-93 and 1996-97 and there have been no large-scale cadastral survey and available data on land use after 1996-97. Between 1992-93 and 1996-97, the forest area reduced by a little over 1% and agricultural area rose by about 1%, though the quality of the forest is believed to have significantly deteriorated (RGC, 2001).

Figure 2.2: Land Use Classification of Cambodia

Source: MAFF & CDRI, 2001

Recently, CDRI has compiled the land use data and classified its into the following: the forest areas cover 59% of the total areas followed by agriculture, which accounts for 21%; shrubs, undergrowth, grasslands and so forth account for 17%; and urban areas, wetlands and rocks, the remainder (figure 2.2). The recent estimate of forest cover between 1996-97 and 2002 by DFW reveals that the forest cover has increased from 59% to 61.15% (DFW, 2003).

In Cambodia, there are several beautiful landscapes along the Mekong, Tonle Sap Great Lake, floodplain, highland and coastal areas. These landscapes consist of natural ecosystem, wetlands, historical sites, mountains, and communities living with the adaptation to the nature around. All of these, of course, attract so many tourists that they come for ecotourism. The Tonle Sap Great Lake and Mekong River form an important wetland ecosystem of the Mekong Sub-region. In addition, twenty-three protected areas, accounting for 18% of the total land area, established in 1993 by the Royal Decree are considered as beautiful landscapes, which are potential for ecotourism development. The coastal areas in the southern part of Cambodia form diversified landscapes different from the other parts of the country including sea beaches, and coastline. More attractively, the historical sites of Angkor Temples in Siem Reap province and other temples across the country are well known for tourists from over the world.

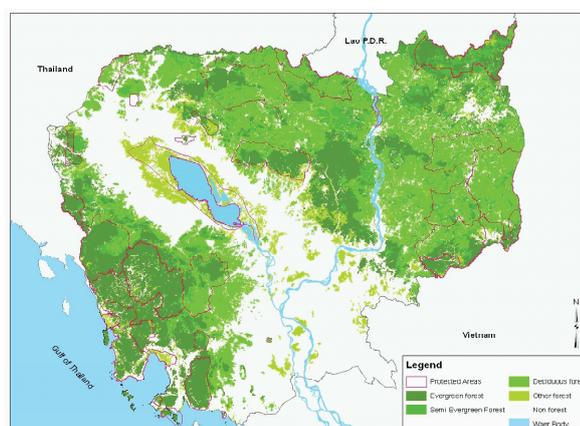
2.1.3 Forestry Resources

Cambodia is predominantly a low-lying country that occupies the central plain of the lower Mekong valley and bordered on three sides by the dense forested mountainous ranges. Forest in Cambodia tends to be located around the periphery in the areas as opposed to the lowland areas where paddy rice is the norm. Forest is one of the important natural resources bases for the country. Moreover, forest sector is the source of various non-timber products such as wildlife, fuel wood and medical plants. It is also the source of employment particularly in harvesting operation.

In ecological term, forest helps to protect the soil erosion, stabilize the watershed and regulate water flows and local weather system. Cambodia is particularly dependent on its forest system due to the unique hydrological system of Mekong River and Tonle Sap Lake. In purely economic terms, forest is considered as one of the country's most valuable economic assets that provide an important source of revenue.

Before 1960, the forest area covered 73% (13.23 million ha) of the country total land area, of which, the inundated forest in the Tonle Sap covered about 1 million ha and the mangrove forest in the coastal areas covered about 94,000 ha.

Map 2.2: Cambodia Forest Cover, 2002



Source: GIS-MoE and DFW-MAFF, 2002

Table 2.2: Cambodia Forest Cover, 2002

Forest Types	Area (ha)	Percentage
Evergreen Forest	3,720,506	20.49
Semi-evergreen forest	1,455,190	8.01
Deciduous forest	4,833,861	26.62
Other forest	1,094,726	6.03
Sub-total	11,104,283	61.15
Non-forest	7,056,388	38.85
Total	18,160,671	100

Source: DFW-MAFF, 2003

The protected areas, which share 18.08% (3,273,200 ha) of the total country's area, are covered by good forests that are important for wildlife habitats. There are 23 protected areas including 7 national parks, 10 wildlife sanctuaries, 3 protected landscapes and 3 multiple use areas. The 7 additional protected forest share 7.36% (1,332,218 ha) of the total land area were established by Forestry Administration, Ministry of Agriculture, Forestry and Fisheries later 1996.

Table 2.3: Protected Areas and Forest of Cambodia

Protected Area/Forest	No.	Hectares	% of Total Land Area
National Park	7	742,250	4.10
Wildlife Sanctuary	10	2,030,000	11.21
Protected Landscapes	3	97,000	0.54
Multiple Use Management Areas	3	403,950	2.23
Total Protected Area	23	3,273,200	18.08
Total Protected Forest	7	1,332,218	7.36
Total Amount	30	4,605,418	25.44

Source: MoE, 1993 and DFW, 2003

2.1.4 Biodiversity and Wildlife Resources

A complex interdependence of Cambodia's geography and hydrology makes it rich in natural resources and biological diversity, among the bio-richest countries in Southeast Asia. The areas with significant biological diversity are southwest of Cardamom and Elephant mountains, eastern section of Dangrek Range, northern and northeastern of Cambodia-Lao and Cambodia-Vietnam border, central plain of Cambodia and Tonle Sap Lake (MoE, 2003).

Cambodia is home to an estimated 2,300 plant species, some of them are very important for local communities e.g. medical plants that are used for treatment. Meanwhile, due to its richness in natural resources and forest cover, the forest area in Cambodia is home to 130 mammals. There are over 500 bird species mainly living in the wetland areas. Mekong River and its tributaries are home to about 500 species of freshwater fish in Cambodia.



Wall carving depicting rich biodiversity at Bayon

The Tonle Sap Lake and the wilderness wetland areas in the northeast of the country are unique and vitally important havens for many wetland species. Since the 1960s, the study on Tonle Sap area has recorded 225 bird species, more than 200 fish species, and 40 reptile species. Moreover, Tonle Sap area is the last stronghold in Southeast Asia for several globally threatened birds. The upper Mekong River in Cambodia is home to endangered freshwater dolphin (ADB, 2002). The continued

survival of freshwater dolphins, globally endangered watershed, and rare turtle species are testament to the importance of Cambodia as a last refuge for many of the wetland species in Southeast Asia.

2.1.5 Freshwater Resources

Geographically, Cambodia is surrounded by the mountainous and highland areas to the north, west and east. The central area is flat like a stove. Because of its geographical situation, Cambodia has many rivers and water bodies. The main rivers, which flow across the country, are Mekong, Tonle Sap and Bassac Rivers. About 86% of the country land area lay on Mekong catchments area. Tonle Sap, a freshwater lake in Cambodia, is a big largest tributary of the 10th largest river of the world, Mekong River. Cambodia has access to substantial surface water resources. An average, the annual inflow from upstream countries is estimated at 410 billion m³ and the internally generated flow 90 billion km³ per year. These data give total water/head of 45,000 m³ and internally generated water/head of 8,000 m³ (MOWRAM, 2000).

Table 2.4: The Water Use by Sector

Sector	Km ³ /year
domestic water	0.136
livestock	0.100
crops etc	0.455
industry etc	0.030
miscellaneous	0.079
Total	0.750

Source: MOWRAM, 2001

The water, at the moment, plays an important role in agriculture and fisheries. Cambodia is an agrarian country, where farmers in Cambodia need most water for growing more rice. The overall estimated water resources are at 500 km³. Total withdrawals of water are estimated to be 0.75 km³ per annum, of which 94% is for agricultural purposes. Following is the water use by other sectors:

Most of agricultural areas are rain-fed and only 16.62% of the total rice-growing areas are irrigated. Nevertheless, the irrigated area provides a

disproportionately large part of total food production (MoWRAM, 2001). At present, water for hydroelectric power generation is only at Ratanakiri station, O Chum-II, 1 MW, and Kirirrom-I, 12 MW. Water in Cambodia is, anyhow, unregulated and this phenomena places Cambodia in between a situation of too much water in wet season and shortage of water for agriculture in dry season. In return, the unregulated water damages Cambodian agriculture, infrastructure and household economy.

In Cambodia, the groundwater resource is extensive and abundant. It is estimated to contain 17.6 billion m³. The ground water is being exploited to an increasing extent particularly by shallow tube wells using for community and household water supply and irrigation (MOWRAM, 2001).

2.1.6 Fishery Resources

Cambodia is rich in fisheries. Tonle Sap Lake is the location providing most of the fish. The inflow of water from the Mekong River into the Tonle Sap Lake has brought along with huge amount of migratory fish into the Lake. The flooded forests, which are rich in nutrient, are the most suitable habitats for fish to grow, breed and lay egg. When the water of Tonle Sap receded, fish migrated toward the upper stream of Mekong River. More than 200 fish species reside in the Tonle Sap Lake. Some of them migrate upward and downward of Mekong River. Together with fish in Tonle Sap Lake, Mekong River Basin in Cambodia is also resided by about 500 fish species out of 1,200 of the country species (ADB, 2002).

Production of inland fish was estimated at 289,000-431,000 tons per year for the entire country, by van Zalinge and Nao (1999) based on catch surveys 1994-97, which made Cambodia's inland fisheries the most productive in the region (table 2.5). The revenue generated from inland fisheries is estimated between US\$ 150-200 million a year with an estimated retail value between US\$ 300-500 million (Van Zalinge, 2002) and from marine fisheries is about US\$ 30-50 million (Tana and Todd). Fisheries in Cambodia contributed 5-10% of the GDP (Van Zalinge and Leng, 2000).



Fishing activities in Tonle Sap Lake

Table 2.5: Annual Inland Fish Catch, mid-1990s

Type	Annual catch range (tones)
Large-scale fisheries	
- Fishing lot	25,000 - 75,000
- Dai (bag net)	14,000 - 16,000
Middle-scale fisheries	85,000 - 100,000
Family fisheries	115,000 - 140,000
Rice-field fisheries	50,000 - 100,000
Total	289,000 - 431,000

Source: MRC, 2002

According to tremendous natural resources and more tolerant natural conditions, Cambodia, is ranked as the fourth largest producer of freshwater fish in the world after China, India, and Bangladesh. About 25% of the total fish catch is exported (about 100,000 tons), half of which is exported through illegal channels. Approximately 75% of exports are delivered to Thailand, as fresh. The bulk of balance goes to Vietnam (MoC, 2002). About 50,000 tons of inland fish have been exported every year to Thailand (FACT and EJF, 2000).

Aquaculture in Cambodia plays increasing roles in fisheries production. The total aquaculture production is estimated between 6,000 tons to 15,000 tons annually. The share of aquaculture in the total inland fish production was 1.8% in 1994 and increased to 9.8% by 1990 and 12.4% in 1992 (FAO, 1994). Mekong delta aquaculture production contributed nearly half of the total fish culture of the country. Cage culture still dominates Cambodian aquaculture, most located in the Tonle Sap Lake. Pen culture is also undertaken in some part of the Tonle Sap Lake and Tonle Sap River. Pond culture starts recently in the southern part of the country, covering provinces with no natural fish.

Marine aquaculture is not much progressive so far. The marine fishery contributes significantly to national economy as well as local livelihood. The marine catch is estimated between 30,000-50,000 tons per year and has been increased since early 1990. An estimated 65-70% of the marine catch, in which 80% shrimp, is exported to Thai markets (FAO, 1994).

2.2 SOCIO-ECONOMIC DEVELOPMENT

Cambodia is an agrarian nation that largely depends upon productive natural resources for food and income. Agriculture remains an important sector for economic development, employing many rural populations. In the past ten years, more than 40% of the national GDP is derived from the primary sector consisting of agriculture, fishery and forestry. The industrial and services sectors, especially tourism, have been growing significantly over the last few years, contributing a significant proportion to economic growth.

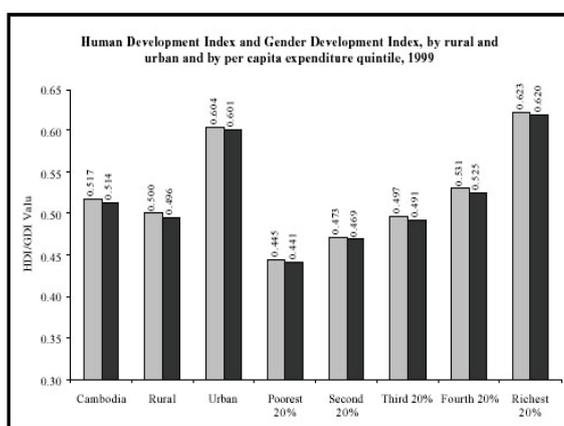
Cambodia continues to emerge gradually and steadily from a long history of war and economic deprivation. The Governmental institutions are re-establishing, the demobilization of arm-force has begun, and the overall standard of living and economic health are gradually increasing. A severely damaged and poorly maintained infrastructure is steadily rebuilding toward stability and security.

The country has fully integrated into the regional and international economic development. This integration has given an opportunity for Cambodia to develop its economy and attract more investment projects for the country. For the first time in almost three decades, Cambodia has now reformed different sectors aiming at raising productivity and living standard, to ultimately alleviate poverty.

2.2.1 Human Development

Cambodia is ranked at Number 130 on all the human development indicators. The Human Development Index (HDI), proposed by the UNDP, is one of several means of measuring the status of human development in Cambodia.

Figure 2.3: HDI and GDI, 1999



Source: Human Development Report (MoP), 2000

The HDI score for Cambodia in 1998 was estimated at 0.517, with only Laos and Bangladesh in Asia having lower scores. Cambodia's Gender-related Development Index (GDI) score (viz., 0.514) is very similar to its HDI score. The value of the Gender empowerment Measure (GEM) for Cambodia is 0.283. Apart from these, Cambodia's score of 42.53 on the Human Poverty Index (HPI) reflects the high levels of mortality and child malnutrition and the poor availability of public services in the country. In 2001, the HDI was estimated at 0.556.

There are large disparities within the country in these human development indicators. The HDI score for urban Cambodia is about 21% greater than that for rural Cambodia. Likewise, there are large disparities in both HDI and GDI across economic groups. The richest 20% of Cambodians have an HDI score that is 40% greater than that of the poorest 20% of Cambodians. The HPI also differs significantly across socio-economic groups, with the poorest consumption quintiles suffering to a much larger extent from human poverty than the richest quintiles. In addition, human poverty is greater among Cambodian women than among men across all economic groups (Figure 2.3).

Table 2.6: Human Development Indicators

Human development index (HDI) value, 2001	0.556
Gender Relate Development Index	0.551
Education index, 2001	0.64
Total Fertility Rate	4.8
GDP per capita (US\$), 2001	278
Incidence of Poverty, 2000	36.1
Life expectancy at birth, 2001	57.4
Access to Rural Safe Water, 2000 (%)	26
Adult HIV Prevalence, 2001	2.7
Adult literacy rate (% age 15 and above), 2001	68.7

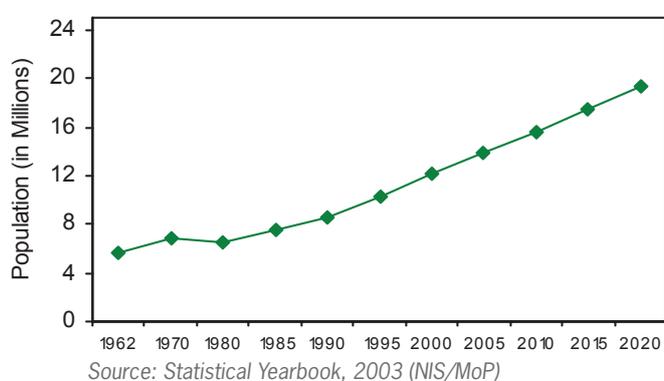
Source: Human Development Report, UNDP 2003

On the other hand, because of the decimation in the Khmer Rouge regime and the baby boom that followed, the population of Cambodia, about 11.4 million in 1998, is very young and growing rapidly. In 1998, 43% of the population was under 15 years of age. Thus, a high dependency ratio is common, particularly in poorer household. With added pressure from returnee refugees and the plan for demobilization of soldiers and downsizing of civil service, indications are that the demands for jobs and social services will increase rapidly over the next several years.

However, Cambodian labor market is characterized by generally high rates of participation (80-90%) among both adult males and females. Labor force participation rates for women exceed those for men at ages 15-19 years, are approximately equal at ages 20-24 years, but are significantly lower at all older ages. As for employment sectors, approximately three-quarters of all adult Cambodian workers cited their sector of employment as agriculture. Farming, fishing and forestry works are the most important occupations in Cambodia, with 71% of all male workers aged 15 years and over and 79% of female workers reporting these activities as their primary occupations.

2.2.2 Population and Urbanization

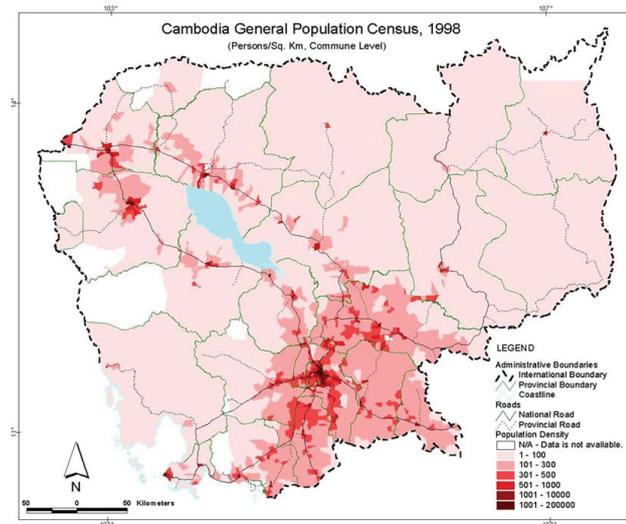
The general official population census was conducted only in 1962 and 1998. The population in 1962 and 1998 was 5.7 million and 11.4 million, respectively.

Figure 2.4: Population of Cambodia: 1990-2003

By 1970 the population was estimated to have grown to 6.8 million with an increase of 19% over an eight-year period or an average annual growth rate of 2.2%. Due to the tragic loss of lives during genocide years of the Khmer Rouge regime, by 1981 the population had declined to 6.7 million. This 1981 estimate compares to an adjusted 1998 Population Census estimate of 11.4 million, implying an average

growth rate of 4.0% per annum to 1998. However, an average growth rate is estimated to be 2.5% from 1998 to 2003. Similarly, with the growth rate, the population was estimated to be 13 million in 2003. In terms of future population growth, Cambodia's population is projected to increase to 13.8 million by 2005, 15.5 million by 2010, 17.4 million by 2015, and 19.3 million by 2020 (Figure 2.4).

Map 2.3: Population Distribution 1998



Source: GIS-MoE and NIS-MoP, 1999

Geographically, the population distribution is unequal and the density among the regions differs greatly across the country. 1998 General Population Census indicates that approximately 52% of the total population lives in the plain region covering an area of about 14% of the total land area with a population density of 235 persons per km². Meanwhile, about 11% lives in the plateau and mountainous region covering about 38% of total land area with 17 persons per km². A further 30% of population lives on and around the Tonle Sap Great Lake with a 37% of the total land area and the population density of 52 persons per km². Just over 7% of the population lives in the coastal region with less than 10% of the total land area and population density of 49 persons per km². In 2000 and 2003, the population density increased to 72 persons per km² and 76 persons per km², respectively.

Majority of the people in the rural areas depend on the uses of natural resources for their livelihoods. Since last few decades, natural resources have been gradually degraded that affect livelihoods of rural households. There is a trend of rural urban migration as results of resource decline. The 1998 General Population Census indicated that 31.5% of the total population was a migrant. About 37% of migrants migrated as family move and other 15% migrated for searching employment. More people migrated to urban each year for employment. At least 100,000 to 150,000 jobs are created each year, mostly in urban cities. However, the labor force is projected to grow at over 3.2% per year, meaning that there will be around 228,000 people migrate to seek employment in the urban areas.

Urbanization rate in Cambodia is still low about 15% (ASEAN, 2001 and SEDP-II, 2001) and about 84% of populations live in rural areas with the density of 259 persons per km² (GPC, 1998). The current Phnom Penh urban population is estimated at about 1 million people and the rural urban migration into Phnom Penh results in pressuring on the urban areas. The urban area is expected to be rapidly increased in the future and involved with the increased dominance the primate city of Phnom Penh of approximately 10 times the population size. The current existing urban infrastructure is inadequate to receive the overwhelming population (SEDP-II, 2001-2005). The urban population is projected to grow at around 3.4-3.5% during the 2001-2005 a year (SEDP-II, 2001; NIS, 2003). The open unemployment rates were 9.2% in urban areas and 4.7% in rural areas (SEDP-II, 2001).

2.2.3 Gender Equity

Females outnumber males in the Cambodian population. Women constitute 51% of the total population. About 84% of the total woman populations live in rural areas. They depend on farming, fishing and took forest as primary sources of household food and incomes. The female

adult literacy rate accounts for 57% compared to 79.5% of males (GPCC98). The status of women in tradition Khmer culture was relatively high by Asian standard, but today, females in Cambodia do not enjoy equal access to the resources and the benefits of development. Women have less access to education, especially higher levels of education attainment, less access to paid employment, especially the higher categories of the occupational scales, and less access to land ownership and other property rights (MoP, 2002). Women are less able than men to translate labor into income, income into choice and choice into personal well-being. Under such circumstances, they are particularly vulnerable to poverty.

The degradation of natural resources has impacts on women and men. Women travel longer distance to collect firewood, water and fish. When fish catch is declined, women and children engage more in fishing together with husbands. Other direct impacts include the increased workloads for women as they take care of day-to-day food for the family. Female headed-households tend to lack access to male labor; capital or saving, become land-poor and are characterized in higher level of dependency. In spite of this, the gender division of labor is breaking down with women and men playing increasing interchangeable roles in fishery and agriculture because women are called on to meet the needs of poor households. In the five provinces around the Tonle Sap Lake, women constitute about 51% of the population and head about 23% of households. In the floating villages, women are engaged more in fishing, fish processing and fish trade. In the land based villages, they are increasingly involved in rice and vegetable production to generate in incomes since they have no other choices and the accesses to natural resources are declined. There is a growing trend toward landlessness among female-headed households because capital, which mostly comes from the natural wealth, is shortage (ADB, 2002).

Table 2.7: Woman participation in Economic Development

Woman Participation in Sectoral Employment	Percentage
Female share in wage employment in agriculture	35%
Female share in wage employment in industry	44%
Female share in wage employment in Services	21%

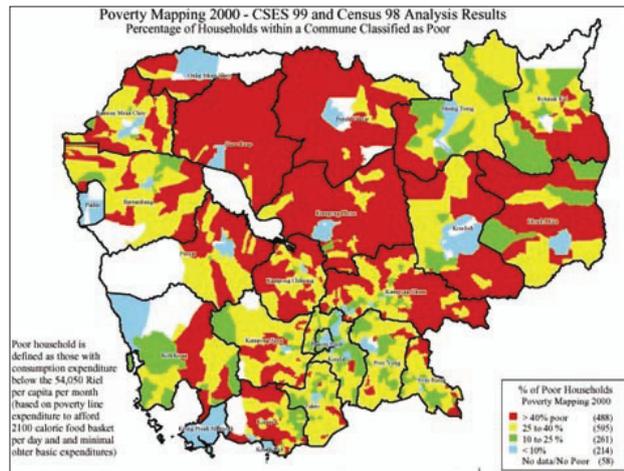
Source: Cambodia Millennium Development Goals Report, 2003

There are an increased number of rural young women migrate to work in urban service and industrial sectors. With the establishment of export-processing garment factories in the mid 1990s, some 100,000 mostly young women work as wage earners in Phnom Penh, with average salary around US\$ 40 per month (MoP, 2000; Sida, 2001). The table 2.7 demonstrates that the share of female employment (SWE) in the industrial and service sectors were 44% and 21% respectively while the percentage of women engaged in agriculture remained at 35% in 1998. SWE in industry was increased to 60.8% in 2001, and has slightly increased from 21% in 1998 to 25% in 2001 in service sector (MoP, 2003).

2.2.4 Poverty

Poverty is linked with environmental degradation. The poor are losing their mean of livelihood following the degradation of natural resources. They are forcing themselves to exploit the diminishing resources to support their day to day living. About 36% of Cambodia populations are living below the poverty line, down from 39% in 1993-94 (Socio-economic survey, MoP, 1997). On a regional basis, poverty incidence declined in such period in secondary cities from 37% to 30% and moderately in rural areas from 43% to 40%, and remained at 11% in Phnom Penh. Rural households account for almost 90% of Cambodia's poor (SEDP-II, 2001-2005). Despite the expanding economy, more than a third of population has income less than US\$ 1 per day (ADB, 2003).

Map 2.4: Poverty Map of Cambodia



Source: MoP, UNWFP & UNDP, 2001

The highest poverty rate, 44%, is found among households headed by farmers whose livelihood depended primarily on the natural resources. The poverty incidence within this group remains high due to their declined livelihood basis. Conversely, households headed by government officials have a poverty rate of 18%. The Poverty rates are high for household whose head has no formal education (42%) or has only primary schooling (40%). These two groups account for four-fifths of the poor. The prevalence of poverty among households whose heads had completed lower and higher secondary education level falls to 24% and 12% respectively. The poverty average of 33% is found in female-headed households, who are divorced or abandoned by her husband during the country's decades of civil war. They are making up the poorest of Cambodian's poor since a third of them are living below the poverty line (UNDP, 1998) compared with 37% in male-headed households (SEDP-II, 2001-2005).

The Tonle Sap Region has the highest population of 38% living below poverty line i.e. higher than the national level (36%); even this region is rich in natural resource in the country (ADB, 2002).

2.2.5 Public Health

Poor health contributes to poverty through reduced productivity and increased household indebtedness, mostly in rural areas. In Cambodia, the levels of morbidity and mortality from infectious communicable disease such as malaria, dengue, tuberculosis, diarrhea, acute respiratory infections, and sexually transmitted diseases are high among the highest in the world. Problems are aggravated by inadequate water supply, sanitation and health services (SEDP-II, 2001-2005).

Health issues and related diseases are at some points the result of environmental degradation. About 71% of the populations do not have access to safe drinking water and 20% are undernourished (GPCC, 1998). Flood and drought cause direct and indirect impacts on people's health. Water pollution directly creates health problems including diarrhea and water born diseases, some time, caused by the chemical substance, industrial waste, chemical pesticide and fertilizer. The degree of its impacts on the environment, living and none living aquatic organism is not well assessed. In addition, the poor get sick due to food shortage, overwork loads, poor shelters, poor sanitation and natural disaster.

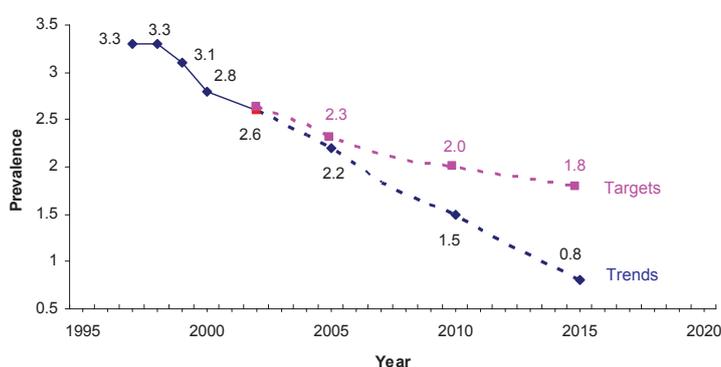
Access to the health services for the poor is constrained by high costs, which are currently the main impoverishing factor in Cambodia. Their physical performance and incomes are mostly generated from natural resources that have been disrupted. Since the clean water

and sanitation facilities are insufficient, they have to spend over a third of the incomes to meet their health care needs. For the poorest villages, the nearest public clinic is in average 4km away, then, they become non-treatment or self-medication (SEDP-II, 2001-2005).

Mortality rate is still high in Cambodia. Estimates of the infant mortality rate are 88 per 1,000 live births for males and 72 per 1,000 for females. Life expectancy at birth is 54.4 years for males and 58.3 years for females (NIS/MoP, 1999). Maternal mortality ratio (per 100,000 live births) is estimated at an average of about 437 over the period 1994-2000. The government targets the maternal mortality ratio to 140 per 100,000 live births by 2015 (CMDG, 2003).

Highest HIV infection, i.e. 50 to 70 persons believed to catch the virus every day in Cambodia, has contributed to high mortality rate. The HIV/AIDS Control Center estimates that 150,000 Cambodians, i.e. 1.4% of the population or 2.4% of adult population aged between 15 and 49, carry HIV (UNAIDS, 1998). About 90% of those infected are unaware that they have such disease. However, HIV prevalence rate in adult (15-49) population fell from 3.3% to 2.6% between 1997 and 2002 (CMDG, 2003). The National AIDS Authority is responsible for policy development, strengthening partnership relations with all stakeholders and coordinating the multi-sectoral response to HIV/AIDS. In terms of HIV/AIDS prevention it has been shown that public information and education has had a great impact on the general awareness of HIV/AIDS among Cambodian population. More and more people are now aware of HIV/AIDS, but behavioral change in some population groups remains limited. In this regard, there should be specific programs for different population groups so that appropriate methodologies can be used for the various target audiences.

Figure 2.5: Trends and Targets in HIV Prevalence among adults aged 15-49



Source: Cambodia Millennium Development Goals Report (MoP), 2003

The total fertility rate estimated at 5.3 live births per woman in 1998 is only marginally higher than in 1996 at 5.2 (MoP, 1999). About 20% of the women were using some forms of family planning or birth spacing with the injection - the method most often used. At the same time, about 78% of Cambodian couples of reproductive age were interested in birth control or spacing, but they were unable to do so due to inadequate supply of contraceptives and limited access to family planning services (UNICEF and UN-WFP, 1998). In this regard, the fertility rate is likely to remain high.

2.2.6 Education and Literacy Level

Adult literacy rate in Cambodia accounts for 67.3%, of which male adult literacy rate constitutes 79.5% while female accounts for 57%, i.e. very much lower than those of males both in urban and rural areas. In urban, the male adult literacy rate accounts for 88.3% while woman accounts for about 71%.

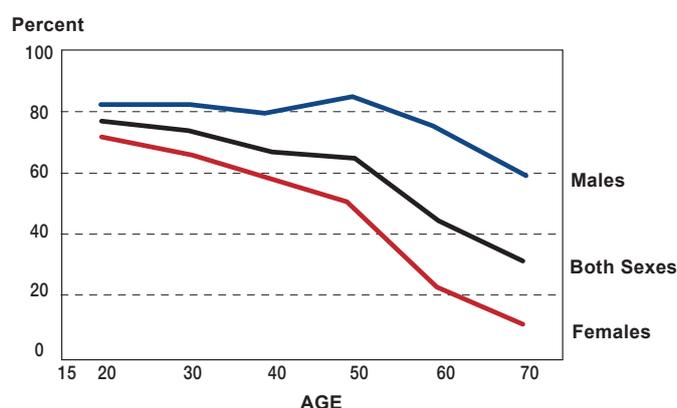
Table 2.8: Adult Literacy Rate in 1998

Total/Urban/Rural	Both sexes	Male	Female
Total	67.3	79.5	57
Urban	79.1	88.2	70.8
Rural	64.9	77.6	54.3

Source: MoE, 1993 and DFW, 2003

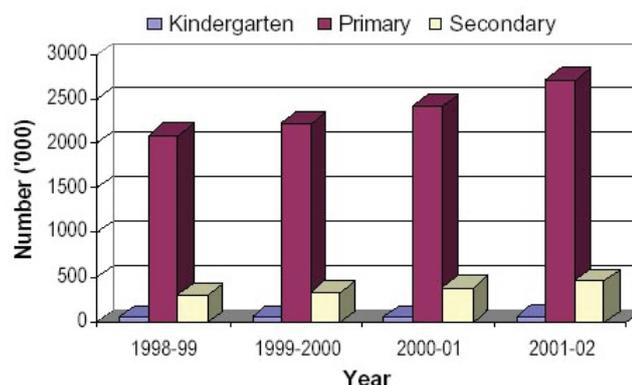
The age groups between 35 and 65 have more knowledge about the natural resources and environment than young group. The old people live more closer to natural environment such as forest and fish. Young people have lesser interaction with environment as the natural environment has largely disappeared by the time they were born.

Figure 2.6 shows the literacy rate across ages. The adult literacy rate of age group of 15-24 accounts for 76%, the highest compared with others. However, male adult literacy rate of age group of 45-54 accounts for 84%, also the highest compared

Figure 2.6: Adult Literacy by Age Group and Sex

Source: Population Census, 1998

The student enrollment numbers have been increasing. Figure 2.7 shows student enrollment in educational institutions over the last five years. The overall participation in pre-schooling (kindergarten) remains low. The estimated gross enrollment for 3-5 year age group is only around 5%. Girls represent roughly half of the enrollment. The number of students enrolled in the primary schools had increased from 2.2 million in 1998 to 2.8 million in 2001. This represents an enrollment growth of around 27% over this period. Gross Enrollment Rate (GER) in lower secondary grade 7-9 and upper secondary grades 10-12 were 23.0% and 8.7% respectively in the year 1998. The data for 1999-2000 suggested GER of 22.9% (lower secondary) and arose to around 11.6% (upper secondary). Net Enrollment Rate (NER) for lower and upper secondary was lowest at an estimated 14.4% and 8.0% respectively in 1998-99. Females represent only one-third of both lower and upper secondary enrollment.

Figure 2.7: Enrollment of Students by year

Source: Statistical Yearbook, 2003

2.2.7 Energy Use

The sources of energy in Cambodia come from fuel wood and petroleum. Petroleum is the main source of commercial energy for power generation, industry, transport, and residential and commercial sector. The fuel wood remains important energy for rural households, which constitutes 84% of the total population.

In 1996, nearly 80% of population used kerosene for household lighting, while 13% of population lights their houses by public electricity (SECS, 1996). In 1998, the percentage of population having access to city power was estimated at about 12.5% of the total population, among which 49% was in urban and 6.3% in rural area (see table 2.9). However, the percentage of households having access to the electricity has increased to about less than 15%, so far. The public electricity supplies have been expanding with 24 small isolated power systems, which serve Phnom Penh and the provincial towns. Kerosene is still popularly used for lighting for about 80% of the total population, of which the rural households accounts for 86% and urban households 43%.

Table 2.9: Distribution of Household by Main Source of Light

Urban/ Rural	Total	City Power	Generator	CityPower & Generator	Kerosene	Battery	Other sources
Total	100	12.5	1.0	1.6	79.9	3.5	1.5
Urban	100	49.2	1.8	2.6	43.1	2.4	0.9
Rural	100	6.3	0.9	1.4	86.1	3.8	1.5

Source: GPCC, 1998 and NIS/MoP

In 1996, about 92% of the population used firewood and another 5% used coal for cooking. In 1998, 90% of the population, of which 94% are rural households, used firewood for cooking. It is estimated that rural communities use 5 million tons of wood and 8,000 tons of charcoal every year. With no available alternatives, the rural populations use enormous amount of wood to meet their fuel needs. The demand for fuel wood is predicted to grow indicating clearly that alternative source of energy is needed to make available for rural communities. The number of urban households using the fuel-wood and charcoal for cooking is believed to have declined due to the increase in use of liquefied petroleum gas. However, the fuel-wood and charcoal still remains widely used as their major energy source for cooking.

Table 2.10: Distribution of Household by Main types of fuel for cooking

Urban/ Rural	Total	Firewood	Charcoal	Kerosene	LiquefiedPetroleum Gas(PLG)	Others
Total	100	90.0	5.3	1.8	1.7	1.2
Urban	100	64.9	22.5	2.8	9.1	0.7
Rural	100	94.3	2.3	1.7	0.5	1.2

Source: GPCC, 1998 and NIS/MoP

2.2.8 Transportation

The current transportation in Cambodia consists of the road networks, railways, inland waterways and air transport. Road networks, which are rehabilitated by the government, consist of 4,153 km of national road, 3,555 km of provincial road and 28,000 km rural and strategic road.

The rehabilitation work includes road enlarging, the resident relocating and clearing bushes along the road. Environmental and social implications are now visible as a result of the

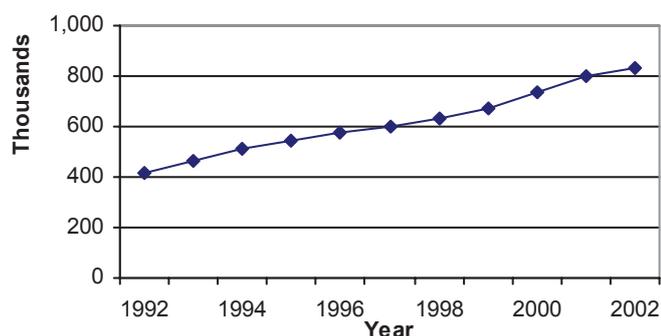
road construction. The main financial sources for national road rehabilitation are the loan from ADB and WB. Both the MPWT and MRD have ambitious plans to rehabilitate their respective networks. During the last 10 years, about 500 km of the main national (primary) roads (incl. bridges) have been improved and another 1,200 km of national and provincial (secondary) roads have been rehabilitated. Up to 2003, the RGC has rehabilitated more than 1,000 km of national roads and 3,000 km of tertiary roads, financed by both the government and development partners. Attention is also being given to road maintenance. The MPWT launched in 2003 a US\$ 1.75 million Routine Maintenance Program, funded by Japan. A total of 1,242 km of national roads will be maintained under this project. Currently, the rehabilitation of all main national (or primary) roads (NR1-7), in total length of the 1,988 km, was secured. It is expected to complete at the end of 2006. In 2003-2005, the RGC plans to rehabilitate and repair more than 1,000 km of the main and other national roads. Cambodia still faces serious challenges in road maintenance, due to unreliable budget disbursement.

There are two railway lines. The first line is from Phnom Penh to Poipet, a town located along Cambodian-Thai border, western part of the country, with the total length of 385 km. Up to 2002, the train could ply only 237 km, from Phnom Penh to Serey Sophorn, provincial town of Banteay Meanchey. The second line is from Phnom Penh to Sihanoukville with total length of 264 km.

In Cambodia, numbers of vehicles are imported and most of them are second-hand. The figure 2.8 estimates the number of imported vehicles by year from 1992 to 2002. There were 418,118 and 828,991 vehicles imported in 1992 and 2002, respectively. In 2002, an estimated 681,201 vehicles or 82.2% were registered or operating in Phnom Penh, with an estimated 147,990 vehicles or 17.8% in the provinces. Motorcycles account for 586,278 vehicles or 70.7% of the 2002 total, followed by cars, minibuses and pickups for 209,128 or 25.2%, trucks for 29,968 or 3.6%, buses for 3,196 or 0.4%, and 421 were special vehicles (NIS/MoP, 2003).

The total of 200 and 219 registered vessels were operating on the river system and coastal water in 2002, respectively (NIS/MoP, 2003). With an increasing number of boats/vessels, the river, Tonle Sap Lake and coastal water could be polluted, if any actions and measures are not properly taken.

Figure 2.8: Estimated Number of Vehicles imported by year



Source: Statistical Yearbook, NIS/MoP, 2003

In Cambodia, the first attempt to evaluate GHG mitigation options in the energy, agriculture and forestry sectors was done under the Cambodia Climate Change Enabling Activity Project (CCEAP) in 2000. The evaluation covered the period up to 2020. As a developing country (non-Annex I) Party to the UNFCCC, Cambodia has no obligation to reduce its GHG emissions. While climate change has not been a specific focus for the government, many government activities and measures also contribute to the global effort to limit GHG emissions and develop GHG sinks. These include creation and management of 23 protected

areas covering approximately 18% of the country's land area; establishment of various legal instruments related to forest management, waste management and air pollution; promotion of energy efficiency and development of renewable energy; and current efforts to eliminate illegal logging (Cambodia's Initial National Communication/CCEAP, 2002).

2.2.9 Agriculture

Cambodia is an overwhelmingly agrarian society with 95% of the poor living in the rural areas. The main agricultural products comprise of paddy rice, livestock, fish, forest, rubber and other crops. Table 2.11 shows number of people employed in agricultural sector. In 2001, paddy rice, crops and livestock sector engaged more than 96% of the total employed manpower, while fishery, forestry and rubber sector engaged more than 3%. Paddy rice is rain-fed cultivation, which is commonly subject to serious disturbances. The large variability in output from year to year results in volatility of the natural condition including exceeded rainfall, flood and droughts.

Table 2.11: Employment in Agricultural Sector by year(000's & %)

Year	1999		2000		2001	
	(000)	%	(000)	%	(000)	%
Agriculture	3,790	100	3,839	100	3,903	100
Paddy	2,813	74.22	2,850	74.24	2,901	74.33
Other Crops	486	12.82	497	12.95	510	13.07
Livestock	368	9.17	370	9.64	374	9.58
Fishery	78	2.06	79	2.06	80	2.05
Rubber	22	0.58	22	0.57	22	0.56
Forestry	23	0.61	21	0.55	16	0.41

Source: Calculated by CDRI from WB, ADB, IMF and Cambodia Government data, 2002

Total cultivated area in 2002 was 2.2 million ha, compared to 2.3 million ha in 2001. Approximately 2.1 million ha of paddy rice were cultivated in 2002, compared to 2.2 million ha in 2001. Yield per hectare decreased from 2.07 tons in 2001 to 1.92 tons in 2002 due to drought and late flooding, resulting in overall production falling from 4.1 million tonnes in 2001 to 3.8 million tonnes in 2002. Wet season paddy production decreased 11% to 2.9 million tonnes, while dry season paddy production increased 10.2% to 0.9 million tonnes in 2002.

Production of other staple crops decreased 18.2% from 556,000 tons in 2001 to 455,000 tons in 2002, while production of cash crops increased 28% from 209,000 tons in 2001 to 268,000 tons in 2002 (NIS/MoP, 2003).

Table 2.12 shows share of agriculture to GDP, which had declined from 34% in 1999 to about 30% in 2000, and further down to 28.4% in 2001 (SEDP-II, 2001; CDRI, 2002). Based on data analysis, although, there is a slight increase in number of population employed in agriculture, the decline in GDP leads to decline in employment of the rural population labor force. Figure 2.10 also illustrates the contribution of agricultural sector to national GDP in 2001.

Table 2.12: Breakdown of GDP by Sector

Structure of Nominal GDP (in percent)			
Year	1999	2000	2001
Agriculture	33.90	29.50	28.40
Crops and Livestock	25.60	22.20	22.00
Fishing, Rubber and Forestry	8.30	7.30	6.40
Industry	21.80	25.10	25.60
Garment	7.00	11.50	12.60
Other Industry	14.70	13.50	13.00
Services	44.30	45.40	46.00
Tourism	6.60	7.40	7.80
Other Services	37.70	38.00	38.10
Total	100	100	100

Source: CDRI, compiled from the government primary data, 2002

The development in the past few decades relied largely on natural resources to generate national revenue. By the way, the contribution of forestry sector to national GDP has declined from 4.7% in 1996 to 4% in 1999, and kept downward in 2000. Table 2.13 shows real GDP growth by sector from 1999 to 2001.

Table 2.13: Real GDP Growth by Sector (in percent)

Year	1999	2000	2001
Agriculture	1.40	-2.40	0.70
Crops and Livestock	6.50	-0.90	3.30
Fishing, Rubber and Forestry	-13.20	-7.80	-9.10
Industry	12.60	16.70	11.20
Garment	40.40	59.50	24.60
Other Industry	3.20	-2.90	1.10
Services	9.40	7.50	6.10
Tourism	16.00	13.40	8.80
Other Services	8.40	6.50	5.60
Total	6.80	5.50	5.30

Source: CDRI, compiled from the government primary data, 2002

In 2002, activities in timber industry declined significantly due to government effective campaign against illegal logging.

Fishery sector performed above the expectation in 1996-2000, with valued added rising from 8.9% of GDP to 10.5% in 1999. In 2000, the government collected less than US\$ 3 million from the fishing lots. However, there is a concern on the unsustainable annual growth rate that exceeds 5% (SEDP-II, 2001).

2.2.10 Industry

Industry was the main engine of the real GDP growth in 1999, increasing its share of GDP, as the textile industry continued to expand and construction experienced a strong rebound after the two years confrontation. The textile industry is now a major source of employment and foreign exchange earning (ADB, 2001).

Table 2.14: The GDP shares in industrial sector and GDP growth

Year	1999	2000	2001
The Real GDP Growth in Industry			
Industry	12.6 %	16.7 %	11.2 %
Garment	40.4 %	59.5 %	24.6 %
Other Industry	3.2 %	-2.9 %	1.1 %
The Share of Industry in GDP			
Industry	21.8 %	25.1 %	25.6 %
Garment	7.0 %	11.5 %	12.6 %
Other industry	14.7 %	13.5 %	13.0 %

Source: CDRI, compiled from the Government primary data, 2002

Industrial sector in Cambodia remains at small scale, but its share in GDP had increased from 22% in 1999 to 26% in 2001 (Table 2.14). It employed about 8% of labor force in 2000 and rapidly grew at about 10% per year in a real term during 1999-2000. The garment industry, electricity and water were the most dynamic sub-sectors. The activities in the rest of industry grew relatively slow. In

2001, the garment industry remained the dominant manufacture sector in Cambodia.

The garment industry attracts young cheaper labor forces mostly women from many parts of the country especially rural areas. More young women migrate to urban areas to work as garment factory worker. The migration to seek employment in the urban areas is increasing because of poor employment opportunity in rural areas and the decline in natural resources.

More industries have been operating without an appropriate environment impact assessment. The discharge of liquid and solid wastes from the garment factories to surrounding water bodies poses major urban environmental concerns, especially water pollution. The fact is that the textile sub-sectors located in the environs of Phnom Penh have inevitably encouraged rural-urban population migration as unskilled labor to earn high income. This, in turn, increases the pressure of over-burdened urban facilities and contributes to urban social problem (SEDP-II 2001).

2.2.11 Service and Tourism

The service sector has been growing rapidly since 1992. Between 1992 and 1996, this sector increased about 10% per year (CDRI 2002). Between 1999 and 2001, this sector shared about 45% of the GDP and employed 15% of labor force (CDRI 2002).

Cambodia's tourism development potential is based on both cultural and natural assets. The government views tourism as a way to generate foreign currency through the promotion of eco-tourism in Cambodia on certain areas, located particularly along the coastlines, and national parks. The share of tourism to GDP has been raised from 6.6% in 1999 to 8% in 2001. Despite this, there was a slowdown of the growth from 13.4% in 2000 to 5.6% in 2001 (CDRI 2002)¹.



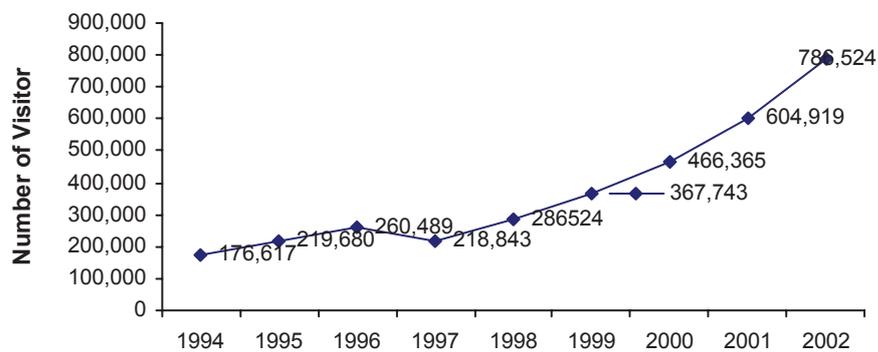
¹ CDRI, Cambodia's Annual Economic Review-2002, August 2002

Table 2.15: The share of service sector and tourism in GDP

Year	1999	2000	2001
The real GDP Growth in Service Sector (%)			
Services	9.4	7.5	6.1
Tourism	16.0	13.4	5.6
Other services	8.4	6.5	8.8
The Share of Tourism in GDP (%)			
Services	44.3	45.4	46.0
Tourism	6.6	7.4	7.8
Other services	37.7	38.0	38.1

Source: CDRI 2002

Second Socio Economic Development Plan (2001-2005) highlights that, to be sustainable for tourism development, the maintenance of the integrity of cultural and religious tradition is of vital importance together with the sound management of the natural and built environment. Temples and archaeological sites, forest, lakes, rivers and national parks need to be conserved. Pollution and other potential adverse impacts need to be effectively addressed. However, the impacts of the tourism on local culture, natural resources have not been predicted. At the same time, there is not enough information about the increase both waste and solid waste generated by tourism and how the authority deals with these. There is not enough information about the impacts of tourism on the protected areas as well.

Figure 2.9: Number of Tourists Visit Cambodia by Year

Source: Ministry of Tourism, 2003

PART 3: KEY ENVIRONMENTAL ISSUES

3.1 LAND DEGRADATION

Land degradation refers to loss of its productive capability as a result of degradation of soil quality due to human activities and natural processes. Human activities include unsuitable agricultural land use, land encroachment, logging, poor soil and water management practices, and infrastructure development. Natural events such as draughts and floods also cause land loss and deteriorate functional capabilities of soil. Unplanned land use is a major cause of land degradation, both in terms of deterioration of topsoil quality and loss of land. Solving this problem, therefore, should be based on integrated multi-sectoral approaches.

In Cambodia, there is no direct government policy on converting more land to agriculture or urban land expansion, but the policy has focused on land administration. An important element in land management by the government is the provision of improved tenure security. The government is focusing on accelerating the provision of private land titles in the hopes that secure title will lead to improved management of natural resources, improved land husbandry, and poverty alleviation. Government also needs to improve its overall coordination of land use planning and land allocation. This includes improving the land inventory system and the national classification system and developing land use plans for forests, agricultural development areas, key urban areas, and road corridors (Cambodia Environment Monitor 2003).

Land is becoming progressively more concentrated in Cambodia with potential for sectoral development. Although there have been relatively few studies on land resource of the country, the growing concern over land degradation is taken into account amongst Cambodian people. Farming, land encroachment and clearing for agriculture, logging, infrastructure and other development initiatives is increasingly exposing sandy soils to erosional forces, leading to significant problems in some areas. Due to severe soil quality problems, there appears to be low potential for yield increases across approximately 50% of Cambodia's cultivated areas (McKenny and Prohm Tola 2003).

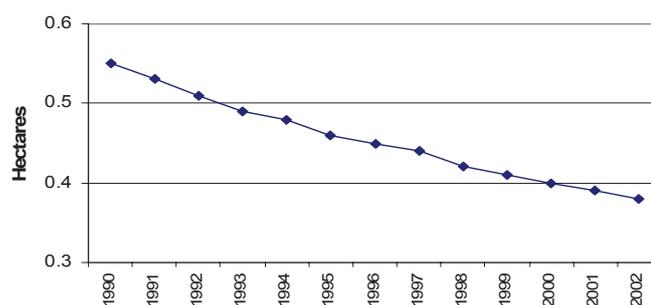
The land degradation section of this report deals with causes of land degradation, in which state and impacts, along with policy responses are highlighted.

3.1.1 Farmland

The Cambodian population depends on agriculture. Increasing agriculture productivity would have a significant impact on economic growth and poverty reduction in Cambodia; agriculture is the most important economic sector in the country, accounting for about 40% of GDP and employing approximately 80% of the labour force. Agriculture has played an important role in ensuring food security (MAFF 2002).

The agricultural land holding is about 1 ha per family. However, about 20-30% of the total population owns land greater than 1 ha per household (nearly 70% of the total agricultural lands), and 30% of the total population owns land between 0.5-1.0 ha per household (nearly 20% of the total agricultural land). The rest of the population (about 40-50%) owns land less than 0.5 ha per household (10% of total agricultural land), which is subject to fragmentation and eventual over-exploitation of land (CDRI 2000). Figure 3.1 demonstrates the agricultural land per capita decreased significantly from 0.55 ha in 1990 to 0.38 ha in 2002.

Figure 3.1: Agricultural land per capita
Agricultural Land per Capita



Source: FAOSTAT July 2004 - Population Database

Due to rural population growth and increasing demand in agricultural productivity, the application of organic and inorganic fertilizer is now being introduced to the fields in order to replace nutrients lost in the previous crop, for example, currently about 82% of rainfed lowland farmers apply fertilizers (Rickman et al. 1995; John et al. 1996). A large number of farmers apply inorganic fertilizer between the seedling and booting stages. Sources of organic fertilizer are urea, di-ammonium phosphate (DAP) and 16-20-0 of N-P-K. Cambodia does not produce pesticides and fertilizers and all agricultural chemicals must be imported. There are only few agrochemical distributors in the country; 26 companies recently applied for the permission to carry out the business operation relating to the import of agricultural chemicals, fertilizer and manure. There is growing evidence that agricultural chemical use has gradually increased (MAFF 2004: Annual Conference on Agriculture, Forestry and Fishery).

Table 3.1: Import of fertilizer for agriculture

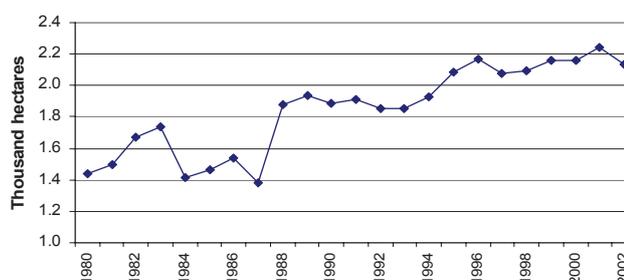
Imported Year	Fertilizer('000 tonne)
1989a	46
1994a	80
1995a	90.5
1996a	88.3
2000b	71.1
2001b	37

a- Fertilizer Procurement and Distribution in Cambodia: Issues and Option, 1996.

b- Bureau of Agricultural Materials Standard (BAMS), 2001

Fertilizer import for agriculture is demonstrated in Table 3.1. In 1989, the total imported fertilizer was 46,000 tons. In 1994 and 1995, the import of fertilizer increased to 80,000 tons and 90,449 tons, respectively. Fertilizer import decreased to 88,340 tons in 1996, 71,131 tons in 2000 and in 2001 to only 37,000 tons (BAMS 2001). In actual, the total demand of fertilizer has increased in Cambodia as rice production area has expanded, particularly dry season rice area.

Figure 3.2: Cultivated areas
Cultivated Areas

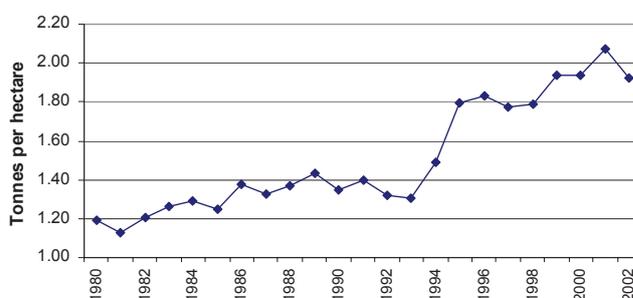


Source: Statistical Yearbook, NIS/MoP, 2003

The total cultivated area has increased from 1.4 million ha in 1980 to 2.1 million ha in 2002 (Figure 3.2). The cultivated area growth is estimated to be 30,000 ha annually. However, most of the cultivated area is under rice paddy field which covered 1.6 million ha in 1982 and 2 million ha in 2002.

Yield of rice per hectare has increased from 1.2 tons in 1980 to 1.9 tons in 2002 (Figure 3.3). Due to recent droughts and floods, yield reportedly decreased during the last few years, for example, in 2001 and 2002, from 2.07 tons per ha to 1.92 tons per ha, resulting in overall production falling from 4.1 million tons in 2001 to 3.8 million tons in 2002 (NIS/MoP 2003). The average yield in 2003 accounted for 2.1 tons per ha with an increase of 0.14 tons per ha higher than the last year. The total production in 2003 was 4,710,957 tons with an increase of 888,448 tons higher than the last year (MAFF 2004). However, farm productivity in the country as a whole is the lowest in all of Southeast Asia, with rice yields averaging 1.8 tons per ha compared with an average of 3.9 tons per ha in Vietnam and 4.0 tons per ha in Thailand, countries with similar climates and resource endowments.

Figure 3.3: Average rice yields
Average Rice Yields



Source: Statistical Yearbook, NIS/MoP 2003

Consequently, the farmers are forced to depend on the diminishing land resource base with an increased use of chemical inputs in order to produce more outputs. Unregulated and poor land use practices in cultivating areas have resulted in soil nutrient depletion and erosion. Soil erosion reduces the productivity, requiring farmers to apply more and more fertilizers, both organic and inorganic, that help check falling productivity. Nevertheless, many small-scale farmers cannot afford to buy these inputs and so get low yields.

In Cambodia, dry season rice field covers about 11% of the total rice production areas and most of this is under receding areas. Moreover, fertilizer consumption rates in this area are generally low compared to other countries. Although, there is no specific study on the impact of fertilizer in this area, but is presumably small.

Cambodia's staple foods of rice and fish are threatened by the effects of deforestation. Soil erosion reduces the amount of productivity of arable land. An increase in the frequency of occurrence of floods and droughts has a linkage with the deforestation and has affected livelihood and security of the people.

The Royal Government of Cambodia through MAFF has been carrying out the Agricultural Productivity Improvement Project (APIP). The project partly addresses the productivity of the agriculture through soil improvement. As in its current five-year Agricultural Development Plan, 2001-2005, MAFF has outlined its major agricultural goals, whose objectives are to ensure food security, increase the value of agricultural products, and practice sustainable agricultural development and resource management.

Through AusAID, the MAFF is currently implementing the project on Agricultural Extension Cambodia-Australia, 2001-2005 to promote the research for development of agricultural sector.

With the technical assistance of International Rice Research Institute (IRRI) and FAO, the RGC has long recognized the importance of integrated pest management (IPM) approaches. An IPM program in rice was started in 1993, and a vegetable IPM program begun in 1997. These programs have contributed significantly towards increase in the farmer's awareness and towards building the capacity of agricultural extension workers by providing training in IPM techniques. The Cambodia-IRRI-Australia-Project has made significant contributions to the soil knowledge base, but much remains to be done to improve the understanding and productivity of soil management.

To achieve these goals, the RGC is implementing policies to increase the productivity of existing land through investments in infrastructure (irrigation), expand cultivated areas, improve water policy, and increase private sector involvement across a range of sub-sectors. Significant efforts have also been made to promote technical packages, which include increased agrochemical use and introduction of improved seed varieties.

3.1.2 Forest Clearance

Forests are at risk due to increasing demand for agricultural lands. The direct causes of degradation and deforestation in Cambodia are agricultural expansion, land encroachment, etc. driven by economic and social forces.

Cambodia has high population growth rate compared to other countries in the region. According to Cambodian General Population Census in 1998, population growth rate was estimated to be 2.49% per annum. Both urban and rural population growth has increased rapidly resulting in pressure on land resource.

As local people become alienated from their lands, there may be increasing apathy and a limited sense of responsibility towards natural forest areas. State appropriation of land and forest leaves a little incentive for local communities to manage these resources in a sustainable way. Land alienation also leads to increase in poverty and often forces people to degrade land they do have access to, or to harvest forest products illegally in the areas to which access is denied.

Cambodia land use/land cover in 1985-87 and 1992-93 were classified based on Landsat-MSS and Landsat-TM satellite imageries by the FAO. It was estimated that about 3.1 million ha of Cambodia territory in 1985-87 were cultivated area and 11.8 million ha were covered by the forest. The cultivated land increased to 3.8 million ha in 1993; this increase has been attributed to conversion of the forest land.

With the support of Mekong River Commission Secretariat (MRCS), the 1996-97 land cover was produced by DFW, MAFF, using Landsat-TM satellite image. It indicated the cultivated land accounted for 4.3 million ha, while the forest land declined to 10.6 million ha. During 10 year period between 1987 and 1997, about 1.2 million ha of forest land had been converted to agricultural land and other land use types. Around the Tonle Sap Great Lake, forest land clearance for agriculture is significant. The area under inundated forest greatly reduced from 0.43 million ha in 1992 to 0.41 million ha in 1997.

Table 3.2: Change in land use between 1987-1997 in hectare

Land Use Type	1985-87	1992-93	1996-97
Forest	11,852,400	11,284,200	10,638,209
Agricultural land	3,119,000	3,839,800	4,330,820

Source: FA, *Cambodian Forest Resource 2004*

Demand for agricultural land is continuously increasing due to rural population growth. Approximately 13% of rural households in Cambodia are still landless (Oxfam Study 2000), and as family landholdings are being divided into smaller parcels, average size of agricultural holdings is quite small, only 1 ha per household. Therefore, land becomes a major issue nationally.

The shifting cultivation is also considered as an important factor contributing to the decline in forest cover. The shifting cultivation mainly occurs in the northeastern part of Cambodia. Rattanakiri and Monduliri are the provinces practicing shifting cultivation. People in these two provinces have been carrying out shifting cultivation for generations. It is undeniable that the shifting cultivation can contribute to deforestation, but their impact is small (Bottomley 2000).

The highlanders who practice shifting cultivation lack the equipments to cut large trees. Their shifting fields are normally cleared out of areas of secondary forest rather than old growth forest. Shifting cultivation becomes a less sustainable system when forest resources become scarce or when people are relocated from their customary lands. However, the debate about the shifting cultivation is still going on.

On the other hand, lack of clear rights to land, proper land use planning and management has led to widespread destruction of natural resources. In some areas, forests are under the control of no one, and are being exploited for short-term gains. Entities that have been granted forest concessions do not feel sufficiently secure to manage them sustainably for the long-term benefits of the country.

The Government has recognized the need to address land issues since late 1989. It enacted the 1992 land law and asked for donor support to issue land titles in 1995. In 1999, with improved decision making, the government moved quickly to address the land issues by: (i) establishing in late 1999 the Ministry of Land Management, Urban Planning and Construction (MLMUPC); (ii) requesting during the Consultative Group meeting of 2000 donor support in addressing land issues; (iii) establishing in late 2000 a Council of Land Policy chaired by the minister of MLMUPC, and comprising of senior officials from 17 ministries and institutions, including ministries of environment; agriculture, forestry and fisheries; rural development; interior; economics and finance; and defense; (iv) causing the Council of Ministers to approve in May 2001 a "Statement on Land Policy" outlining the direction of government policies in the land sector as in Box 3.1.

Box 3.1 : Statement of the Royal Government on Land Policy

May, 2001

Statement of the Royal Government on Land Policy

The Royal Government of Cambodia is endeavoring to implement a coordinated set of laws, programs of work, and institutional arrangements regarding land which are directed toward enabling the achievement of national goals of economic development, poverty reduction and good governance, as described in the Socioeconomic Development Plan, Interim Poverty Reduction Strategy, and Governance Action Plan.

The objectives of these initiatives regarding land are:

- To strengthen land tenure security and land markets, and prevent or resolve land disputes;
- To manage land and natural resources in an equitable, sustainable and efficient manner;
- To promote land distribution with equity.

To reach these objectives, government will endeavor to accomplish the following tasks:

In the area of land administration:

- Enactment of the Land Law, complementary laws, regulations and other related legislation;
- Operation of the Council for Land Policy to promote and monitor the implementation of land policy in consistency with the direction of the Council of State Reform;
- Creation of a state land inventory and state land classification system;
- Implementation and operation of a nation-wide land registration system using both sporadic and systematic registration procedures, including all property, both public and private;
- Resolution of land disputes through the local Administrative Commission, Provincial/ Municipal Land Dispute Settlement Commissions and the court organs;

In the area of land management:

- Development of land use plans for priority areas including tourism and investment zones, key urban areas and major road corridors;
- Co-ordination of land use planning with natural resource management of forests, fisheries, coasts, waterways, and mineral deposits in a harmonized legal framework;
- Decentralization of land management and planning authority to local and provincial authorities, after the establishment of national land use guidelines and supervisory structures;
- Development of procedures for urban land management and re-settlement;

In the area of land distribution:

- Execution of a broadly consultative process and pilot projects to create a land distribution strategy for needy groups;
- Prevention of illegal land acquisition and land concentration.

For the three above areas, institutional strengthening and capacity building in land policy implementation and improvement of public awareness of land legislation are priorities.

In order to achieve these tasks it is envisioned that a long term Land Administration, Management and Distribution Program (LAMDP) will be implemented, beginning with an initial phase to test approaches, achieve changes, clarify institutional roles and identify financial requirements. Important materials for the success of this program include the establishment of accurate geodesic networks, aerial photography and base mapping, and up-to-date land information systems.

The government's strategy, expressed in its "Statement on Land Policy", articulates government policy on land management, administration and distribution. It calls for the creation of a state land inventory and classification system; increasing capacity to resolve disputes; registering all land in the nation (both public and private) over the long-term using both systematic and sporadic procedures; strengthening land tenure security and preventing or speedily resolving land disputes; developing land use plans for priority areas (including areas with potential for tourism, industrial investment, urban areas and major road corridors); improving management of natural resources; and developing procedures for urban land

management. The government recognizes that implementing the strategy will be a long-term process requiring broad public consultation and consensus building. It will also require clarifying roles of various government agencies involved with land management, developing mechanisms for improving coordination among them. It will also involve the creation of accurate geodetic networks, maps and land information systems. The government views the proposed project as an important instrument to support the implementation of these policies.

3.1.3 Logging

In the selective cutting system applied in Cambodian forest harvesting, intensity is expressed in terms of volume of merchantable timber to be removed during logging or in terms of the percentage of the standing merchantable volume to be removed. Forest growth in Cambodia has been estimated to be about 0.3 m³ per ha per annum. Applied to a cutting cycle (35 years), this has been used to fix the harvest limit at 10 m³ per ha or approximately 30% of the total standing volume. This is essentially the Cambodian standard established under Article 3 of the Regulations on Forest Resources Exploitation, which specifies selective cutting and sets the extraction rate at 30% of the total volume available for harvest for evergreen and mixed evergreen forests (DFW/MAFF 2003).

Timber is considered to be a valuable forest product, especially for providing revenue for national development. Large quantities of timber are also used for the construction of houses, and furniture within the country.

From 1996 to 2001, timber production from concession areas amounted to 1.2 million m³, and the amount processed and exported (round logs, sawn timber, veneer, plywood, and so on) was 920,415 m³. About 36% of Cambodia's forest (6% dense evergreen and 30% disturbed evergreen) are commercially attractive, with other 15% forest areas (mixed and mosaic evergreen) unlikely to be viable for commercial timber production.

Fuel wood and charcoal production also contributes to forest reduction. Fire wood and charcoal plays important roles in providing wood energy for rural communities. About more than 90% of rural population remains dependent on the wood for fuel for cooking.

Table 3.3: Fuel Wood Extraction since 1961

Year	Total Wood in Million M ³	Extraction from forest (50%), (million m ³)
1961-1970	18	9
1971- 1980	10	5
1981-1990	24	12
1991-	6	3

Source: World Bank/FAO/UNDP, 1996

1970-1980 decade had dropped the fuel wood extraction to approximately 1.0 million m³ per annum (Table 3.3). Production of fuel-wood, however, rebounded to about 2.4 million m³ per annum from 1981 to 1990 and further increased after 1990s (MoE & UNDP/GEF 2001). In 1996, it was estimated that half of all fuel-wood was being extracted from forests. The production of firewood and charcoal in the forest supply areas close to roads and rivers may be greater than log production (MoE & UNDP/GEF 2001).

Commercial logging, shifting cultivation, and wood harvesting for fuel-wood and charcoal production has resulted in a net loss of about 1.1 million ha of dry land forests and 316,900 ha of edaphic forest (NEAP 1998). The civil war and periods of political instability during the

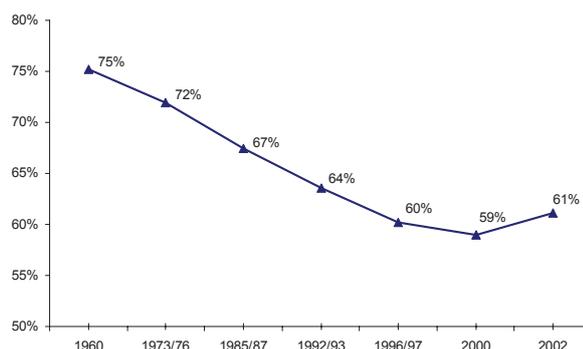
Table 3.4: Firewood and Charcoal Products in 1980-1990, 1995-2002

Products	1980	1990	1995	1996	1997	1998	1999	2000	2001	2002
Firewood(10^3 m ³)	26	105.1	2.085	3.59	3.	730	255	56	-	-
Charcoal(10^3 ton)	3.5	7	7.5	277	380	-	472	350	-	-

Source: Ministry of Agriculture, Forestry and Fisheries, NIS/MoP 2003

The Table 3.4 demonstrates data on firewood and charcoal production extracted from the forests in 1980, 1990, and from 1995 to 2002 (DFW/MAFF 2003). This table underestimates the firewood and charcoal production. With no alternatives available for them, the growing rural population uses enormous amount of wood, in particular to meet their fuel need. Despite the decline in charcoal uses among urban dwellers, the charcoal production remains high at certain part of the year.

At the moment, there are no other alternatives to replace fuel-wood and charcoal for energy uses. Some urban population at present use cooking gas for household cooking energy, but rural population still uses firewood and charcoal for their energy at large. However, the RGC, in conjunction with the NGOs, have paid much attention to promoting fuel-wood saving activities through developing an efficient cooking stove and demonstrating to a wide range of local communities. The cooking stove using both firewood and charcoal has been experimented and tested to explore potentials for less uses of fuel-woods for rural dwellers.

Figure 3.4: Change in Forest Cover

Source: DFW/MAFF, 2003

Meanwhile, the forest cover which had declined from 75% in the late 1960s to 59% in 2000 and has increased to 61% in 2002 (DFW/MAFF 2003). In the period of 1973-1993, approximately 1.4 million ha of forest land were deforested, mostly for commercial logging (WB 1999; MoE & UNDP-GEF 2001). During the period 1973-1993, the annual deforestation rate was about 70,000 ha, but it increased to more than double at 140,000 ha during the period 1993-1997 (ADB 2003; CDRI 2002). The reduction in forest cover in Cambodia during the last two decades is about 2 million ha, which in percentage terms is about 0.56% per annum compared to about 1% average for neighboring countries (Fig. 3.4).

If deforestation is not slowdown, the resulting reduction in crop yields because of soil erosion and increased flooding may contribute to poverty in the rural population that is heavily dependent on agriculture. Deforestation has led to lower water discharge in the dry season. The greater sediment loads and floods in the rainy season are special concern to agriculture in the floodplain. In general terms, the effects of logging and deforestation in Cambodia are wide ranging. Logging destroys habitat and devastates forest areas. Logging also encourages other environmentally destructive activities such as colonization, commercial hunting, and clearance for agriculture.

Deforestation poses an immediate threat to forest dependent communities, biodiversity conservation, and delivery of various forest and non-forest products and services to meet

present and future needs. Its negative impacts are already being felt, especially in rice-deficit areas where the rural population relies heavily on wood and non-wood forest products to augment their farm production.

The significant depletion of forest resources provides an impromptu for compressive reform in forestry. The government is committed to this process and has undertaken a number of actions that aim to bring the management of the country's forest resources under sustainable control and development. Starting in 1996, the government reformed the management of forestry sector by revising the Forestry Law and issuing Sub-decree on Forest Concession Management and improving land use management in forestry. The principal legislation dealing with the land use planning and land forest allocation consist of the Land Law and Forestry Law which were revised and passed by the National Assembly in 2001 and 2002.

The Cambodia Forest Concession Review by ADB in 2000 recommended a series of action to improve the forest concession management and protection of livelihoods of forest dependent communities and help them to develop plan for sustainable community forestry management.

There has been policy works conducted to prevent further deforestation particularly from commercial operators. The government has reduced the forest concessions from 30, covering 6.5 million ha in 1997 to 12 concessions, covering 3.3 million ha by 2003. At present, the remaining operating forests concessions are required to develop forest concession management plans including environment and social impact assessment (EIA) before they proceed any further.

The Royal Government of Cambodia is endeavouring to implement a coordinated set of Laws, action plans, and institutional arrangements regarding forest resources, which are directed toward enabling the achievements of national goals of environmental protection, biodiversity conservation, poverty reduction, socio-economic development, and good governance. The RGC also considers the ecologically, socially and economically viable conservation and management of forest resources as a major pillar of public welfare directly contributing to environmental protection, poverty reduction and socio-economic development.

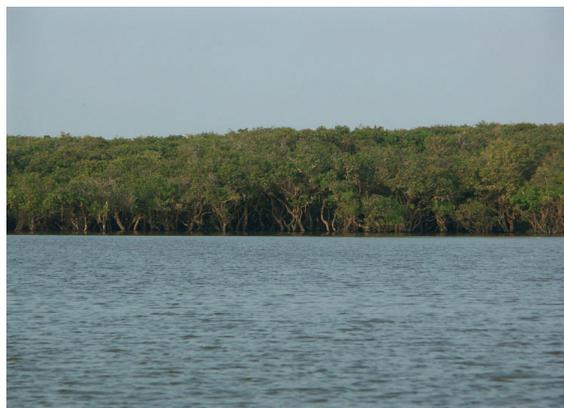
The new Forestry Law was developed and the National Assembly passed the Law on August 2002. This Law provides a legal framework to support the management of the forest resources. The Sub-Decree on the Forest Concession Management also provides the legal framework for the management of forest concessions. The government formulates the Sub-Decree on Community Forestry, aiming at promoting community participation in the protection of the forest resources. Community forestry is established across the country. The capacity building for the community to manage forest is built with a great assistance from international community. Approximately by 2003, 159 communities forestry covering an area of 64,901 ha with a total population of 192,911 persons have been established in order to ensure the long-term security and cover.

From 1985 to 2002, the total area of forest plantation established was 11,125 ha, which included trees planted on National Arbour Day. The rate of reforestation varies from year to year, beginning with 289 ha in 1985 and increasing to 1,007 ha in 2002. Acacia and Eucalyptus are the most common tree species planted (DFW 2003). According to a temporary assessment, there are 6 million ha of degraded forest land that need to be rehabilitated from 2001 to 2005. Tree planting programs are implemented in many forms in provinces and towns with the object of planting 50,000 ha per year of forest plantation; planting 120 ha per annum on National Arbour Day and planting approximately 16,000 ha per annum through people's participation and community forestry (DFW/MAFF and SEDP II 2001-2005).

3.2 DEPLETION OF BIODIVERSITY

Biodiversity is the measure of the world's variety of life. Article 2 of the CBD defines biological diversity as "the variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystem and the ecological complex of which they are a part". The value of biodiversity products and services is enormous. It has been estimated that more than 40% of the world economy and 80% of the needs of the world's poor are derived from biodiversity (ASEAN SoE 2000).

Cambodia is endowed with rich biodiversity in Southeast Asia and in the world. The country still contains relatively intact and contiguous original forests, which allows for substantial and original natural habitats. In April 2001, the Royal Government of Cambodia nominated the Tonle Sap Multiple-Use Area as Biosphere Reserve and extended its 1,167,000 ha area as transition zone. The transition zone is an integrated economic zone, which is managed for sustainable agriculture, human settlement and land use, without having adverse effects on the flooded forest, water quality and soils around the Tonle Sap Lake. Therefore, the total system of protected areas was increased to 24.7% of the total land area. In 2002, an additional 1,332,218 ha of Protected Forests were added to the system of protected areas, increasing the total amount to 32% of the total land area.



Tonle Sap Inundated Forest

3.2.1 Fauna

Macro-invertebrate species: In Cambodia, these are found in various aquatic environments such as in flowing water including river, stream, small ponds, flooded forest, rice fields, etc. These small animals are without backbone such as shrimp, worms, snail, beetles, flies, frog, etc. There is still little information about macro-invertebrate in Cambodia due to lack of biodiversity inventory, lack of human resource, technical and financial support. Some Cambodian macro-invertebrate species are also found in neighboring countries like Thailand, Vietnam and Lao PDR.

Amphibian and Reptiles Species: Amphibians are cold-blooded animal with backbone and scaleless skin. There are approximately more than 4,000 species of amphibian mostly living in water and over land. Moreover, about 6,500 species of reptiles are reported to be living across the world.

The Wildlife Conservation and Fauna and Flora International have conducted a survey of amphibians and reptiles throughout Cambodia. However, a majority of specimens collected during this survey have been deposited in international museums and their complete taxonomic analysis could take several years. Meanwhile, the World Resource Institute had reported the total number of amphibians and reptiles in Cambodia as given in the Table 3.5 below.

Table 3.5: Amphibians and reptiles species from 1992-2003

Number and Status of Species	No.
Amphibians	
Total known species (number), 1992-2003	8
Number of threatened species, 2002	None
Reptile	
Total known species (number), 1992-2002	114
Number of threatened species, 2002	10

Source: World Resource Institute, 2003

revealed that 39 of bird species are globally threatened or nearly globally threatened. The Cambodia's threatened species in the six geographical areas are listed in the Table 3.6 below.

Birds: Database from neighboring countries suggests that about 500-600 bird species currently are found in Cambodia and are spread in different geographical areas, e.g., the core lowland area, the channel of Mekong River, the coastal areas, the Cardamom Mountains, the upland forest area of the east and north-east areas, and northern plains of the east and west of Mekong River.

The Bird Wildlife International, 2000

Table 3.6: Cambodai's globally theatened Species in Geographical Area

Area	Critical	Endangered	Vulnerable	Near-threatened	Total
Tonle Sap	1	2	7	6	16
Mekong River			2	4	6
Coastal		1	2	2	5
Cardamoms		1	2	3	5
S.Annamites			2	3	5
Northern Plains	4	2	5	7	18

Source: UNDP-GEF 2001

Mammals: Mammals are animal with warm-blooded, nursing baby, having hair, well developed brain and protecting and training baby. In its geographic distribution, Cambodia mammals are found living in four different areas known as the northeastern area, the eastern and northwestern areas, and the southwestern areas which is dominated by the Cardamom Mountains Range. In addition, Cambodia is home to about 130 mammal species living across its territory.

3.2.2 Flora

The accurate assessment of Cambodian flora size is not available and an elaborate study needs to be undertaken to determine the accurate size. However, in 1982 Dy Phon reported that about 2,308 species of seed plants are found in Cambodia. Until 1989, Schmid had estimated the existence of about 12,000-15,000 species of flora for three countries namely Cambodia, Lao PDR and Vietnam. The endemic species are not expected to be in significantly large numbers in Cambodia. According to Dy Phon's work, the Cambodian floras are as listed in the Table 3.7 below.

Table 3.7: The Generic level of Cambodian Flora following the biogeography

Indomalesian / Sino-Indomalesian genera	30%
Pantropical genera	24%
Australian/Pacific genera	15%
African/Malagasy genera	14%
Cosmopolitan genera	10%
Continental Asian genera	7%

Source: Cambodia biodiversity status report 2001

As about 85% population in Cambodia lives in the countryside, most of them derive their resources and foods from the biodiversity resources. Habitat loss due to deforestation, population pressure on biodiversity, biodiversity trading, pollution and impact from agricultural activity on species and landmines and other unexploded ordnance are key factors which have increasingly threatened the biodiversity in Cambodia in recent years.

3.2.3 Habitat Loss Due to Deforestation

Excessive logging, conversion of forest lands for agriculture, and hunting wildlife for trade and local consumption have contributed to the increasing rate of wildlife habitat loss and biodiversity destruction in Cambodia. The exploitation of the forest resources is still carried as timber represents one of the nation's most realized natural resources and unsustainable. A biodiversity survey conducted in 2000 in Cardamom Mountain, which is considered as the richest biodiversity area in the country, indicated that "logging of the Cardamom Mountain will never generate significant amount of economic gains for Cambodia". ADB Concession Review has also stated that every forest concession in the region is overexploiting the forest resources. The Cambodia's Biodiversity Report (2001) indicates that together with the volume taken for firewood and charcoal, the current rate of both extractions is approximately seven times the sustainable level and can decimate much of remaining commercial stands within next 10 years (MoE, UNDP/GEF & FAO 2001).

Another area of concern is the reclamation of wetland and forest land for agriculture, housing, transportation or industrial development at the expense of the long-term preservation of land system and biodiversity. The absence of a strong land use policy framework, inadequate coordination among ministries and department dealing with natural resources and land use development as well as a lack of accurate information to guide land use allocation are other important factors that have contributed to continuing pressure on the forest and hence, constraints on appropriate land use management of the country.



Cambodia's forest cover declined from about 75% in late 1960s to around 61% of the total land area in 2002 and continues to decline further (Figure. 3.4).

Habitat loss for most of wildlife following the forest degradation is a most significant threat to biodiversity in Cambodia, and it is most apparent consequence of the exploitation of natural resources. Numerous forest and wildlife resources have continued to be overexploited. Many species are

overexploited for food and shelter, and continued search for the tradable commodities has now threatened other species in the region as well.

Table 3.8: The Three Main Threats to Wildlife in the Cardamon Mountains

Threat	Plant	Large mammal	Small mammal	Bate	Birds	Reptiles	Amphibians	Fish	Insect
Habitat loss and fragmentation	X	X	X	X	X	X	X	X	X
Hunting/ collecting for personal consumption		X		X	X	X	X	X	
Hunting / collecting for profit	X	X			X	X		X	

Source: MoE, DFW/MAFF and Fauna and Flora International, 2000

The flash floods and droughts have occurred frequently in the recent years, perhaps due to the change in the forest cover and relatively higher temperature. It has created serious soil erosion and increase in the siltation of the river and reservoirs such as the Tonle Sap Lake. Some natural streams have slowly disappeared and these led to reduction in wetland habitat as many of the deep water pools which are important for aquatic animals have now been filled with sediments.

Recently, the RGC (Royal Government of Cambodia) has halted all forest concessions and is engaged in developing a comprehensive forest concession management plan. The new Forestry Law re-enforces the current forest management. At present, while the number of forest concessions has been reduced, the government has merged 1,345,226 ha of forest land into the existing 23 protected areas thus prohibiting its use for timber extraction.

The forests watch communities have been established and posted across the country. This initiative has increased the participation of local communities in protecting forest and providing increased protection to wildlife habitats. Many NGOs are involved in this establishment and have raised awareness among local community members about the merits of protecting their forest and wildlife resources for future generations.

Many international NGOs such as IUCN, FFI, WWF, WCS, and Wild Aid are currently actively involved in the conservation and management of wildlife. Relevant information about the conservation approaches and practices has been generated and disseminated to public. Awareness raising activities have also been undertaken which are aimed at increasing public attention as part of attracting their interest in contributing to protection and conservation of wildlife across the country.

3.2.4 Population Pressure on Biodiversity

The increase in population, accompanied by expansion of the land areas, and urban, agricultural and industrial development have contributed to the loss and reduction of extents of natural forest ecosystem (see Table 3.9 below), their inherent species as well as genetic diversity in recent decades in Cambodia. The densely populated area is in the central floodplains of Cambodia. As the population grows, there is corresponding impact on the loss of habitat and increased consumption of resources. The urbanization trends have forced humans to convert wildlife habitats into agriculture and urban land, and produce a variety of toxic wastes that pollute the habitats and poison wildlife.

Table 3.9: Population increase and decrease in forest cover since 1962

Year	Population (in million)	Forest Cover (%)
1962	5.7	75.2
1962	9	63.6
1998	11.4	60
2000	12.2	53
2002	13.43	61

Source: Statistical Year Book (NIS/MoP, 2003); Forestry Statistics of DFW/MAFF 2003 & FAO 2001

Any improper use of biological resources results, to some degree, in alteration of ecosystem, and often in their implications, and effect which might result in ecosystem instability. The harvest of biomass from ecosystems constitutes a mortality factor for the species harvest, which may add to the natural mortality.

Most human harvest, however, imposes selection that differs from the natural one, such as affecting the genders, age or size

of group present. Many species and genetic variations are specific to a habitat, and if that habitat is lost or altered the species or genetic variation may also be lost.

The degradation of natural ecosystems has resulted in adverse impacts on the environmental, fauna and flora characteristics of these systems in Cambodia. Due to terrestrial ecosystem degradation, the physical environment has also become amendable as a result of higher ground temperature, lower humidity, and increase in levels of dust, accelerated soil erosion and loss of moisture and nutrient.

With regard to the biotic component, changes and loss of habitats of plants and animals could lead to reduction in their population sizes. The rare species represented by low density in particular would be most affected with further decline in their population (see Table 3.10 below). Some rare species would face extinction within the Cambodian territory.

The decline in biodiversity resources in the region would affect the food security of local population. As the forest area is also rich in non-timber forest products, it has close link with people living around them. With growing attention being paid to environmental management at both global and local levels, Cambodia has responded positively to protect its biodiversity.

Table 3.10: Threatened Species by Major Habitat Type - 2004

Habitat	Mammals	Birds	Reptiles	Amphibians	Fish	Total	Citations %
Forest	21	20	0	3	0	44	33.59%
Wetlands	2	15	0	3	5	25	19.08%
Artificial/Terrestrial	0	14	0	0	0	14	10.69%
Grasslands	4	9	0	0	0	13	9.92%
Shrub land	6	6	0	0	0	12	9.16%
Sea	1	5	1	0	1	8	6.11%
Coastlines	1	1	1	0	4	7	5.34%
Savanna	4	2	0	0	0	6	4.58%
Artificial/Aquatic	1	1	0	0	0	2	1.53%
Rocky Areas	0	0	0	0	0	0	0.00%
Caves and Subterranean Habitats	0	0	0	0	0	0	0.00%
Desert	0	0	0	0	0	0	0.00%
Introduced Vegetation	0	0	0	0	0	0	0.00%
Other	0	0	0	0	0	0	0.00%
Unknown	0	0	0	0	0	0	0.00%
Total Citations	40	73	2	6	10	131	100.0%

Source: IUCN Red List - 2004

To reduce pressures on the wildlife habitat, RGC in cooperation with NGOs and international organizations is engaged in raising awareness among the people on prevention of destructing forest areas. The Participatory land use planning is also being practiced in order to improve land management. The Commune council roles have recently been extended to protection and conservation of natural resources. Their participatory involvement has reduced the encroachment of the forest areas. In addition, the family planning program is also being implemented across the country by the government in collaboration with NGOs and International Organization.

In recent years, MoE has paid considerable attention in the conservation and protection of biodiversity by all means including policy initiatives as well as law enforcement activity. The National Biodiversity Strategy and Action Plan 2002, was created to use, protect and manage biodiversity from sustainable development considerations in Cambodia. It also provides the conceptual view and implementation plan toward the biological resources conservation and the promotion of the implementation of community-based natural resources management as well as interministerial coordination and collaboration in a sustainable development perspective.

To ensure the environmental sustainability, in the goal seven of the Cambodian Millennium Development Goal (CMDG 2003), the Royal Government of Cambodia had set a target to maintain forest cover at 60% for the period 2005 and 2015. Since year 2000 the rate of reversal forest has been maintained and since 2002 the CMDG target of maintaining forest cover at 60% has been met; this amply demonstrates the efforts undertaken in Cambodia towards improvement as well as the restoration of wildlife habitats to ensure the sustainability of Cambodia biodiversity.

3.2.5 Biodiversity trading

As stated in the sub-section above, the deforestation and the conversion of forest areas to agricultural land uses and population increase have pressured on wildlife habitat in Cambodia. At the same time, the biodiversity here is also under threat from commercialization and trade, which have rapidly increased as prices have risen and access to previously remote unsecured areas improved. Beside subsistence use, various wildlife species are also being sold as food, medicines, and pets for a variety of decorative purposes to buyers within the country. These incidences have increased following the growth in trade and commercialization.



Wild animal

The wildlife trade in Cambodia has targeted some of the country's most valuable species such as tiger, elephant, bear, gaur and banteng. Gaur horns sell for up to US\$ 120 and a good head may fetch as much as US\$ 1,000 from Thai traders. Elephant Ivory is said to cost around US\$ 400 per kg in Cambodia and tiger skin fetches well over US\$ 1,000 (MoE, FAO & UNDP/GEF 2001). The traditional hunting of the past has increasingly been replaced in recent decade by modern hunting for trading which exceeds the subsistence uses.



Bird hunting for food



Tonle Sap fish

The wildlife of the Tonle Sap Lake is also seriously threatened by hunting which has resulted in a direct negative impact on many bird, reptile, and mammal species. Birds and snakes have been largely harvested from around the Lake and traded locally and overseas. In the Tonle Sap, more than 8,500 snakes are harvested daily during the peak season. The Cambodian turtle population has also become exposed to intensive collection pressures as a source for the Chinese food market. Local use and domestic trade of turtles in Cambodia is widespread. At the same time, the legal international trade body under the Government Export Agency, namely KAMFIMEX also exports live turtles weighing around 200 tones, of which 100 tones were being exported to China and Hong Kong in 1989-90.

The Mekong Giant Catfish has been recently declared by the Department of Fisheries (DoF) as an endangered species - this has resulted due to the overexploitation of the Mekong Giant Catfish in the past few decades. The Mekong Freshwater Dolphin's population remains small in number. A large number of Dolphins have been killed and some died over the past few decades. It is estimated that, only about 80 of Dolphins remain today. Some other fish species have also become rare in terms of the current size of their population.

Market for Wildlife in the neighboring countries for trade purposes is a lucrative business. Traders in Vietnam, Thailand and Laos admit to obtaining a large proportion of their stock from Cambodia (Broombridge & Luxmoore 1991, Le Dien Duc & Broad 1995). The current extent to which trade specifically affects plants or animal population in Cambodia is unknown; however, the trade is likely to grow as access to this region improves in future (MoF and DoF 2000).

In the past, collections of certain NTFPs in Cardamom Mountains for trade have been wide spread. People from different areas used to come to collect aloe wood to sell to local middlemen. The aloe wood from Cambodia can be purchased for US\$ 370 per 5 ml for perfume production in Thailand which continues to have large market potential for aloe wood. The collection of woody liana known as yellow wood is also wide spread here. The Cambodian yellow wood is sold in Vietnam for US\$ 50 per kg (MoE, FAO & UNDP/GEF 2001).

Cambodia is a member of CITES and, hunting of wildlife in Cambodia is illegal. However, there is still a large illegal trade in wild plants and animals throughout most of provinces in Cambodia (UNDP-GEF 2001) to meet local and international demand. This trade is having a direct impact on targeted species and is based on demand from people for variety of purposes.

The decline in biodiversity resources also affects the food security of local population. As biodiversity is lost, the function of ecosystem, which is the basic of all living organism, would be impacted. This would also impact the living conditions of people, especially, poor people whose livelihood largely depend on natural resources.

With growing attention to environmental management at both global and local levels, Cambodia has responded positively to protect its biodiversity. The Law on the Wildlife Protection was developed to combat the wildlife trade activities in Cambodia. This Law prohibits the trade and serving of wildlife meat in restaurants throughout the country. RGC is taking stricter actions to restrict wildlife trade and collaborates with NGOs to raise awareness on non-consumption of wildlife meats among the public. Even CITES is being implemented in Cambodia with supports from NGOs though much needs to be done to reinforce its implementation.

The Government of Cambodia has issued the Law on Environmental Protection and Natural Resource Management and Royal Decrees to protect natural resources. The King issued a Royal Decree to support 23 protected areas in 1993, covering 3.3 million ha, in the form of national park, wildlife sanctuaries, protected landscapes or multiple use areas. The Boeung Chmar portion of Tonle Sap Multiple-Use Area, the Koh Kapik wetland and associated islets in the Peam Krasop Wildlife Sanctuary, and the middle stretches of the Mekong River Area between Stoeng Treng and the border with Lao PDR were designated as Ramsar Sites at the time of Cambodia's accession to the Convention, 23 October 1999. For the management of protected areas, a zoning system has been developed. Basically, they include cultural zone, traditional uses, core zone and buffer zone. Buffer zone management incorporating the needs of the local people is now being considered and would include income-generating activities for local people, especially for Virachey National Park, Phnom Aural and Phnom Samkos Wildlife Sanctuaries.

A concise policy and management plan must be in place to prevent hunting and over-exploitation of wildlife trades and to ensure the sustainable development and protection of biodiversity. National Environmental Action Plan and National Biodiversity Strategy Action Plan (NBSAP) have identified the loss of biodiversity as one of high priority requiring the development of strong policy, enforcement and regulatory framework for action. Cambodia's NBSAP have laid down concrete action to preserve and protect the biodiversity, ranging from policy development to poverty reduction.

Local participation in sustainable natural resource management is being promoted in a number of protected areas. Conflict Resolution and Consultation Steering Committee for certain protected areas has been established at both provincial and national levels to improve the management of the protected areas. The Tonle Sap Great Lake was formally listed as a Biosphere reserve of international importance.

3.2.6 Pollution and impact from agricultural activity on species

Many of the agricultural chemicals are not used according to safety and quantity instructions and as such are causing environmental and health problems. There is also an increase in availability of highly toxic agricultural chemicals that are banned in many other countries. The improper use, storage and disposal of these chemicals are likely to cause severe pollution problems now and in the future.

Conversion of forest land to crop production is rapidly increasing and the discriminate application of agrochemicals is too widespread. Agrochemicals and the disposal of industrial waste eventually pollute the waterway and contribute to the poor quality of the water resources. Fish and aquatic animals are reported being killed in the Tonle Sap Lake and the eutrophication in localized water bodies has been reported. The pesticide use could also cause harms to the natural biodiversity of this system directly and indirectly, through their effects on food chain. The past health records suggest that the farmers who used pesticide products to increase the agricultural yield mostly become sick, thin and pale in few years after using those products.

Table 3.11: Pesticides available in Cambodia

NO	Chemical name	Chemical type	WHO class	Trade name
1	2,4-D	PAA	II	2,4-D 720EC, ANCO 720DD, CO 2, 4-D 80BHN, HEDONAL, VI 2, 4-D 80BTN, ZICO 720DD
2	Alanycarb	Carbamate	II	Lenet
3	Alphacypermethrin	PY	II	FASTAC 5EC
4	Alphacypermethrin	PY	II	VIFAST 5ND
5	Aluminium Phosphide	Inorganic	-	CELPHOS
6	Bacillus thuringiensis	Biological	IV	THURICIDE, DELFINE
7	BMPC	Carbamate	II	BM-701
8	Butachlor Propanil ⁺	Acetamide	IV	CANTANIL 550EC
9	Carbofuran	Carbamate	Ib	FURADAN 3H
10	Cartap-Hydrochloride	Thiocarbamate	II	PADAN 95SP
11	Chlordane	OC	II	CHLORDANE
12	Chlorfluzaron	Trifluoromethyl	IV	ATABRON 5EC
13	Chlorophenyl	?		SHASICIDINE
14	Cychloropropane	?		CYPERALPHA 5EC, CYPERALPHA 5ND
15	Cypermethrin	PY	II	CYPERAN 25EC, VISER 25ND, CYPERMETHRIN, CYRIN, CYPERRMETHRIN 10EC, CYPROID 25% EC, TENZO
16	Deltamethrin	PY	II	DICIS 2.5EC
17	Diazinon	OP	II	BASUTIGI 50ND, CAZINON 10H
18	Dichlorvos	OP	Ib	DDVP, DDVP 50ND, DICHLOVORVOS, STRUN GLINHI 5EC
19	Dimenthoate	OP	II	BiAn 40ND, DIBATHOATE 40EC, DIMETHYL CARBAMOYL, BI 48 50EC, DIMETHOATE, BI 58ND
20	Endosulfan	OC	II	Age Evo, Sonii, THIODAN, THIODAN 35EC, THIODAN 35ND, THIODAN 50ND
21	Etofenprox	Bridged diphenyl	IV	TREBON 10 EC
22	Fenitrothion+Trychlofon	OP	II	OFATOX 400EC
23	Fenobucard	Carbamate	II	BASSA 50EC, BASSA 50ND, BASUDIN 50ND, HOPPESCIN 50ND
24	Fenobucarb+Phenthoate	Carbamate	II	HOPSAN 75
25	Fenobucarb 2%+	Carbamate	II	VIBAM 5H
26	Fenvalerate	PY	II	SUMICIDIN 20EC, SUMITHION 50EC, VIFENVA 20ND
27	Fipronil	-	II	REGENT
28	Glyphosate	-	IV	SANOS
29	Humatvilu	?		HPV 401N
30	Lambda-cyhalothrin	PY	II	KARATE
31	Mancozeb	Dithiocarbamate	IV	MANCOZEB

NO	Chemical name	Chemical type	WHO class	Trade name
32	Methamidophos	OP	Ib	FILITOX, FILITOX 60DD, FILITOX 70SC, MONITOR, METHAMIDOPHOS, MONITOR 50EC, MONITOR 70DD, Vindaiy
33	Methyl parathion	OP	Ia	FOLIDOL, FOXENTOL M50, METHAPHOS 40ND, METHYLPARATHION 50EC
34	Methylpyrazol	?		RAZOR
35	Mevinphos	OP	Ia	CIKEMOCRAFT, ERAWAN ERAPHOS, EX-phos, LOCKPHOS, MEVINPHOS, Phavyteu, PHOSDRIN, SUDRIN
36	Monocrotophos	OP	Ib	AZODRIN, AZODRIN 50DD, CROTONAMIDE, MONCROTOPHOS, TANCHEYDRINE
37	Nereistoxin	?		SHACHONG, SHACHONG 18DD, SHACHONG SHUANG 95WP, NETOXIN 95WP, SAT TRUNG DAN 18SC
38	Pegasus	–	IV	PEGASUS 500DD
39	Permethrin	PY	II	PERAN 50EC
40	Phenthoate	OP	II	ELSAN 50EC, VIFEL 50ND
41	Phosporotioate	?		GOLDEN DOOR 3.5.9
42	Propiconazole	Triazole	II	TILT 250ND
43	Pyrazosulfuron	OP	Ia	GIANT
44	Validamycin	Antibiotic	IV	VIV ADAMY 3DD
45	Zinc phosphide	Inorganic	Ib	Foke ba 20%, ZAWA, Sinc Phosphaide
46	Zineb	Dithiocarbamate	IV	ZINEB

Source: MAFF, 2002

Environmentally speaking, the more polluted ecosystems become, the less species, and varieties can be observed. A polluted river has far less biodiversity than healthy one. Therefore, awareness raising activity about pollution and impacts on biodiversity from chemical and pesticide use is essential and has been undertaken by the Ministry of Agriculture, Forestry and Fishery (MAFF) in recent years in addition to those by several other local and international NGOs such as DANIDA, World Bank, FAO, etc. Through the National Integrated Pest Management Programme (IPM) of Cambodia which includes community-based IPM activities, IPM Farmer Training Project, etc., more and more people including farmers, trainers, students and disable people have been trained about the harmful impacts of substances from either pesticide or chemical uses on the human health and on the environment. Huge amount of chemical and pesticide products have been produced or imported into Cambodia, in the past. However, in the recent years, improvements and reconstruction of irrigation system have been undertaken to extend the green farming activities. Meanwhile, MAFF reports have demonstrated that IPM trained farmers are able to increase their crop yields up to 10% or 350 kg per ha equivalence to US\$ 42 per ha.

Table 3.12: Number of IPM trainers and farmers trained in rice farming

Year	Season-long training of trainer			Farmer trainer orientation course			Farmers field school		
	No. of course	Participants		No. of course	Participants		No. of course	Participants	
		Female	Total		female	Total		Female	Total
1996	2	23	62				50	478	1,398
1997	1	12	33	1	4	20	135	1,149	3,368
1998	1	20	56	3	36	90	199	2,225	5,668
1999				3	32	74	184	1,953	5,312
2000				2	19	63	113	1,133	3,396
Total	4	55	151	9	91	247	681	6,938	19,142

Source: MAFF, 2002

The MoE and other relevant ministries have enforced the restrictions over the input of chemical and pesticide use and on discharge of waste from agricultural activities in recent years to ensure that farmers use proper fertilizer in their farms. Sub-decree on Water Pollution Control and Solid Waste Management provides a legal basis to counter attack the pollution from both industry and agricultural activities.

3.2.7 Landmines and Other Unexploded Ordnance (UXO)

It is believed that about 4 and 6 million landmines are scattered on 2.5% of arable land across Cambodia, and some 300 people are killed or seriously injured every month (MoE, DFW, Fauna and Flora, 2000 and ADB, 2003). The serious threats for human as well as wild animal are the anti-personnel mines. The natural biodiversity have become increasingly degraded due to the clearance of forest areas which have not been mined and are being used for agriculture purpose. Meanwhile, the hunters have used the abundance of weapons leftover after the war throughout the country to hunt the wild animals such as tiger and ungulate. There is no record of the amount of wildlife or the volume of biodiversity which have been killed or affected by the abundance of landmines and UXOs. The long term impacts on biodiversity caused by the chemical weapon in the form of defoliants and herbicides, known as Agent Orange, which was dropped along Cambodia-Vietnam border during American-Vietnam war also needs to be investigated further (UNDP 2001).

In the Cardamom Mountain, UNDP/CARERE estimates that as much as 30% of Veal Veng District in Pursat province, the western part of the Cardamom Mountain, encompasses minefields. While this figure is almost certainly an overestimate, landmines and other unexploded ordinances unquestionably pose a serious threat to both humans and large animals in many parts of the mountain range, although it is believed that these mines could also have restricted the access of the wildlife poachers to some wildlife habitat in the remote areas.

There is likelihood that the same landmine is now being deployed in the forest to hunt wildlife. The presence of landmine also exerts constraints on biodiversity conservation in this area, by making large areas hazardous for rangers, biologists and other workers to travel in (MoE, DFW & Fauna and Flora 2000). Ongoing efforts to demine the land around roads and villages should be sustained.

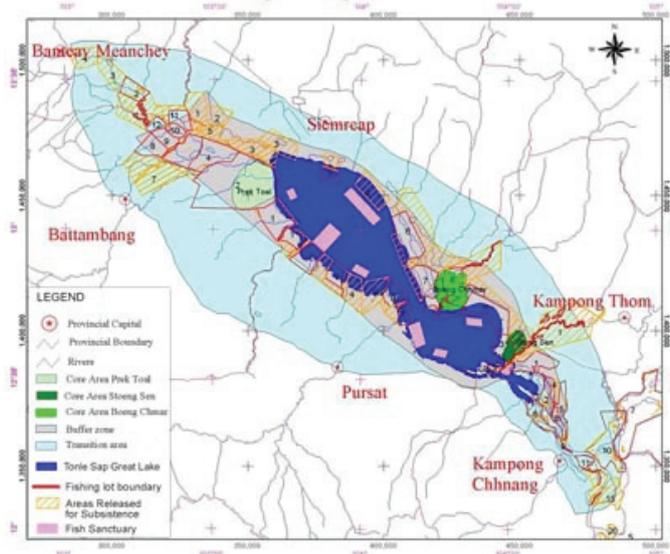
Demining is an ongoing activity. In order to improve the coordination and implementation of demining activity, the RCG established the Cambodia Mine Action and Victim Assistance Authority (CMAA) in September 2002 with four major goals including setting up mine action database and complying the Ottawa Convention, implementing socio-economic mechanism, prioritizing mine clearance based on impact, and developing mine risk reduction and following up mine victim assistance. CMAA plays very important role in demining across the country. Donors have provided financial and technical supports to CMAC to carry out the demining activities. CMAA has to address the non-cleared and remote areas by 2012 as part of its long term vision (CMDG 2003). About 3,000 ha of land are being cleared annually with an estimated cost of US \$30 million per year. The number of landmine accidents has reduced substantially over time, to about 900 per year in 2002 (ADB 2003).

3.3 DEGRADATION OF INLAND AQUATIC RESOURCES

Fisheries play central role in strengthening the national economy as well as in daily livelihood of Cambodian people. On average, fish and fishery products are believed to account for 40-60% of the protein intake of the population. The fishery sector is also an important part of the national economy, contributing between 5-10% to the GDP. The fish catch in the Tonle Sap Lake represents about 60% of the total commercial fish catch for the whole country (Van & Leng 2000). The annual inland fisheries catch has been estimated at more than 400,000 tons per year, making Cambodia's inland fisheries the fourth most productive in the world, and fisheries have been promoted as a sector where Cambodia holds a "comparative advantage".

Rural Cambodians consume fish everyday and rely on other aquatic resources. Fish consumption per capita for Cambodia was estimated by many other experts and surveyed in different locations in the country with different results being obtained. The annual fish consumption per capita over the period 1980 to 1991 was estimated as stable at approximately 6 kg per year. It fell below this level between 1992 and 1998 and then increased rapidly thereafter. The fish consumption per capita between 1980 and 1998 was low because the total inland fish catch figures did not include the small scale fisheries and the rice field fisheries. It reached 16 kg in 1999 and then peaked in 2001 at 27 kg per year. However, in 2003 fish consumption per capita decreased to approximately 19 kg. Between 1999 and 2003, fish consumption per capita can be estimated at approximately 20 kg per year. However, the national rate of fish consumption per capita is estimated by the Mekong River Commission and Department of Fisheries as 30 kg per annum.

Map 3.1: Tonle Sap Biosphere Reserve and Fishing Lots



Source: GIS-MoE and DoF-MAFF, 2004

The fee collection system for fish sales and exports depress fish prices, which in turn reduces the income earned by small and medium scale fishers and others working in the fisheries sector. Moreover, about 80% of fish export fees are collected by institutions with no direct link to fisheries management, and that fisheries official responsible for managing the local landing sites and fishing grounds only collect 3% of all fees.

Low fish prices and competition over decreasing resources have caused poverty in many fishing communities. Despite the richness of natural resources around the Tonle Sap Lake, about 39% of the population in that area lives below the poverty line, compared with 36% at the national level (RCG 1998). Therefore, to reduce poverty, efforts should be taken to improve sustainable access to fishery resources and ensure the equitable share of these resources for the poor.

Sale of traditional fishing areas as commercial fishing lots in Cambodia which had deprived many communities of one of their main livelihood resources has been reduced since 1994. In October 2000 the Royal Government of Cambodia announced a major change in fisheries management policy. The core elements of the new policy are the reduction of fishing lot concession areas by 56%, the broader participation of fishing communities in the management of fisheries and a focus on the efficient, sustainable and equitable use of the living aquatic resources. The commercial fishing lots reduced from 307 in 1988 to 164 in 2000, representing 56% of the total commercial fishing lot areas. The release of fishing lot areas continued in 2002 and 2003 and the total number of fishing lots remaining are 162 in 2003. The fishing areas released from the commercial fishing lots were organized into the community fisheries. Initially in 1996, five of community fisheries were established, although government policy just started in 2000. Subsequently, numbers of community fisheries were drastically increased from 5 to 382 from 1996 to 2005 and matched to Cambodia Millennium Development Goal's target line in 2003 with 333 communities.

3.3.1 Major issues of inland aquatics

Although there are now less major conflicts between communities and fishing lot owners, the conflicts related to encroachment, illegal fishing, and destructive fishing practices are increasing. Meanwhile, there are direct and indirect factors causing depletion of fisheries in Cambodia. These include loss of fisheries due to over fishing, destructive and illegal fishing practices and clearance of inundated forests.

Table 3.13: Inland fish catch

Year	Inland fish (ton)
1992	68,900
1993	67,900
1994	65,000
1995	72,500
1996	63,510
1997	73,000
1998	75,700
1999	231,000*
2000	245,600*

* Data include family and rice field fisheries
Source: Annual Conference on Agriculture, Forestry and Fisheries (1999-2003)

3.3.1.1 Loss of fishery due to over fishing

MRC estimated the fish production in Cambodia at 190,000 tons and 230,000 tons annually in 1994-1999 periods, while the DoF estimated at around 65,000 tons to 75,000 tons annually (Table 3.13). The reconsideration of fish catch in Cambodia includes commercial, medium scale, small-scale and rice field fisheries. Based on the new calculation method, the total fish catch has been estimated at a range between 290,000 tons and 430,000 tons annually (MRC 1999). However, the officials, researchers, scientists, economists, and administrators argue that the total freshwater fish production had never exceeded 250,000 tons annually (Tana & Bruce 2001).

The current efforts for fish export lead to increased fish catch in every scale. It is reported that approximately 25% of the total fish catch (including marine fish catch) is exported (about 100,000 tons) and half this amount is done through illegal channels. Meanwhile, about 75% of exports are delivered to Thailand, as fresh fish products and the bulk of balance to Vietnam (MoC 2002). On the other hand, about 50,000 tons of inland fish are being exported every year to Thailand (FACT & EJF 2000). The estimated values of fish landing are between US\$ 150 to US\$ 200 million and a retail value of US\$ 500 million (FACT & EJF, 2001).

Large-scale commercial fisheries in Cambodia are organized under a system of exclusive spatial and temporal use rights of large scale auctioned lots. Because of fishing lots, communities traditional dependent on fishing were marginalized due to the reduction of areas open access.



Large scale commercial fishery

Despite reduction of 56% commercial fishing for local communities, the problems associated with fishing lots continue for the more productive areas unreleased (44%) for community fisheries. Concession holders will fully exploit fish resource in the designated areas, although providing some measure of protection from poaching and large-scale destruction of flooded forest. The open-access nature in newly designated communities fisheries areas, middle-

scale and family-fisheries also leads to over-fishing particularly with a growing population dependent on natural resource extraction.



Fish catch in Tonle Sap

The total fish catches have been relatively stable over time, but its figures are extremely misleading as an index of fish abundance and value. In recent years, fishing efforts has greatly increased. The mean fish body size has decreased and species composition has shifted, favoured small-bodied and low value species. These are all symptoms of over-fishing (ADB 2003).

Commercial fishing needs to be managed to eliminate destructive and illegal fishing practices, and to avoid over-fishing. But

there will be little incentive to do this as long as profit margins on fish sales remain so low. Official fees and informal payments, including random checkpoints to “check the transport permit” and demands for fees from institutions that have no clear basis for fee collection, are so numerous and so high that fish exporters are forced to keep fish prices at the landing sites as low as possible.

Fisheries management processes are being applied based on the Fiat-Law on Fisheries Management and Administration of 1987 and Sub-Decrees, declarations, and proclamation. Recently, MAFF has revised the Fisheries Law and Sub-decrees including Sub-decree on Community Fisheries. Fishing and management of the entire inundated areas are mainly regulated by DoF under MAFF as part of reducing overexploitation of fisheries. MoE is responsible for the EIA and the management of Protected Areas.

Given the importance of the fishery to the national economy and the central role that fishery plays in the everyday livelihood strategies of millions of Cambodian, wise management of this vital resource is a key element in poverty reduction. Regulations for commercial fish trade and export need to be overhauled, in particular the regulations regarding the permit license and fee systems. But this by itself will not be enough. Communities must also be made active partners in the process of protecting, managing and sustainable use of fishery resources.

The “Co-management” of fishery has been adopted for community fishery management. The DoF has focused more efforts on developing community fisheries as such fishery reforms, decentralization efforts and greater focus on community-based natural resource management. About 264 community fisheries across the country were established during 2000 and 2001.

3.3.1.2 Destructive and illegal fishing practices

The use of destructive and illegal fishing practices is widespread in Cambodia. Small and medium scale fishers resort to illegal fishing practices due to pressures to feed their families, pay off debts, and adequate income/capital. Large scale fishing uses illegal practices to compensate for high costs related to purchase of commercial scale equipment, licenses, auction sales of fishing lots, and official and unofficial transportation and marketing fees.

Destructive fishing practices include the following:

- The use of long [1-2 km] fine-mesh nets to trap small and/or less valuable fish which will be turned into fish feed or animal feed. Also, the use of bag nets on river ways to catch fish moving upriver to spawn and of large commercial fish traps in the Tonle Sap;
- The collection of fingerlings (newly hatched fish) from natural breeding areas for illegal export and sale;
- The commercial practice of pumping out lakes or bodies of water in order to capture all the fish at one time. Pumping disrupts the ecological balance by removing virtually all aquatic life including juvenile fish. It also causes problems for communities who lose their access to water needed for crop irrigation;
- Electrocuting, explosives or use of poisons used by both commercial and small scale fishers. Electrocuting fish is the preferred option for illegal fishers along the Tonle Sap as it is relatively cheap method that can be undertaken from the shore line, and is also a quick and efficient means to catch fish;
- Trawling or use of pushboats in shallow waters. Commercial fishing boats designed for sea fishing are increasingly encroaching on shallow coastal waters, destroying the seabed and fish breeding grounds and the livelihoods of traditional coastal fisherfolk; and
- Encroachment, sometimes backed by armed men, on community areas, protected areas, or neighboring fishing lots where fish are more plentiful.

Apart from destructing fisheries resources by illegal fishing, lack of clarity over fishing lot boundaries have led to conflicts between local users groups and commercial fishing operators. In some cases, lot owners accuse villagers walking by the fishing lot with intention to fish illegally or harass community people fishing near the fishing lot border.

Competition for decreasing stocks is becoming more severe, and fishers at all levels have resorted to taking advantage of a weak law enforcement environment and lack of management systems to capture as much as they can immediately, without concern for the future.

Community fisheries also face frequent problems with encroachment and often have difficulty defending themselves against more powerful and wealthy adversaries. Community fishery groups have been threatened by illegal fishers because the community has reported the illegal fishing to the government. There is also the problem that larger scale illegal fishing and encroachment are sometimes backed by armed men and by local authorities.

Small scale or subsistence fishing is defined by the use of fishing gears. The current definition of subsistence fishing was designed during the French colonial era and allows the free use

of traditional fishing methods, but only for consumption, not for sale. It does not recognize the category of floating communities who fish for their daily living, selling their catch for rice, clothes and other necessities, or of communities that grow rice for part of the year and fish for both consumption and income in the dry season. Neither of these groups can catch enough to survive using only traditional subsistence methods. Although the fisheries reforms have turned over 56% of the fishing lots for local communities to establish community fisheries, organized communities are only allowed to engage in subsistence fishing.



Fishing Activity in Tonle Sap

In a separate policy decision, the Government recently eliminated the tax on medium scale fishing. This creates a serious disincentive to fishers deciding whether or not to work together to protect resources; if they join community fishery they can only use traditional fishing equipment, if not, they can use medium scale gears. Under these terms, individuals and communities that fish for income have little incentive to organize in order to manage, protect and use their resources sustainably.

Communities should have both the right and the responsibility to make plans that protect the resource for current and future generations. Communities around the country have shown that it is possible for community fishery committees to peacefully patrol and arrest violators and they can work in close cooperation with local officials in enforcing rules and regulations. However, the draft sub-decree and the Fisheries Law do not allow community fishery organizations the right to arrest those who encroach on the community areas.

Fisheries Law and Sub-decree on Community Fisheries form a strong base of legislation that can help protect fisheries resources, from destructive and illegal fishing activities, and Community rights and livelihoods from a conflict with large scale fishing operator. The DoF, MAFF have issued the Declaration to combat the use of electro-fishing practice, small mess size with long fishing, collecting fingerlings and other types of illegal fishing practice. The community fisheries have been empowered across the country as a tool to improve management in fisheries and reduce illegal destructive fishing practice in the fishing grounds.

The government has an important role to play in setting guidelines and standards for community fisheries and monitoring implementation. In doing so, RGC has allowed a high level of participation by fishing dependent community and other stakeholders across the country in its drafting and in face-to-face meeting between community representatives and DoF. NGOs, local community fisheries and other stakeholders appreciate RGC's effort to include civil society and local fishers in the discussion of the current fisheries laws and policies.

3.3.1.3 Pollution and Clearance of Flooded Forest

Water pollution: Even though the level of water pollution in Cambodia is still low and the impacts of water pollution on fishery are somehow unknown, the pollution from agricultural run-off is becoming more common due to increasing use of chemicals, such as fertilizers, herbicides and pesticides. Apart from reduction of wetland areas, the increased conversion to agriculture leads to increasing fertilizers, and pesticides use and consequent runoff. Fish stocks are also threatened by other toxic elements from industrial waste and organic

pollutants from domestic sewage, which damage the aquatic ecology (ADB 2003). In 2000, an estimated 1.3 million liters of pesticide were used in the catchment areas of the Tonle Sap Lake, including many highly hazardous chemicals such as DDT, methyl parathion and monocrotophos, imported from neighboring countries (Koma et al. 2000). It was recently reported that 10 tons of DDT and Folidol (Methyl Parathion) had runoff from the 2,000 ha of mangle bean crops into the Tonle Sap (Phnom Penh Post 1999). The widespread use of fertilizers in the dry season could also affect the ecology of the Lake, causing localized temporary eutrophication and even kill fish.

Cambodia's population is mostly concentrated in the lowlands and near inland freshwater. Freshwaters are becoming more polluted wherever people are living. Although water quality so far still exists in a good condition, acceleration of industrial growth in recent years with no transparent landuse planning, increased agrochemical consumption, urbanization etc, the water quality will deteriorate in the not too distant future.

Table 3.14: Land use change of Tonle Sap Watershed between 1991 and 1996-99

Location/Parameter	Unit	1998	2000	2001*
Mekong River (Upstream) Location-Chroy Changva (Kandal Province)				
DO	Mg/l	6.02	5.38	5.61
BOD6	Mg/l	8.17	6.99	7.05
Mekong River (Downstream) Location-Kien Svay (Kandal Province)				
DO	Mg/l	6.14	4.94	5.45
BOD6	Mg/l	5.19	7.00	6.02
SS	Mg/l	56.99	56.99	61.06
Tonle Bassac Location-Takhmao (Kandal Province)				
DO	Mg/l	6.47	5.28	5.47
BOD6	Mg/l	10.83	7.36	6.85
SS	Mg/l	65.13	65.13	69.59
Tonle Sap River Location-Phnom Penh Port				
DO	Mg/l	6.07	5.68	5.00
BOD6	Mg/l	10.67	7.60	7.65
SS	Mg/l	56.31	58.31	58.15

DO-Dissolved Oxygen; BOD-Biochemical Oxygen Demand; SS-Suspended Soils

Source: ADB, draft Environmental Assessment of the Greater Mekong Sub-region

Water and Soil Quality Management Office, Ministry of Environment, 2001

*2001 average from January-November

Source: ADB 2003



Human settlement on Tonle Sap Great Lake

Cambodia's urban areas have limited domestic wastemanagement infrastructure and most domestic waste goes directly into waterways without any treatment. This does not only pollute the waterways with toxic and disease-laden septic water but also adds increased nutrients which foster low oxygen concentrations through localized eutrophication. Meanwhile, small industries are booming as Cambodia's economy is starting to grow, but the effective management of their wastes is still limited. Most small

industrial wastes directly or indirectly is discharged into local waterways. Such pollution will harm fish species and the humans who consumed that fish.

The threats to fisheries sector are internal, largely stemming from natural resource management policy; and external, due largely to upstream development in the Mekong River system (ADB 2003).

RGC has issued the 1999 Sub-decree on Water Pollution Control and finalized the Draft Water Law with clear objectives that covered the principles on management, monitoring, utilization and protection of water resources to ensure their effective development. The Government also formulated a National Water Policy in March 2001 and the draft Law on Water Resources Management, March 2002, to provide guidelines for efficient and effective water resources management, socio-economic development and welfare of population and to ensure sustainable environment.

More than 14 national institutions influence the management regime of the Tonle Sap watershed, including the recently established Tonle Sap Biosphere Reserve undertaken by MoE and MAFF. Awareness Raising programs have been implemented by NGOs and government agencies to provide information and knowledge about the impacts of the pollution on human health, environment, fish and other aquatic resources.

Clearance of inundated forest: The richness of fish in Cambodia, particularly in the Tonle Sap Lake is closely linked to the flooded ecosystem of the Lake and the Mekong river. The inundated forests turn into the habitats where many migratory fish species come from the Mekong river system to breed and lay egg. Many fish species utilize the freshwater inundated forests as important habitats that act as fish nurseries. Without this habitat there will be a huge and direct reduction of fish species in that region as well as in Cambodia.

As the population increases, the absence of income earning opportunity makes the seasonal migration and conversion of forest and wetland into farming plots more pronounced. The demand for increased agricultural lands has led to the clearing of freshwater floodplain forests and the demand for fuel-wood has caused unsustainable harvesting of the flooded forest, resulting in the degradation or loss of flooded forest habitat.

Table 3.15 demonstrates that in 1991-92, the Tonle Sap watershed was estimated at 80,000 km², of which dense broad-leave forest constituted 21.60%, inundated evergreen forest including mosaic of inundated forest and swampy vegetation 6.67%, paddy fields including with palm trees, upland crops, secondary vegetation and rubber plantation 20.52%. In 1996-97, the evergreen dense and evergreen disturbed constitutes 16.22%, inundated forest and inundated forest mosaic accounted for 3.38% and agriculture and mosaic of cropping represented nearly 22%. The landuse in the Tonle Sap areas has shown remarkable change between 1991 and 1997, for example 5.38% of the Tonle Sap watershed dense broad leaved forest and 3.29% of the inundated evergreen forest and mosaic of inundated forest have been lost, while 1.41% of the paddy field, upland crops and rubber plantation have been expanded.

Table 3.15: Land use change of Tonle Sap Watershed between 1991 and 1996-99

Land use type 1991-92	Area in ha.	Area in %	Forest type 1996-97	Area in ha.	Area in %	Change in ha.	Change in %
Dense broad-leaved forest	1,711,901	21.60	Evergreen Dense, Evergreen Disturbed	1,287,144	16.22	-424,757	-5.38
Flooded evergreen forest and Mosaic of Flooded Forest	528,455	6.67	Inundated Forest and Inundated Forest Mosaic	268,119	3.38	-260,336	-3.29
Paddy fields, Paddy fields with palm trees, Upland Crops and Rubber Plantation	1,185,455	20.52	Agriculture and Mosaic of Cropping	1,578,706	21.93	393,251	1.41

Source: MoE, 2002

The forests surrounding the lake have acted as a filter to maintain the hydrological system of the lake, and protection of the agricultural productivity of the surrounding areas. The decline in surrounding watershed forest will increase the erosion phenomena and these will impact the lake itself. Due to fair slope and less filter, during the rainy season, the water erodes the top soil, which is good for agriculture, and discharge into the stream and rivers loading finally to the lake. At the same time, decline in inundated forest affects the fish habitat. Together with impacts of the soil erosion from the watershed, this would further degrade the fish productivity of the lake as well as the habitats of wildlife such as snake, turtles, water birds and other species in the wetland areas. Since local communities depend on these resources for food, the food security as a result would be threatened.

The governmental decrees have forbidden the clearance of the inundated forest and killings of the wildlife in the floodplain of the Tonle Sap Lake. NGOs and UNDP/GEF have been engaged in the conservation of the natural resources in the Tonle Sap Lake. UNDP Capacity 21 is preparing for the investment in the capacity building of government employees and local community in conservation of natural resources. Additionally, ADB Tonle Sap Environmental Management Project addresses the coordination, cooperation and planning, capacity building for biodiversity conservation and community based natural resources management. Moreover, community fishery and forestry have been established in the provinces around the Tonle Sap Lake to conserve both upland forests and flooded forests to get rich in fishery resources and to strengthen their food security.

The Law on Fishery was drafted by the DoF/MAFF in 2003 to provide for the management, protection, preservation, utilization and exploitation of fishery, aquaculture, inundated reforest and development of fishery resources in freshwater and maritime domains. This draft law is also aiming at ensuring the preservation of fishery resource as well as environmental sustainability and maintenance of ecological balance for the sake of national economy and society. It has also stressed on the protection of inundated forest from illegal and destructive activities such as clearance, encroachment and burning of inundated forest for agriculture or industry purposes, human settlement, fuel wood, infrastructure or dam construction, and so on. The draft law has also provided the right to the local communities to establish the fishery community and encourage them to fully manage, conserve, develop and utilize the fishery resources in sustainable means.

3.3.2 Aquaculture

The importance of aquaculture is fully recognized in providing alternatives to current declining fisheries resource since it could reduce the pressure on the natural fish resources. Cambodia's aquaculture has long existed in small scale and significantly increased in recent decades. Its production varies from 1,620 tons in 1984 to 14,431 tons in 2000.

The shrimp culture boomed along the coastal areas in Cambodia around 1995 and destroyed huge mangrove forest areas; however, it declined from about 700 tons in 1995 to 20 tons in 2000. Many shrimp investors went bankrupts and only very few shrimp farms could remain in operation. In the process, the polluted waste discharged from the shrimp pond into the seas, had significantly intensified. Coastal aquaculture activities, specifically shrimp farming, cause pollution and may spread diseases into wild populations in the coastal areas (UNDP 2001).

Table 3.16: Fish & shrimp culture in Cambodia

Year	Fish (ton)	Shrimp (ton)
1992	8,550	
1993	7,400	500
1994	7,640	560
1995	8,779	731
1996	9,000	600
1997	11,534	266
1998	13,903	197
1999	14,938	62
2000	14,410	20

Source: DoF, 2001

Alternative aquaculture in the Tonle Sap region as well as in other parts of the country is now being explored. Traditionally, aquaculture in and around the Tonle Sap is mainly carried out in the cages and pens while in the southern province aquaculture is grown in fish ponds. The cage and pen culture causes pollution to the water, especially when the water flow is slow and the uses of chemical fertilisers in the fish pond could increase the eutrophication in the water. Local people actually collect the fingerlings from natural rivers and feed them for few months before they sell them out.

There are 12 species of aquaculture fishes currently occurring in Cambodia, of these, 50% are introduced. These problems are widely recognized and there is a concern of the impacts of the externally introduced fish on local species.

Fish fingerling collection for aquaculture inside and outside Cambodia is now prohibited by the Fisheries Law. At the same time, RGC has issued several Decrees restricted the use of long mess size net to harvest small fish for either animal food, fish food or for direct marketing purposes.

The aquaculture program that Asian Institute of Technology supported to DoF has long been implemented in the southern provinces. At the same time, technology developed from Aquaculture Program of Asian Institute of Technology is being extended to all parts of the country and in the Tonle Sap Lake. Training programmes are also being conducted to provide local communities knowledge and skill about aquaculture. Fortunately, the current pollution level by aquaculture is being taken care of and remains small. The efforts are being made to improve the current fish culture practices in the Tonle Sap Lake and to reduce the degree of pollution in the river.

In addition, rice field fisheries are being promoted in most of provinces with limited access to natural fisheries. The rice field fisheries have been proven of increasing the productivity of rice paddy as well as the fish because while farmers are taking care of fish, the fish feeds help enrich the fertilizer for the paddy as well.

3.3.3 Threats to Tonle Sap Wetlands Ecosystem

The erosion and sedimentation are both natural and man-made phenomena which become more pronounced when forest covers decline. Over the last few decades, the Tonle Sap Lake watershed areas have become heavily deforested, leading to significant increase in erosion

and sedimentation. In addition, the deforestation of the upstream Mekong country also enhanced the erosion and silt deposits in the Tonle Sap Lake. The inland fishery, especially the fish richness in wetland ecosystem of Tonle Sap Lake and the surrounding environment, is facing downward trend due to environmental degradation.

The connection between the Great Lake and Tonle Sap River, and the junction of the Tonle Sap with the Mekong in Phnom Penh, has become shallow because of silt deposition. Increased siltation in the southeast of the lake, much of which is due to the inputs through the Tonle Sap River, in the future may result in separation of a section of the Great Lake and formation of two water bodies instead of one that would have unforeseeable consequences for the Great Lake fisheries (FAO 1994).

Since the 1950s, nearly 6,000 large and small dams, of which 13 have output of 10 MW or more, have been built in the lower Mekong Basin. Lao PDR plans to build 23 dams by 2010 and China reportedly has plans to build 12 more power projects on the Mekong Main stream, including two large reservoir projects that will have significant impacts on downstream flow regime.

The increased rate of siltation in the Tonle Sap Lake, from 20 mm to 40 mm per year, is speeding up the aging process of the Lake, with the accompanying symptoms of swallowing and narrowing and increased water temperature during the lowest water levels. The reduction of the water flow in the Tonle Sap River has been considered even to be the reason for mortality of sand goby in cages. In the northwest of the Great Lake, it is reported that it has narrowed by 5 km, for example, from 40 km to about 35 km (FAO 1994).

Other impacts on Tonle Sap wetland ecosystem are the construction of hydro power dams as stated above that will have cumulative impacts on river flow levels and disrupt the vital migratory fish stock, if the construction continued in future.

Accelerated regional activities further up the Mekong River, cause pollution and erosion through deforestation, and require increased water usage for urban and industrial water need, irrigation schemes and hydropower generation. Fisheries and fish migration are threatened and disrupted by the potential changes in the flooded regime due to upstream changes in the hydrological cycle.

The upstream countries should have strong commitment in stopping the deforestation in state jurisdiction forest areas as well as in the forest concession areas to ensure the forest rate as stated in their development goals/strategy in term of maintaining forest cover at targeted sustainable level. The RGC has reduced the number of forest concessions and ordered all forest concession companies to prepare their forest concession plans. This shows a positive move toward protecting the vital Tonle Sap Lake and preventing further erosion and sedimentation.

MRC is a regional institution addressing the environmental issues resulting from dam and hydropower construction. All four Lower Mekong Countries are signatories to the Agreement on the Cooperation for the Sustainable of the Mekong River Basin. MRC has developed a Mekong Basin Development Plan for the Lower Mekong River system. At national level, CNMC, which consists of 10 relevant ministries member, plays an important role in coordinating its members in addressing the Mekong River Issues and acts as an advisory body assisting in water policy and strategy formulation, management, investigation, planning, restoration and development of water and other natural resources of the Mekong River Basin within Cambodia.

3.4 COASTAL AND MARINE RESOURCES MANAGEMENT

Map 3.2: Coastal Areas of Cambodia



Source: MoE, 2002

Administrative jurisdictions of the Cambodian coastal zone include Koh Kong Province, Sihanoukville Municipality, Kampong Speu Province, and Kep Municipality (Map 3.2).

The coastal settlement in Cambodia is about 7.38% (844,861 people) as per the census records of 1998 with population density of 49 persons per km²; highest is reported to be 179 persons per km² in Sihanoukville and lowest 12 persons per km² in Koh Kong. About 75% of the households in the four coastal provinces and municipalities rely on the primary sectors, namely, agriculture, fishing, and forestry, as the main source of their employment and income. Coastal and marine biodiversity provides substantial benefits to local communities and the country (Table 3.17). The major coastal and marine ecosystems of Cambodia fetch an estimated US\$ 12 million in benefits per year which translates to about US\$ 162 per household per year for all residents living in the coastal districts in which these ecosystems occur³.

²Data taken from National Institute of Statistics, Ministry of Planning. 1999. *General Population Census of Cambodia*. 299 pp.

³ADB. *Coastal and Marine Environmental Management in the South China Sea, Phase 2*.

Table 3.17: Characteristics of Cambodia's coastal area

No. Coastal Provinces	2
No. Coastal Municipalities	2
No. Coastal Districts:	16
No. Coastal Villages	93
Area of Coastal Provinces	17,791 km ²
Area of Coastal Districts	15,748 km ²
Area of Claimed EEZ	42,000 km ²
Population of Coastal Provinces (1998)	836,973
Population of Coastal Districts (1998)	515,253
National Per Capita GDP (1998)	R 654,000
Area of land Mines in Coastal Provinces	5,120 ha
Marine Fisheries Production (1998)	31,843 tons
Marine Aquaculture Production (1998)	1,600 tons
Marine Products Exports (1998)	15,082 tons
Length of Coastline	435 km
Number of Islands	64
Area of Mangroves (1997)	63,039 ha
Area of Priority Coastal Wetlands (1997)	54,500 ha
Number of Coastal, Marine Protected Areas	6
Area of Coastal, Marine Protected Areas	388,700 ha

Source: ADB 5712-REG Coastal and Marine Environment Management in the South China Sea, II and MoE, 2003

Cambodia's coastal areas are currently reported to be degraded as a consequence of loss of mangrove forests, depletion of fisheries and coral reefs and impacts of coastal development activities.

3.4.1 Loss of Mangrove Forest

The total mangrove area in the coastal zones of Cambodia was estimated at about 85,100 ha in the year 1992 (Chea 1993 MRC/UNDP/FAO 1994). About 75% (63,200 ha) of these mangroves were found in Koh Kong, while 16% (13,200 ha) in Sihanoukville. The remaining 9% (7,300 ha) were located in Kampot. In 1997, the mangrove forest area was reported to be limited to about 63,039 ha (Ashell 1997), and by the year of 2002, it was further reduced to 56,241 ha (JICA 1997 and MoE 2002).

Table 3.18: Mangrove areas and their rate of decrease in Cambodia

Year	Mangrove area (ha)	Average annual decrease (ha/yr)
1973	94,000	995 ha
1992-93	85,100	
1997	63,039	
2002	56,241	

Source: DFW, JICA and MoE, 2002

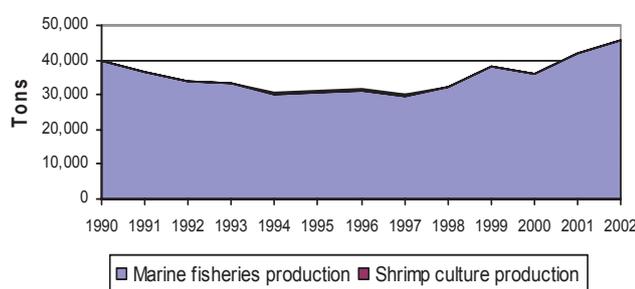
The mangrove flora in coastal provinces particularly in Peam Krasob Wildlife Sanctuaries is estimated to contain about 74 related species from 35 families and 53 genera (Chun Sareth 1993). A study in 1995 conducted by IDRC and MoE identified 17 families and 35 species in the field.

National Committee for Land Management Urbanization and Construction was created in 1997 to regulate construction planning based on zoning plan; (ii) the National Steering Committee for the Coastal Zone Management under MoE was created in 1997 to address coastal management issues; and (iii) Coastal Coordinating Unit within MoE addresses environmental problems. These Committees today look after the overall management works in the coastal province and it contributes to the management of mangrove forests including prevention of the conversion of mangrove area for shrimp farming, charcoal production and salt farming.

3.4.2 Depletion of Marine Fisheries

The Cambodia/USSR study of the 1980s reported some 435 fish species from 97 families in the waters falling within Cambodia's EEZ with a total stock of some 50,000 tons per year. From 1990 to 2002, the marine production is estimated at 30,000 – 50,000 tons per year (Fig. 3.5), but it is believed to be under estimated (DoF 2001, Tana and Todd 2002).

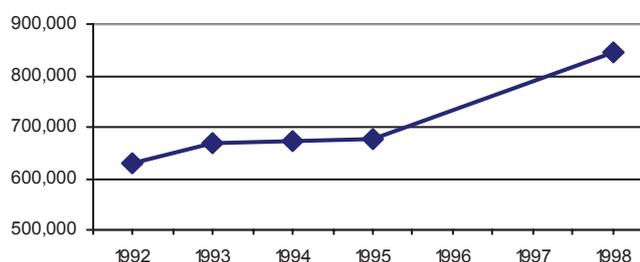
Figure 3.5: Annual Marine Fish Production



Source: DOF 2001, Tana and Todd 2002

Coastal population has increased sharply between 1992 and 1998 (Fig. 3.6). At the same time, the pressure on fisheries resources has also increased. More and more fishers currently employ modern fishing methods and prohibited gears to catch more fishes. While the numbers of fishing boats in the coastal fishing areas have increased, the catch per units of effort seems to have declined and the size of fish and other products caught has also decreased. An increasing number of local trawlers are now being deployed who fish in water less than 20 m, which is prohibited by the Fisheries Law. As the result, near-shore areas are being generally over-fished although the catch per unit effort has declined.

Figure 3.6: Population of coastal province



Source: Statistic Yearbook, 2003 (NIS/MoP)

Today, the fish habitats are significantly degraded and are generally considered to be less productive. The livelihoods of subsistence fishers have been already threatened by a decline in catch.

The National Policy for Marine Fisheries Management, Conservation and Development in Cambodia focuses on: (i) prevention of over-fishing and restoration of depleted fish stocks;

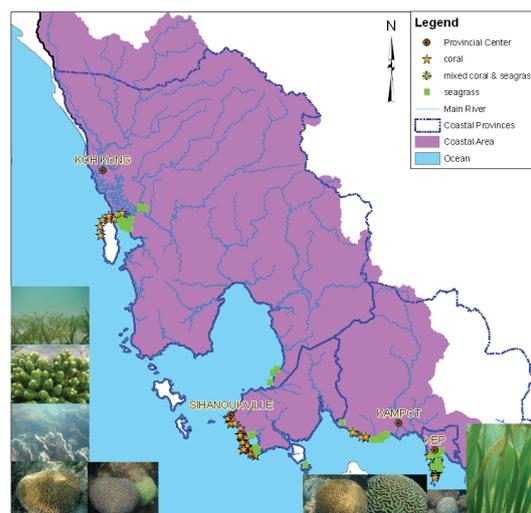
(ii) reduction of illegal fishing practices by educating fishers; (iii) conflicting reduction by creating a zoning system for access right; (iv) development of a sustainable aquaculture sector; (v) provision of alternative livelihood option to reduce reliance on fishing; (vi) increased understanding through research option; (vii) DoF capacity building; (viii) reduced corruption; (ix) community co-management; (x) providing affordable micro-finance to fishers and aquaculturalists; and (xi) help communities establish processing and port facilities for improving value of fish catches.

The Draft Sub Decree on Management of Protected Areas is proposed to address these important institutional issues to harmonize the efforts of relevant ministries. The present draft of this Sub Decree needs to clearly specify and address the range of management parameters in protected areas within which coordination and cooperation between these ministries will be essential.

3.4.3 Coral reefs and sea-grasses

Sea-grass beds and coral reefs occur throughout the coastal zone of Cambodia with the most extensive beds in the waters off Kampot Province and Kep Municipality growing as pure or mixed stands, and *Caulerpa* beds along the entire coast to the border with Viet Nam. The recent study (ADB, 2000) estimates coral reef and sea-grasses at 476 ha and 175 ha respectively and the coastal wetlands at 54,500 ha.

Map 3.4: Location of coral reef and Sea-grass



Source: MoE, 2002

There are about 70 species belonging to 33 genera and 11 Families have been identified. The offshore islands have higher coral diversity.

Threats to coral reefs of Cambodia are much the same as those encountered in neighboring countries and include destructive fishing practices (particularly motorized push nets, shallow water trawling, and weighted bottom nets which rip up and destroy sea-grass meadows, dynamite and cyanide fishing), collection of corals for trade, declining water quality due to unsustainable logging practices, and domestic and industrial waste disposal.

The decline in fisheries catch due to the destruction of coral reef and sea-grass beds has caused concern among local communities and government. The Fisheries Law and the Law on the Management and Conservation of Natural Resources prohibit the destruction of the coral reef and sea-grass. At present, the sale or collection of coral reef is prohibited and the Provincial Department of Environment is restricting the movement of the coral reef in large

amount. The motorized push nets and shallow water trawling in water less than 20 m is not allowed in the coastal areas.

The marine community fisheries are established in some key areas along the coastal provinces such as in Koh Kong, Kampot and Sihanoukville. Most of these community fisheries have been supported by government, NGOs and donors. NGOs have also engaged in raising awareness about the marine resources management and protection. Part of this effort is to protect the fisheries, coral reef and seas-grass as it is important for fisheries and people.

3.4.4 Coastal Development

Urbanization and industrialization in the coastal zone of Cambodia are of a relatively small-scale and their magnitude can be compared to neighboring countries. Most urban and industrial developments have usually occurred along the coast of Sihanoukville and Kampot Province. Operational cement factories are located in Kampot, breweries, handicraft manufacturing, petrol storage, local and international ports, hotels, restaurants, and so on are being increasingly developed in Sihanoukville.

The absence of clear mandates for routinely incorporating environmental inputs into planning and zoning activities, as well as the absence of integrated management plans, regional plans, research, and monitoring programs, are the main issues which need to be addressed for effective management of urbanization and industrialization along the coastal zones.

Other types of ongoing activities that could damage coastal water quality, ecosystems, and fishery habitats include dredging, untreated domestic and municipal waste, and related heavy construction work associated with port and harbor improvement and maintenance and building.

The impact of these activities has led to the fragility of physical coastal ecosystem, oligotrophic, coastal water pollution, eutrophication (due to high concentration of Nitrogen and Phosphate and oily-water), public health deterioration, declining of eco-tourist area, near shore fishery product decline, etc.

MoE, one of important institutions in charge of marine resources, has now seriously embarked on in the protection and management of the coastal and marine resources. Some protected areas have already been established which include Preah Sihanouk (Ream); Kep, Bokkor and Kirirom National Parks; Dangpeng multiple use; Bottom Sakor and Peam Krasop Wildlife Sanctuaries; and Koh Kapik Ramsar site.

The National Coastal Steering Committee created in 1997 holds a regular meeting with relevant ministries, coastal provincial governors, NGOs and international organizations. This committee has a Coastal Coordinating Unit that serves as its secretariat and is based at MoE. This Committee is responsible for providing the overall direction to the coastal project activities. The Coastal Coordinating Unit, as part of the MoE, coordinates all the activities relating to coastal and marine environmental management of the Kingdom of Cambodia.

3.5 WASTE MANAGEMENT

The industrial and service sectors in Cambodia has expanded year by year with a more stable political environment and alongside with the expanding economy, Cambodia's urban and industrial growth is expected to increase in the coming years.

The growing industrial and service sectors results in increased rural-urban migration population which puts additional pressure on the limited urban infrastructure and services, coming along with the pressures from the waste generated by industrial, service sectors and population growth. Consequences from waste pressures⁴ cause harmful impacts to the environment and human health; especially communities live adjacent to the dumpsite. Meanwhile, some solid wastes imported illegally from overseas are dumped elsewhere with no dumpsites; include electronic equipment, vehicles, clothes, plastic/leather shoes and bags, film residues, etc. Actually, some of these second hand facilities are no longer used and are illegally disposed at dumping sites or at open areas.

There is no solid waste related data/information for the country as a whole, except for few major cities and provinces. Therefore, solid waste issues presented in this report is indicative only for Phnom Penh City.

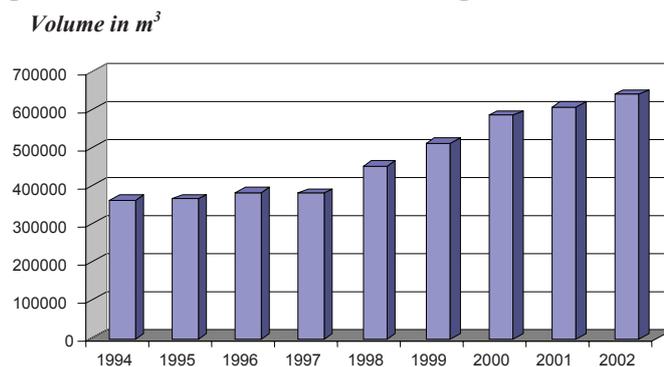


Wastewater discharged into Stung Siem Reap

These second hand facilities are no longer used and are illegally disposed at dumping sites or at open areas.

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Figure 3.7: The volume of solid Waste generation in Phnom Penh



Source: MoE, 2003

As indicated in the figure 3.7 above, the volume of solid waste in Phnom Penh City has doubled between 1994 and 2002. The collected mixed solid wastes, from different sources like domestics, hospital, commercial sectors, are being disposed in an open dumped site which is no longer suitable with increasing piles of waste.

⁴The pressures of air, water and soil pollution, and obnoxious odor

There is no data relevant to domestic wastewater for the country as a whole, except in Phnom Penh. In Cambodia, there is no central wastewater treatment plant to treat domestic wastewater. Domestic wastewater commonly is collected either by and/or without combined public sewers, opened canals/drainage systems and flow into receiving sources. Some areas where public sewers or opened canals or drainage systems cannot access, for example, at the Siem Reap Province, most domestic wastewater are left to percolate into the ground⁵ and some of them directly run off to Stung Siem Reap.

Most areas in Phnom Penh City, domestic wastewater collected by combined public sewers, opened canals/drainage systems, are run off to natural lakes/wetlands inside the dyke⁶ (Boeng Trabek, Boeng Tumpun, Boeng Salang, Boeng Kok, and so on) within a retention period for passing natural treatment process, and pumped out of the dyke to Boeng Cheng Ek (at south of the City) and Boeng Pong Peay (at north of the City) to pass once more through a natural treatment process, and flow to Bassac River afterward.

However, some areas at East and North-East parts of Phnom Penh discharge domestic wastewater directly into the Tonle Sap River and Bassac River during the dry season through some sewage systems.

By high demand of human settlement, those natural lakes/wetland⁷ are being filled gradually without permission from responsible institutions. Recognizing that this practice has caused pollution to the environment, and affected human health, and city aesthetics, appropriate measures on effective urban waste management are now being taken up.

3.5.1 Urban Waste Management

Increasing levels of urbanization are probably caused by natural growth of the urban population and migration of the rural population into urban areas alongside with the growth of industrial and service sectors. Cambodia's urban population has grown by about 26% in the last decade occupying an increasing area of land (ADB 2002) with Phnom Penh as dominance with approximately 10 times the present population size.

The current expansion of some urban areas has not been planned, and there is little investment for maintenance or improving of the urban environment and sanitation. There is also no investment in home improvement and construction, and has outstripped investment in public infrastructure (ADB 2001). Thus poor urban infrastructure has not been able to cope with the increase of urban population.

Much of solid waste generated in the urban area remains poorly managed and some are either deposited in surface waters, at opened areas or along the streets or at vacant areas closed to their residents.

The inadequate disposal of wastewater and solid waste continues to cause a major threat to the urban environment. Municipal and domestic sewage is a key source of seasonal and local water pollution.

Commonly, dumpsites in Cambodia are unsuitable in respect to conventional technical standards or guidelines; therefore, the environmental and public health risks are serious.

⁵Septic tank

⁶Phnom Penh City is located inside the dyke. Without a protecting dyke, Phnom Penh City must be flooded by water of the Mekong River

⁷Both inside and outside the dyke

Communities surrounding the Stung Meanchey Dumpsite live under the health hazard, which is caused by leaching, polluted smokes, obnoxious odor, infectious agents⁸ etc. Meanwhile, the waste pickers are also confronted to high risk and hazard, because they spend whole day at dumpsite without using safety facilities, e.g. mask, glove or boot, and they eat and/or drink in unhygienic conditions.



Solid Waste Dumping Site

solid and liquid waste, which cause water quality degradation, result in loss of aquatic biodiversities, and lead to human health impacts, etc.

At present, provinces and cities, including Phnom Penh City have neither central incineration plants for solid waste nor special incineration for special wastes. Mixed solid wastes⁹ are commonly burned at open area and this causes atmospheric pollution resulting from emission of CO, CO_x, SO₂, NO_x, especially, Dioxins and Furans.

In short, the pollution issues from waste in most provinces and cities originate from the challenges of limited national budget, weak legal instrument application, inadequate human resources, improper management of

Recognizing the need of solid waste data at provincial level for setting up effective measures for managing its disposal, in the mid-2001, the Department of Environmental Pollution Control attempted to collect data and information on solid waste generation and its management from respective provinces/cities with the assistance of JICA expert. This mission was closely collaborated from Environmental Provincial/Municipal Departments. The outcome of this mission indicated that solid waste management in provinces and cities was still limited, which resulted from inadequacy of human resources, collecting and transporting devices, including budget to support this process.

Currently, the Ministry of Environment follows up and monitors the application of domestic solid waste management including disposal, collection, transportation, storage, recycling, minimizing, and dumping of household waste in collaboration with local/municipal authorities as stipulated in the Sub-decree 36/ANRK/BK on Solid Waste Management, 1999 and the Declaration 80 MoI-MoE on The management of provincial and municipal solid waste in the Kingdom of Cambodia, 2003. In addition, the Ministry of Environment has the nodal role to guide them and prepare relevant regulations for effective management at local level.

With regarding to the air pollution control measures, the Sub-decree 42/ANK/BK on Air Pollution Control, 2000, MoE has the role to regularly monitor and assess the air quality standard by taking measures to prevent and reduce air pollution caused by improper waste incineration at open areas or factories. Moreover, MoE has been cooperating with concerned ministries to propose the activities to mitigate the air pollution from heavy traffic and to prohibit the import of the used mobile machinery which emit the smoke beyond the maximum prescribed level.

The RCG has issued the Instruction 51 MoE on Water Pollution Control, 1999, to encourage the provincial and municipal authorities and MoE to pay attention on the prevention and

⁸Those are domestic animals, rates, houseflies, etc.

⁹Domestic, medical and industrial wastes and others

reduction of water pollution caused by the discharge of liquid waste from domestic use in the provinces and municipalities by improving the monitoring the water quality and the controlling the source of pollution. The “Polluter pays principle” is also included in this instruction to allow the MoE, provincial and municipal authorities to seize and fine or accuse the polluter.

The Phnom Penh Municipal Authority (PPMA) in cooperation with line ministries and institutions try to find out an effective mechanism to minimizing the pollution and its consequences. Recently, PPMA has finished the study on wastewater treatment location at Boeng Cheng Ek in cooperation with the French experts. The Ministry of Environment and other supporting inter-ministries, with the technical and financial assistance from the Japan International for Cooperation (JICA), PPMA has also constructed new sewage drainage system to improve the quick wastewater run off in the Boeng Trabek, Boeng Tumpun and Stoeng Meanchey into natural wastewater treatment location at Boeng Cheung Ek.

3.5.2 Industrial Waste

Number of industrial factories has increased over the past few years since 1994, dominated by the garment and textiles, but the new factories registered at Ministry of Mine and Energy have declined from 98 in 1998 to only 17 in 2001 due to the decrease of exported quota for the United States and European markets.

Table 3.19: Factories Registered under the MIME

Year	Number of Factory (by year)	Erased Factories from the Registration List
1994	8	2
1995	10	2
1996	28	5
1997	69	13
1998	98	10
1999	56	9
2000	38	-
2001	17	1

Source: Ministry of Industry, Mine and Energy, 2002

The increasing numbers of factories have contributed to the increase of the waste production, mainly in Phnom Penh City and Kandal Province.

Industrial waste includes the waste which is generated from industrial production such as useless pieces of cloths, sludge, leathers, rubbers, raw material residues, tin/can etc., and industrial wastewater.

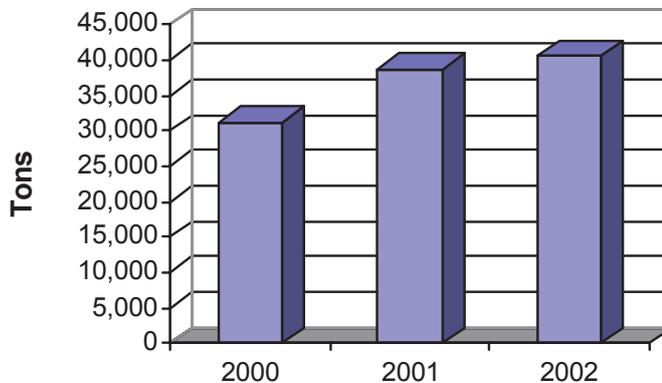
3.5.2.1 Solid Industrial Waste

In general, the industrial technology applied in Cambodia does not meet the environmental requirements and there is inadequate mechanism and facilities to control the wastes. As reported by the Department of Environmental Pollution Control, industrial solid wastes in Phnom Penh City noticeably increased from about 31,325 tons in 2000 to about 40,000 tons in 2002.

The dumpsites for the industrial waste are also inadequate. Often the industrial solid waste and urban solid waste were disposed together in the same dumpsite, except that the high level hazardous waste were suitably managed in Phnom Penh City and Kandal province, under regular control and monitoring by the Ministry of Environment.

Although, a legal mechanism for industrial waste management has been set up and applied, but some unlawful activities are still secretly undertaken, which cause environmental and public health pollution. One example is selling of unusable cloths from industrial owners/managers to the poor for its use as a cooking fuel.

Figure 3.8: Industrial solid waste being generated in Phnom Penh City



Source: DoEPC, MoE 2003

The burning of unusable cloths for cooking purpose causes severe air pollution with adverse health impacts, especially, among women and children living close to those burning areas.

To solve the problem, the MoE has now strengthened the legal instrument to industrial sector and also educated communities about relevant adverse impacts caused by their activities, unless alternative methods were applied.

Complying with the Sub-decree on Solid Waste Management, transporting industrial waste from place to place¹⁰ requires permission from the MoE. Meanwhile, the MoE staff regularly control industrial wastes at the determining dumpsite¹¹. In this regard, respective industries have to ask for a disposal license of industrial waste at the dumpsite. Up to the year of 2004, MoE has provided technical assistance to 32 factories on solid waste disposal management to protect the environment as well as public health (DoEPC 2004).

3.5.2.2 Liquid Industrial Waste

Industrial wastewater is generated variedly from year to year in accordance with the increase and/or decrease in the number of factories. Among 241 factories monitored and controlled by MoE, garment factories account for 61.8%, soft-drink/brewery and the likes for 3.8%, factories using chemical substance for 14.10%, and others for 20.30%. However, it is indicated that the utilization of toxic and/or hazardous substances in Cambodia for industrial development purpose is still low compared to other neighboring countries.

About 92.6% of the factories use chemical substance for their production, for instance dying, washing, galvanizing, printing, and paper factories, and only 5% of factories including garment, shoe and drink factories have proper on-site wastewater treatment facilities.

¹⁰ From factory to dump site only

¹¹ The suitable industrial waste dumpsite determined by MoE in cooperation with local authorities

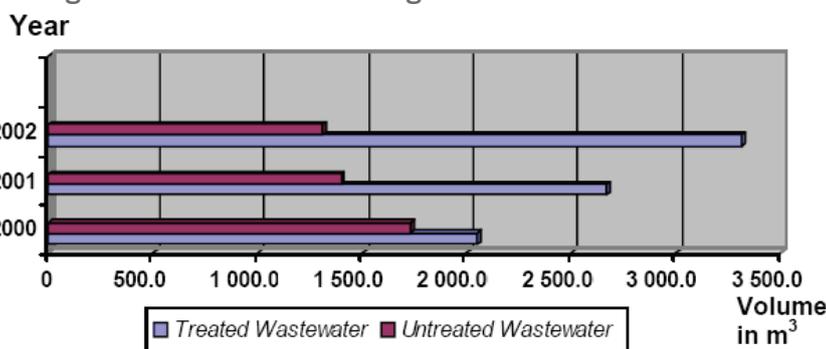
Table 3.20: Wastewater Generation from Factories in Phnom Penh City and Kandal Province

Type of Factory	Amount of Wastewater (M ³ /year)		
	2000	2001	2002
Non-chemical use factories	852,180	1,097,880	1,340,360
Chemical used Factories	2,928,100	2,964,920	3,282,440
Total	3,780,280	4,062,800	4,622,800

Source: DoEPC, MoE, 2003

Table 3.20 demonstrates the amount of wastewater generated in Phnom Penh between 2000 and 2002 by factory types. The amount of wastewater generated by each of factory type is increasing from year to year with about 3,780,280 m³ in 2000 to 4,622,800 m³ in 2002. The amount of wastewater is generated only from factories located in Phnom Penh and Kandal province. The above figures cover both treated and untreated wastewater.

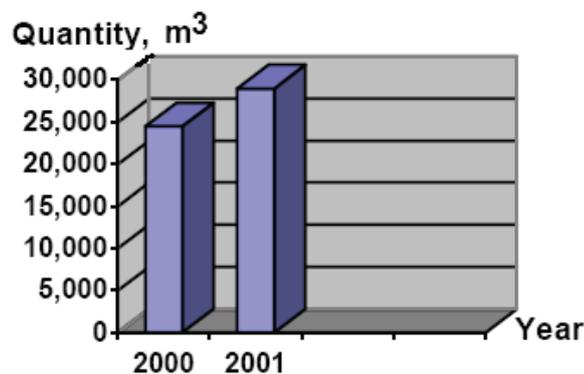
Figure 3.9: Wastewater management in monitored factories



Source: MoE 2000-2002

Despite lack of technical expertise, facility and resources for the monitoring, the MoE has informed to all factories that wastewater must be treated before being discharged to open areas. The volume of treated wastewater from the factories has been increasing year after year while the untreated water from the factories has been decreasing year after year since 2000 (Figure 3.9). This reflects the action taken by MoE in collaboration with other line ministries in addressing the wastewater issue.

Figure 3.10: Estimated industrial sludge generated by factories in Phnom Penh and Kandal Province



Source: MoE 2000-2001

There is also an ongoing effort to manage sludges from factories by technical agencies. Firstly, sludges of non-chemical factories, for example, Brewery, and Drinking Water Factories etc., can be used as fertilizers and animal feeds. Secondly, sludges produced by chemical factories are required to be handled properly based on the technical guidelines developed by the MoE. In complying with the environmental legal instruments, all factories are required

to store and manage the sludges at safe location, forbidding the dump of these sluges to open dumpsite with other domestic wastes, and wait for its collection by a responsible company in order to be delivered at designated safe dumping site under the monitor and following up of the MoE. However, illegal disposal of industrial sludge rarely occurs and this violates the environmental regulation if it happens, but some industries do so because of high service charge for sludge collection and transportation and sludge storage space in industrial premises is limited.

It is generally known that any discharge of untreated wastewater cause the water pollution and raises public health concerns such as serious epidemic of diarrhea and loss of aquatic biodiversity and aquacultures.

Industrial wastewater combined with domestic wastewater run off to public receiving sources including pond, river, groundwater, lake, stream, seawater, etc. through public sewers and opened canals/drainage. Although wastewater receiving sources commonly receive all kinds of wastewater from pollution sources, MoE has, so far, ordered the factories using chemical substance and are discharging wastewater into the receiving sources, to have the water treatment plant so that the polluted water is properly treated before being discharged (DoEPC 2004).

The RCG has issued the Sub-decree 27 on Water Pollution Control, 1999, aimed at controlling, preventing and reducing the water pollution at public receiving sources, protecting human health and conserving biodiversity. The hazardous components, standard of liquid waste discharge from the every discharging source into the open receiving sources or sewage system, type of wastewater discharging sources which require the permission from the MoE, water quality standard at public receiving sources for aquatic biodiversity conservation and for public health are clearly described in the appendices of the above Sub-decree.

To protect the water quality at the public receiving sources, MoE had paid much attention in monitoring and assessing the variation of quality of public receiving sources to support the public health quality and biodiversity conservation. The DoEPC of MoE has allocated the water quality control stations on the main rivers of the country known as:

Table 3.21: Water quality control stations on the main rivers

No.	Location Name	River Name
1	Chroy Changva	Upper Mekong
2	Kien Svay	Lower Mekong
3	Phonm Penh and Prek Kdam port	Tonle Sap
4	Monivong Bridge and Svay Rolum Port	Lower Mekong
5	Takmao Bridge	Basac River

Source: DoEPC, MoE, 2002

By the end of 2004, DoEPC had conducted the water quality analysis for as many as 11 parameters including pH, conductivity, DO, TSS, BOD5, COD, NO₂, NO₃, PO₄, total coliform and fecal coliform and the results suggested that the level of these parameters in the water were lower than the prescribed standards. Meanwhile, to ensure the water quality, DoEPC with the cooperation of JICA had also conducted the monitoring process of the water quality in the sewage around Phnom Penh municipal area (18 samples) and the wells surrounding Stoeng Meanchey waste dumping site (12 samples) on 15 parameters including pH, conductivity, TSD, turbidity, total hardness, total iron, arsenic, manganese, chloride, sulphate, fluoride, NO₂, NO₃, total coliform and total bacteria (DoEPC, 2005).

The survey indicated that, prior to the discharge of chemical waste water into the public receiving areas, as many as 36 factories (mostly washing and dyeing factories) had installed their own waste water treatment plants. One factory had its water treatment plant under construction and another 2 were improving their cleaning system to treat the waste water according to the permissible discharge standard. In total, there were approximately 81.5% of the factories in the area which were discharging the waste water in quality below the prescribed limits.

3.5.3 Hospital Wastes

Medical wastes in Cambodia account for approximately 2% of total waste production, and are composed of needles, syringes, glass bottles, glasses, surgical wastes, and other pharmaceutical wastes, pathological waste, chemical and heavy metal waste, pressurized containers, etc (Chrin Sokha 2000). Currently, the medical waste is generally reasonably managed in terms of waste classification, collection, storage, and disposal/burning. The hospital wastes vary from year to year. In 2000, hospital wastes were estimated at 182 tons and increased to 462 tons in 2001 and further up to 300 tons (in addition to liquid waste of about 66,430 litres) in 2002. Noticeably, this amount was taken merely in Phnom Penh. However, the hospital waste data and information for the whole country is not available.



Medical Waste Management by Type Separation (Calmette Hospital).



Medical waste incineration in Calmette Hospital

Commonly, the hospital wastes consist of general wastes and medical wastes. Certainly, most of these two-type wastes were packed in two different plastic bags or plastic bins for each of the health centers both public and private. Some hospitals burn the wastes in their own incinerators. The medical wastes are not separated into specific kinds, but actually are disposed together with other.

The normal incinerator is operated at the temperature between 350oC and 600oC maximum. Practically, the medical waste can not be completely destroyed at these ranges of temperatures. The non-incinerator hospitals, polyclinics, clinics, and health centers send their wastes to the on-site incinerator hospitals for burning. However it has been reported that only small amount of the waste is treated by on-site incinerators. Approximately 357 kg¹² and 68 litres of medical waste is burned daily by incinerators within some hospitals (see Table 3.22 below). Some amount of ash or residue resulting from incineration is disposed at sites in the vicinity of the incinerators; while the others is collected by PSBK Company to disposed off at the open dumping site.

¹²This figure is not included general waste or waste burned by facilities other than by on-site incinerators. According to the survey questionnaires, few on-site incinerators are presently out of functioning so that a number of medical wastes have not been burned.

Table 3.22: Medical Wastes in Phnom Penh Municipality, 2002

Type of Wastes	Hospital		Polyclinic/Clinic		Healthcare Center	
	Kg/day	Liter/day	Kg/day	Liter/day	Kg/day	Liter/day
Kitchen Wastes	236	-	55	-	131	-
Medical Wastes	344	178	37	4	22	-
Burning Wastes	330	65	5	2	22	1

Source: Medical Waste Management: Survey Report & Medical Waste Management Plan, MoE 2002.

On the other hand, the governmental institutions and provinces and municipalities of Cambodia are still facing the problem of human resource and technology as well as the national budget to manage the hospital waste.

The release of Dioxins/Furans and other pollutant substances into the atmosphere through medical waste incineration is reported to have caused severe health impacts on local scale. Additional environmental impacts have also reportedly been caused by improper disposal of residues from medical waste burning.

Attention has also been focused on hospital waste as its amount has been increasing rapidly alongside with the increase of clinics and health centers over the years. During 2003, about 75% of the National Hospitals used the safety boxes and about 25% did not for disposal of hospital wastes. For referral hospitals, about 36% used safety boxes and 64% did not (Chrin Sokha 2004). However, it is difficult to identify the number of safety boxes burned; therefore, the actual burned amounts have varied depending on the real circumstances (for example, during the campaign of various disease precautions, the number of used safety boxes was increased). For effective management, safety boxes are now widely distributed to the National hospitals and referral hospitals for storage of needles, syringes, or other sharp wastes in a safe manner before being taken to a final place for incineration.

The policy to address the hospital waste is still rather limited as compared with other wastes. The Ministry of Environment is playing an important role in addressing the hospital waste issues. More efforts need to be taken to address these issues through collaboration of different institutions ranging from local authority to national government.

3.5.4 Dump of Toxic Waste

The toxic and hazardous wastes are generated from a wide range of industrial, commercial, agricultural, and to a lesser extent, from domestic activities. They exist in major form like liquids, solids, and sludge. Toxic and hazardous wastes, such as chemical reactivity, toxicity, corrosiveness or a tendency to explode, could easily pose a risk to human health and environment in short and long terms by improper use, discharge, storage, explosion, incineration, transportation, etc. This section addresses merely for industrial sector, as other sectors have not been surveyed up to now.

The toxic waste dumping in the least developing country has often been reported. In late 1998, some 3,000 tons mercury-bearing wastes from Taiwan were dumped in Sihanoukville, (30 November, 1998), causing a major internal incident with short-term public chaos. The importation of disable VIDEO film from Korea was dumped in Sihanoukville shortly before the Taiwanese waste was dumped. The unusable shoes were also imported and disposed in the Phnom Penh recently.

Fortunately, the RGC was able to take back the wastes dumped in Sihanoukville to Taiwan. The experiences from Taiwanese waste dumped in Sihanoukville gave a good lesson for the RGC to prevent further dumps of the toxic waste from the developed countries. With

these experiences, the RCG has signed the Basel Convention¹³ on 02 March 2001. Even though it has not been ratified as yet by the National Assembly, it is notable that from 1998, there were no new dumps of the toxic waste imported from overseas and the government institutions, particularly MoE, have gradually built staff capacity to cope with the dump of the toxic wastes.

In Cambodia, the factories that use chemical or chemical compound indicated that the utilization of toxic and/or hazardous substances for industrial purpose is still at a low level compared to other adjacent countries.

¹³The convention focus on trans-boundary movement of hazardous wastes/substances

PART 4: CONCLUSIONS

4.1 LAND DEGRADATION

Land degradation is related to loss of land productive capability as a result of degradation of soil quality due to Human activities and natural events such as unsuitable agricultural land use, land encroachment, logging, poor soil and water management practices, infrastructure development, and draughts and floods cause land loss and deteriorate functional capabilities of soil. During 10 year period between 1987 and 1997, about 1.2 million ha of forest land had been converted to agricultural land and other land use types. The increase or decrease in yield of rice depends on water management practices, fertilizer uses and natural events such as droughts and floods. Both urban and rural population growth has increased rapidly resulting in pressure on land; and the poverty (landless ownerships) are subjected to fragmentation and eventual overexploitation of land and natural resources especially logging and conversion of forest land to agriculture land and other purposes. The shifting cultivation is also considered as an important factor contributing to the decline in forest land.

A number of factors contribute to the emergence of land as a predominant environmental and social issue. Among the most important land issues are:

- Population growth places high demographic pressure on land.
- Land tenure is not secure for many of the country's rural poor.
- Land speculation is uncontrolled and ownership is driven by outside interests.
- Large areas of potentially productive land are still affected by landmines.
- Natural hazards, especially flooding, affect sustained land productivity.
- Land allocation for agricultural, forestry, industrial, and other purposes still lacks transparency.
- There are competing land claims, even between government ministries.
- There is uncertainty over land boundaries under control by various entities.
- Information and understanding of laws and procedures governing land is inadequate.

RGC need to undertake some activities to solve the issues on land degradation as following:

- Due to the weak of policy on converting land to agriculture or urban land expansion, Government needs to improve its overall coordination of land use planning and land allocation. This includes improving the land inventory system and the national classification system and developing land use plans for forests, agricultural development areas, key urban areas, and road corridors;
- Soil quality degradation reduces the productivity, requiring farmers to apply more and more fertilizers, both organic and inorganic, the specific studies on the impact of fertilizer uses need to be undertaken. Sub-Decree on Standards and Management of Agricultural Materials and the Stockholm Convention banning POPs need to be enforced to reduce highly hazardous and persistent chemicals;
- The RGC is implementing policies to increase the productivity of existing arable land through investments in infrastructure (irrigation), expand cultivated areas, improve water policy, and increase private sector involvement across a range of sub-sectors;
- Greater attention given to environmental protection and a determined action by RGC in establishing, expanding and managing the system of protected areas.

4.2 DEPLETION OF BIODIVERSITY

Biodiversity is the measure of the world's variety of life. Article 2 of the CBD defines biological diversity as "the variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystem and the ecological complex of which they are a part". Depletion of biodiversity refers to loss/threat of wildlife and natural habitats and reduction of the value of biodiversity products and services. Excessive logging, conversion of forest lands for agriculture, reclamation of wetland, infrastructure and industrial development have contributed to the increasing rate of wildlife habitat loss and biodiversity destruction. Cambodia is home to an estimated of 2,300 plant species, 130 mammals, over 500 bird species mainly living in the wetland areas and about 500 species of freshwater fish. However, there is still little information about biodiversity in Cambodia due to lack of biodiversity inventory, lack of human resource, technical and financial support. Most of Cambodians in the countryside derive their resources and foods from the biodiversity resources. Habitat loss due to deforestation, wildlife trading targeted in most valuable species, pollution impact from agricultural activity and landmines and other unexploded ordnance are the key factors which have increasingly threatened the biodiversity in Cambodia in recent years.

Policy gaps related to biodiversity management:

- The absence of a strong land use policy framework, inadequate coordination among ministries and department dealing with natural resources and land use development as well as a lack of accurate information to guide land use allocation are other important factors;
- Cambodia currently lacks clear rules and guidelines on what is allowable and what is not with regard to hunting and utilization of natural resources. Natural resources, forest and wildlife collections and harvesting should be clearly regulated. Local residents and leaders need to be educated about the long-term benefits of the natural resources and wildlife;
- For the most part the country lacks good systematically collected and evaluated data on the distribution, populations and dynamics of major species. The dearth of scientific information has created problems for reaching consensus agreement on national priorities.
- The effective management of protected areas will require the collaboration of numerous institutions nationally. Often these national bodies have conflicting interests, as between government, private business, military, and provincial and central government authorities.
- Weak information related to the impacts on biodiversity with improper use, storage and disposal of chemical and pesticide products for agricultural purpose.
- There is no record of the amount of wildlife or the volume of biodiversity which have been killed or affected by the abundance of landmines and UXOs. The long term impacts on biodiversity caused by the chemical weapon in the form of defoliants and herbicides, known as Agent Orange, which was dropped along Cambodia-Vietnam border during American-Vietnam war also needs to be investigated further.

4.3 DEGRADATION OF INLAND AQUATIC RESOURCES

Degradation of inland aquatic resources in Cambodia can be illustrated to loss of fishery productivities due to over-fishing, destructive and illegal fishing practices, fish management, and decline of wetland and flooded forest. In addition, in Cambodia, fish production takes place in a wetland ecosystem that is driven by the annual flooding of the Mekong. Fisheries

play important role in strengthening the national economy as well as in daily livelihood of Cambodian people. Fish and fishery products are believed to account 40-60% of the protein intake of the population. Production of inland fish was estimated at 289,000-431,000 tons per year for the entire country, based on catch surveys 1994-97, which made Cambodia's inland fisheries the most productive in the region. The national fish consumption per capita was estimated as about 30 kg per annum. Despite the richness of natural resources around the Tonle Sap Lake, about 39% of the population in that area lives below the poverty line, compared with 36% at the national level (RCG 1998).

The total fish catches have been relatively stable over time, but its figures are extremely misleading as an index of fish abundance and value. The mean fish body size has decreased and species composition has shifted, favoured small-bodied and low value species. These are all symptoms of overexploitation of fishing resources (ADB 2003). The use of destructive and illegal fishing practices is widespread in country. Small and medium scale fishers resort to illegal fishing practices due to pressures to feed their families, pay off debts, and adequate income/capital. Large scale fishing uses illegal practices to compensate for high costs related to purchase of commercial scale equipment, licenses, auction sales of fishing lots, and official and unofficial transportation and marketing fees. The demand for increase in agricultural lands has led to the clearing of freshwater floodplain forests and the demand for fuel-wood has caused unsustainable harvesting of the flooded forest, resulting in the degradation or loss of flooded forest habitat.

Policy gaps related to fisheries management:

- Official fees and informal payments, including random checkpoints to “check the transport permit” and demands for fees from institutions that have no clear basis for fee collection, are so numerous and so high that fish exporters are forced to keep fish prices at the landing sites as low as possible. Low fish prices and competition over decreasing resources have caused poverty in many fishing communities.
- Commercial fishing (fishing lots) needs to be managed to eliminate destructive and illegal fishing practices, and to avoid over-fishing. Because of fishing lots, communities traditional dependent on fishing were marginalized due to the reduction of areas open access.
- To reduce poverty, efforts should be taken to improve sustainable access to fishery resources and ensure the equitable share of these resources for the poor. Communities must also be made active partners in the process of protecting, managing and sustainable use of fishery resources.
- Lack of clarity over fishing lot boundaries have led to conflicts between local user groups and commercial fishing operators. In some cases, lot owners accuse villagers walking by the fishing lot with intention to fish illegally or harass community people fishing near the fishing lot border.
- Competition for decreasing stocks is becoming more severe, and fishers at all levels have resorted to taking advantage of a weak law enforcement environment and lack of management systems to capture as much as they can immediately, without concern for the future.
- The impacts of water pollution on fishery are somehow unknown; the pollution from agricultural run-off is becoming more common due to increasing use of chemicals, such as fertilizers, herbicides and pesticides. Settlements and floating villages have limited domestic waste management infrastructure and most domestic waste goes directly into waterways without any treatment.
- Other impacts on fisheries are the construction of hydro power dams in up stream countries that will have cumulative impacts on river flow levels and disrupt the vital migratory fish stock, if the construction continues in future.

4.4 COASTAL AND MARINE RESOURCES

It is recognized that the marine and coastal resources are one of the priority issues to be addressed in Cambodia to achieve environment protection and sustainable development. The increased economic activities have resulted in increase of development projects and migration of people in coastal provinces and have added more pressure on the coastal and marine resources. The mangrove, marine fisheries, sea-grass, coral reef and other marine resources are under pressure from increased development trends and overexploitation due to high growth of populations. These have happened because there are inadequate capacities of agencies in charge of marine and coastal areas, poor financial support for marine resources management, overlap of roles and responsibility, weak policies and legal framework and lack of coordinated and integrated development plans for coastal areas.

The coastal and marine fisheries in Cambodia are known to have declined due to the increased pressure from human activity and increased rapid economic development. The increased open access in marine areas has resulted in conflict among fisheries user groups. The conflicts between small and larger fishers are occurring due to the absence of enforcement of the law and poor management of the marine areas due to overlapped roles and responsibilities among government agencies. It is therefore necessary to promote community based natural resources management in coastal fishing community in order to reduce fishing conflicts through building supports from the government agencies.

The Department of Fisheries in Cambodia has set a target (Goal 1) to ensure all living aquatic resources are harvested within their sustainable limits by 2010. According to the Fisheries Sector Policy and Action Plan Briefing, accomplishing Goal 1 requires that the following objectives are realized:

- (i) The extraction of living aquatic resources follows what is safe and prudent under precautionary principles for the management and administration of living aquatic resources;
- (ii) A scientific base to support the management and administration of Cambodia's living aquatic resources is established and operational; and
- (iii) The authorities in close collaboration with local communities carry out monitoring and enforcement.

Urgent measures could be taken up which are listed as follows:

- Development of marine sectors must be projected in accordance with the view point of multi-sector integration and national utilization together with protecting the marine and coastal resources and environment;
- Implementing international conventions and agreements related to seas and oceans, as well as dealing with the marine environment.
- Providing sustainable economic development awareness and programs to manage and protect the environment in coastal areas;
- Strengthening the roles of the National Coastal Steering Committee and improving the coordination between relevant agencies involved in coastal management;
- Strengthening and improving the coordination between MAFF and other ministries to effectively regulate and manage the offshore and coastal marine resources;
- Strengthening the implementation of the legal framework pertaining to marine and coastal resources and environment together with means of enforcement;
- Participating in regional fisheries management bodies to represent the interests of Cambodia as a genuine stakeholder in the marine resources of China Sea;

- Improving and implementing the management plans for marine protected areas;
- Formulating and adopting an integrated marine policy that will harmonize policies and strategies formulated by different government ministries/department with respect to marine resources and environment; and
- Ensuring the availability of the most current scientific knowledge and advice to enable the conservation, sustainable management and development of marine resources and the habitats which sustain those resources.

4.5 WASTE MANAGEMENT

The growing industrial and service sectors has resulted in increased rural-urban migration population which puts additional pressure on the limited urban infrastructure and services, coming along with the pressures from the waste generated by industrial, service sectors and population growth. The waste issues are taken into consideration only for major cities especially Phnom Penh City due to lack of information. The volume of solid waste in Phnom Penh City has doubled between 1994 and 2002. Much of solid waste generated in the urban area remains poorly managed and some are either deposited in surface waters, at opened areas or along the streets or at vacant areas closed to their residents. There is no central wastewater treatment plant to treat domestic wastewater, even in Phnom Penh city. Domestic wastewater collected by combined public sewers, opened canals or drainage systems, are run off to natural lakes/wetlands and in some areas the waste are run off direct into rivers. The medical wastes from hospitals are packed in two types into different plastic bags or plastic bins and some hospitals burn the wastes in their own incinerators. It is notable that since Cambodia had experiences imported Taiwanese waste dumped in Sihanoukville, there were no new dumps of the toxic waste imported from overseas and the government institutions, particularly MoE, have gradually built staff capacity to cope with the dumping of the toxic wastes.

There are still concerns and issues related to waste management:

- The current expansion of some urban areas has not been planned, and there is little investment for maintenance of or improvement in the urban environment and sanitation. The inadequate disposal of wastewater and solid waste continues to cause a major threat to the urban environment. Municipal and domestic sewage is a source of seasonal and local water pollution.
- Commonly, dumpsites in Cambodia are unsuitable as per conventional technical standards or guidelines; therefore, the environmental and public health risks are serious.
- Weak legal instrument application, inadequate human resources, improper management of solid and liquid waste, which cause water quality degradation, result in loss of aquatic biodiversities, and lead to human health impacts.
- The dumpsites for the industrial waste are also inadequate. Often the industrial solid waste and urban solid waste are disposed together in the same dumpsite, except that the high level hazardous waste are suitably managed in Phnom Penh City and Kandal province, under regular control and monitoring by the Ministry of Environment.
- Lack of technical expertise, facility and resources for the monitoring, the MoE has informed to all factories that wastewater must be managed and treated by themselves before being discharged to open areas.

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Annex 1: Priority Project Proposals

Project 1: SOLID WASTE MANAGEMENT - PROMOTING SANITATION AND RECYCLING OF SOLID WASTE

The government strategies on the development, economic growth and poverty alleviation are based on achieving sustainable and affordable environmental improvement of its main urban center. Present development trends increase urbanization, rural to urban migration, and expanding industrial and tourism sectors which lead to exponential increase in the waste related environment problems. The urban expansion is not well-planned; the urban infrastructure is poor and inadequate to adsorb the rapid growth of economic, industry and service sectors. As a consequence, the wastes are poorly managed due to underfinanced services, unreliable collection services because of insufficient and poor equipment maintenance, unsanitary and indiscriminate disposal and burning of wastes by residents reluctant to pay the collection charge and general lack of awareness about the proper waste disposal, particularly in the urban areas.

Some strategies are identified to address the waste management issues:

- Building the capacity of MoE, Municipality and other agencies in management of the wastes, industrial wastes and wastewater;
- Improve coordination, planning and management for the waste management among relevant agencies;
- Strengthen the roles of MoE and Municipality in waste collection, development of urban solid, liquid and air pollution management policies;
- Identify new landfill in order to develop new dumpsite that is suitable and appropriate for the current urban size and population;
- Develop alternative dumpsites for domestic, industrial, hospital and toxic wastes ;
- Strengthen the implementation of a comprehensive framework of laws pertaining to management of industries together with means of enforcement;
- Promote the pollute pay principles for the factories in order to protect the environment; and
- Raise awareness and involve local community in waste management.

In order to effectively address the solid waste management issues in Cambodia for sustainable development, recycling of waste and promoting sanitation is crucial and a project study on this issue as briefly discussed below could be a priority area.

Project Rationale and Objective

The rapid growth in population and changing consumption patterns has increased the problem of solid waste management in urban areas of Phnom Penh. The lack of effective solid waste disposal methods has caused constraints to sustainable development.

The main objectives of this project are to promote sanitation and recycling of the solid waste for the sustainable solid waste management. This is achieved through involvement of public in classifying wastes and segregating these according to different types of wastes before sending them out to the dumpsite.

Planned Activities and Outputs:

1. Carry out a waste survey to assess the composition of the waste stream and identify the amount that can be reused and recycled.

2. Carry out a waste survey to assess the solid waste disposal problems that affect the people due to unsanitary environment.
3. Set up community recycling waste management as a mean of increasing effectiveness of solid waste management by involving publics.

Project 2: WATER RESOURCES FOR IRRIGATION SYSTEM

Agriculture is the backbone of the Cambodian economy, and it depends on irrigation/water provision for wet season crops and full irrigation for dry season crops. In Cambodia, agriculture or rice production is dependent on irregular patterns of rainfall, but with dry spells during the growing season or the annual inundation, water management is quite difficult. The total rice cultivated area has steadily increased from 1.44 million ha in 1980 to 2.31 million ha in 2003. Most of the rice cultivation occurs in the wet season, while the cultivated areas in the dry season are very small in comparison to cultivated areas in the wet season and has only marginally increased from about 95,000 in 1980 to 283,000 ha in 2003. The small increase in rice production in dry season is due to the lack of an efficient irrigation system or a robust water management program.

Cambodian socio-economic development requirements and proposals make several references to water resources and their management. Water is seen as contributing to Government priorities including poverty alleviation and economic growth principally as irrigated agriculture, seen as essential to addressing poverty by achieving food security and promoting income generation in rural areas. The Royal Government of Cambodia (RGC) needs to enhance the irrigation systems, because agriculture activities in Cambodia are solely dependent on the weather.

Irrigated agricultural area has steadily increased from 60,000 ha in 1961 to 270,000 ha in 1994. However, during the war period from 1969 to 1975, the irrigated area declined slightly. After 1975, the irrigated area rose rapidly to approximately 270,000 ha in 1993 and, according to estimates, has remained stable since then. The RGC, supported by international donors, has increased expenditure on rehabilitation and construction of new irrigation systems in recent years. During 1999-2003, the irrigation coverage increased from 16.62% of all farmlands to 20% or by about 3.3 to 4% of total farmland areas annually. A variety of construction and maintenance expenditure includes: expenditure on irrigation and drainage, flood protection, polder protection, colmatage, rehabilitation and maintenance of structure, dike rehabilitation, excavation and restoring canals, and rehabilitation and installation of pumping stations.

As can be observed from the trend, the expansion of agricultural irrigated area has led to a modest increase in rice production. Hence the government response to irrigated agriculture has been promising and must continue to cover the entire country.

Project 3: SUSTAINABLE ACCESS TO SAFE DRINKING WATER

Adequate quantities of water for meeting basic human needs are a prerequisite for existence, health, and development. If development is to be sustained, adequate quantity of water supply must be available. Accessibility to safe drinking water is also of fundamental significance to lowering the fecal risk and frequency of associated diseases. As development increases, the demand for water will normally also increase for personal, commercial, and agricultural purposes.

The UN Millennium Development Goal related to safe drinking water is stated as “Halve, by 2015, the proportion of people without sustainable access to safe drinking water (and sanitation).” Stated differently using the baseline figure of 31% for 2000 for a population with access to safe drinking water or 69% for a population with no access to safe drinking water, this translates to a target of 65.5% of the total population by 2015.

The national target, through the 2003 Cambodia Millennium Development Goals is expressed differently in terms of urban and rural population as “Increase the proportion of rural population with access to safe water source from 24% in 1998 to 50% in 2015 and urban population from 60% to 80% in 1998 to 2015”. Based on projected population estimates in both rural and urban areas, this translates to a target of 58% of the total population with access to safe drinking water by 2015. The nation has therefore two sets of targets.

The volume of drinking water provision for Phnom Penh is much higher than the volume for the total of all other provincial towns about 35 million m³ each year. Drinking water provision for both Phnom Penh and other provincial towns slightly increased. The annual rate of increase is about 4 million m³ of total urban water provision.

The Cambodian population has increased from 5.5 million in 1961 to 14.1 million in 2003, while the total rural population is much higher than the total urban population. The urban population has slightly increased within the period 1961 to 2003 from 0.6 to 2.6 millions. The rural population has steadily increased from about 6 to 11.5 millions from 1980 to 2003, while it marginally increased from 1961 to 1980. The total number of the population, and both urban and rural populations has increased rapidly for the whole country and has resulted in pressure on water resources and created a future national water shortage.

The combined urban and rural population with access to drinking water supply in Cambodia was approximately 34% in year 2002. About 1 million urban population or 53% of the urban population had access to drinking water supply in 1998. This increased up to 1.4 million or 58% of the urban population in 2002. Likewise, for the rural population approximately 2.4 million persons or 25% of the rural population had access to drinking water supply in 1998 and this increased to 3.3 million people or 29% of the rural population in 2002. However, the urban population with access to drinking water supply throughout the period 1998 to 2002 is still short of CMDG targets (the state of access to safe drinking water in Cambodia is relatively poor and only marginally improving in recent years).

Significant Achievements of the Royal Government of Cambodia during the Second Legislature of the National Assembly (1998-2003) include the improvements in drinking water production (and the expenditure from the Ministry of Industry, Mine and Energy); and the provision of infrastructures for drinking water such as wells and ponds (by the Ministry of Rural Development) as indicative of the government’s response to provide the services on safe drinking water for the population in both urban and rural areas.

However, it is less indicative of expenditure for urban areas, because data are available only for Phnom Penh city. Furthermore, the numbers of wells, ponds, giant jar and water basins are only indicative of the government’s effort to provide the support to the rural population, and data for the volume of water provided are not accessible/available. There are no data or study related to the safe drinking water level both for the treated and untreated drinking water. There are also no drinking water quality standards for treated water with concentrations of chemical compounds and bacteria that are considered as safe. These need to be taken up as priority area of development activity.

Project 4: DEVELOPING CLIMATE CHANGE ADAPTATION STRATEGIES

The most sustainable and effective solution to global warming is to reduce its greenhouse gas emissions (reducing emissions of greenhouse gases will delay and decrease the damages caused by climate change). But this is a slow process as it requires major changes to the world's economy and society, which will take decades, if not centuries. Owing to the inertia of the climate system, it is already too late to stop any further warming from occurring. Moreover, there will still be some degree of unavoidable climate change, and the projected magnitude and rate of those residual changes will require addressing through adaptive actions. Adaptation involves developing ways to protect people and places by reducing their vulnerability to climate impacts. The benefits of adaptation are likely to be immediate because the current risks due to climate variability and change are also reduced.

Avenues for planning under climate variability and change in Cambodia are diverse. In most cases, adaptive capacity will need to be developed by taking into account the fact that the regional and local climate is changing, the so-called climate proofing concept in the traditional planning processes. Examples include but are not limited to:-

- Watershed planning
- Water supply planning
- Land use planning
- Coastal zone management planning
- Flood control planning
- Forest management plans
- Water quality management

In these examples, climate variability and change will simply become additional facets to be considered in the national planning process of Cambodia. It would be prudent to assess the climate change impacts on all locally or regionally relevant development activities in relation to varying time horizon for policy making process including the identification of appropriate adaptation options and for investment decisions. A careful evaluation of the following would be required in taking appropriate adaptation measures:-

- how climate variability and change can affect resource availability and use,
- the effects of different management policies and infrastructure development, and
- the tradeoffs that may be required to balance different operating objectives.

Project 5: CLIMATE CHANGE ENABLING ACTIVITY PROJECT

Attempts have been made to measure the anthropogenic emissions of Greenhouse Gases (GHGs) namely carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) in Cambodia. These GHG Inventories are contained under "Cambodia's Initial National Communication" under the United Nations Framework Convention on Climate Change (UNFCCC), published by the Climate Change Enabling Activity Project under the Ministry of Environment, August 2002. The figures therein are representative of the country's greenhouse gas emissions in 1994 and Cambodia's contribution to global warming from various sectors such as energy, industry, agriculture, waste, and land use change and forestry. As required by the UNFCCC, estimates for year 2000, 2010 and 2020 are also provided and based on the 1994 baseline figures.

While there are natural emissions of GHGs, anthropogenic emissions have been identified as a source of climate change (IPCC Fourth Assessment Report, 2007) and are the subject of an international instrument (the UN Framework Convention on Climate Change). Such

emissions are largely influenced by a country's energy use and production systems, its industrial structure, its transportation system, its agricultural and forestry sectors, and the consumption patterns of the population. Methane and nitrous oxide emissions are particularly influenced by a country's agricultural production, waste management, and livestock management.

For Cambodia, as a developing country (a Non-Annex I party to the United Nation Framework Convention on Climate Change, UNFCCC), it is mandatory that the national GHG inventory covers three main greenhouse gases: carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O). Cambodia ratified the United Nations Framework Convention on Climate Change (UNFCCC) on 18 December 1995 while the Convention came into force in Cambodia on 17 March 1996. Following the recommendation of UNFCCC Secretariat, the Cambodian National GHG inventory was developed using the 1996 revised Intergovernmental Panel on Climate Change (IPCC) methodology with the base year of 1994.

The first-ever GHG inventory in Cambodia covered five sectors: (i) energy, (ii) industry, (iii) agriculture, (iv) waste, and (v) land use change and forestry (LUCF). Each of the GHG's has different contributions to the total greenhouse effect, which can be expressed as global warming potential (GWP). The GWP is expressed in tons (or units) of CO₂ equivalent (CO₂-e) emissions per ton (or unit) of GHG emissions. CH₄ has 21 tons of CO₂-e per ton of methane emitted. Nitrous oxide (N₂O) has 310 tons of CO₂-e per ton of N₂O emitted. The methane and nitrous oxide emissions were converted to tons of CO₂-e by multiplying the methane emissions by 21 and the tons of nitrous oxide emission by 310.

In 1994, Cambodia was contributing GHG emissions of approximately 68,000 Gg of CO₂ equivalents which are primarily from land use change and forestry (LUCF) sector. As observed by sector, LUCF contributed to approximately 81% of total GHG emissions, while agriculture and energy contributed to approximately 16% and 3%. The contribution of the industrial sector to the total GHG emissions was insignificant. However, Cambodia removed approximately 73,000 Gg of CO₂ equivalents by land use change and forestry sector. Therefore, in 1994 Cambodia was a net sink country. The overall assessment of Cambodia's contribution to greenhouse gas emissions using Global Warming Potential showed that Cambodia could offset approximately 5,000 Gg of CO₂ equivalents of global GHG emissions.

The results from this projection analysis of greenhouse gas emissions and removals by sectors indicated that, in 2000, Cambodia was already a net emitter of GHGs. The net emissions were approximately 6,000 Gg of CO₂-e. It was predicted that the net emissions will increase to approximately 44,000 Gg of CO₂-e in 2020. Among different sectors, LUCF would be the main source of GHG emissions (63%), followed by agriculture (28%). Energy would only contribute to approximately 9% of the total national emissions. However, projected GHG emissions from the agricultural sector increased more than other sources from 16% to 28% of total national GHG emissions.

The GHG emissions inventory allows Cambodia not only to better estimate the various emissions but also to focus on a more climate sensitive development program, which entails the formulation of mitigation and vulnerability and adaptation policies. The nation will need to continue preparation of updated GHG inventories for various sectors.

Climate change results in part from the increased concentration of greenhouse gases in the atmosphere. Global warming due to anthropogenic emissions of greenhouse gases can be said to have no significant adverse effect on ecosystems if the increase in global temperature is within 0.1 degree C per decade, with a maximum total warming of 2 degrees C above the pre-industrial situation since ecosystems can adjust or adapt to the temperature changes within these limits.

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