Section 7. The Environment

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Introduction

Cambodia is bordered to the east by Vietnam, to the west by Thailand, to the north by Thailand and Laos, and to the south by the Gulf of Thailand. The area of the country is 182,000 km^2, which is equivalent to about 50% of the area of Japan, and its population was 11,440,000 in 1998, which is about 10% of that of Japan.[1] The Tonle Sap Lake, or the Great Lake, lies in the western part of the country, and the Mekong River flows through the country from the north to the south. The country is, therefore, endowed with extensive water systems and wetlands. A low alluvial plain extends throughout the central part of the country. There are no high mountains, with the highest one being only 1,810 meters. The higher lands lie near the border with Laos and Vietnam to the northeast, near the border with Vietnam to the east, and in the southwestern area. The coastline is short at 443 km. The climate belongs to the tropical monsoon type, with the monsoon season in summer, May through October, and the dry season in winter, November through April. Annual precipitation in the plain is 1,200-1,900 mm, that in the eastern part of the Mekong River system is 1,800-3,000 mm, while that in the western part of this river system exceeds 3,000 mm.

The land has always been highly productive and the nation enjoyed abundant agricultural, forestry, and fishery resources before the domestic conflicts began in 1970. Under the Pol Pot regime between 1975 and 1979, agricultural production was limited to rice growing, and human resources were depleted. The civil war continued for 25 years, which led not just to the abandonment of maintenance, management or quality improvements to the land and the structure of the society, but to their total devastation.

Although the country has been able to rid itself of the worst of the social and natural conditions resulting from the civil war, the situation is still too serious for the country to quickly recover its old prosperity through self-help efforts alone. This requires the assistance of developed countries, in particular, Japan.

The following analysis, focused on the natural environment and daily life environment, discusses the present state, the main issues, and the direction of development, as well as Japan's assistance towards this development, in this order.

1. Present state of the environment

1-1 Basic conditions

There are many factors to consider in study of the environment in Cambodia. Among these, the land, production and living conditions require particular attention. The following describes the basic conditions, which are important but sometimes neglected as being self-evident.

Firstly, the main industries of Cambodia are agriculture, forestry and fishery, and most of the land and population are concerned with these industries. On the other hand, since Phnom Penh and Battambang and their surrounding areas have attracted a large population, these have urban problems that are common to large cities in developing countries around the world. The capitals of provinces can also be considered cities, but their size is so small.

Secondly, water systems have been developed throughout Cambodia, including the Mekong River, the Tonle Sap Lake, the Tonle Sap River, other lakes and marshes, and wetlands. Consequently, besides agricultural products, fishery products form an essential component of food, so fishery is, in addition to agriculture and forestry, an important primary industry.

Thirdly, from the first perspective above, the nation can be considered as being divided into an urban population concentrated in the large cities, such as the capital and Battambang, as well as local towns, and the rural inhabitants who live mainly in agricultural districts and forested areas.[2] According to the second perspective,

[1] The World Bank (1999b).

[2] For example, Gordon Peterson (1999)

division of the nation requires the addition of those fishermen and people who depend on rivers for their living.

Fourthly, various industries have arisen in urban districts to meet domestic and foreign demand. This trend involves foreign investment, but these industries, however, are still small in scale, and many of them are located in residential areas.

1-2 The state of the natural environment

1-2-1 The state and features of natural resource management

A diverse range of factors needs to be considered in natural resource management. The complement of natural resources includes forest resources, fishery resources and biodiversity, which are discussed here. In connection with these factors, natural parks, the protection of wetlands, and the protection of rare species are also discussed. The Tonle Sap Lake has abundant fishery resources and is an essential element of nature conservation in the country, including the conservation of wetlands. In this section, Tonle Sap Lake is discussed from the perspective of natural resources management, and not from the perspective of water resources.

Once, the pressure of development on natural resources as a result of economic growth was less in Cambodia than in other Southeastern Asian countries, such as Thailand, Indonesia, and the Philippines. The pressure of development, however, has been increasing in line with the rapid shift to a market economy, economic development and rehabilitation, as well as population growth since the PKO in 1992 and the general election in 1993. As a result, the illegal cutting of forests, overfishing, and poaching of rare species have rapidly increased, causing a deterioration in natural resources. The inadequate policies and legal systems and the insufficient enforcement capacity of the Ministry of Agriculture, Forestry and Fisheries and the Ministry of Environment have accelerated this deterioration.

The forests were decimated to such an extent that urgent improvement of policies and systems was required. In response, the Prime Minister Hun Sen tightened controls on illegal cutting and established policies for the improvement of forests in January 1999. This was a radical change in forest resource conservation policies.

The state of fisheries and biodiversity will become more serious without proper measures to improve the present situation. The Ministry of Agriculture, Forestry and Fisheries and the Ministry of Environment, which both have jurisdiction over natural resources management, have extremely poor levels of technology, capacity to formulate legal systems and policies, capacity to enforce the laws, and finance. It is no exaggeration to state that the Ministries cannot exist without the assistance of donor countries and agencies.

1-2-2 The state of forest resources

(1) The importance of forest resources

Forests are one of the most important natural resources for the acquisition of foreign currency. Primarily, however, the forests provide a means of living for the population, 85% of whom are engaged in primary industries, and contribute to the stabilization of climate and protection of the land through the prevention of floods and soil erosion. Forests also provide the basic environmental conditions for agriculture and fisheries.

The total forest area in Cambodia was 10,540,000 ha in 1997. Fuelwood and charcoal totaling six million cubic meters per year are the main source of household fuels.[3] Forests are also a source of food, medicinal herbs, bamboo, rattan, and resins. Forest products accounted for 6.1% of the GNP in 1998.[4] The volume of forest accumulation is 1,560,000,000 m^3 nationwide based on the estimated volume of 154 m^3 per hectare.

(2) The decline in forest resources and illegal logging

The change in forest area according to the type of forest is shown in Table 7-1 based on a study by FAO and the Department of Forestry and Wildlife of Cambodia.[5]

[3] Fuelwood and charcoal account for 84% of energy sources in Cambodia, followed by coal, gas and electricity, which together account for 14%, and agricultural waste, 2%. - Data from the Ministry of Industry, Mining and Energy.

[4] FAO and the Mekong River Committee prepared the data on the forest area. With regard to the forest inventory, the study was undertaken only in limited areas by UNDP and FAO through technical training for the Cambodian staff. There are no reliable data concerning growth rates.

[5] The data for 1969, 1973 and 1985 are based on a study of forest resources by FAO, the data for 1993 are based on a study of land utilization by the Mekong Committee, and the data for 1997 are based on a forest resource monitoring project by the Mekong Committee and GTZ. Since these studies differ in their systems of classification of forests and measuring methods for forest areas, the table indicates approximate rates of change.

Table 7-1 Natural Forest Area According to the Type of Forest

(Unit: 1,000 ha)

	1969	1973	1985	1993	1997
Evergreen forest	3,995.3	6,876.4	4,852.7	4,763.3	5,488.7
Mixed forest	2,504.0	N.A.	1,113.0	977.3	N.A.
Deciduous forest	5,296.7	4,792.9	4,367.9	4,301.2	4,052.2
Coniferous forest	17.8	9.3	8.2	9.8	N.A.
Secondary forest	N.A.	N.A.	618.5	517	544.7
Bamboo forest	387.4	N.A.	N.A.	N.A.	21.8
Dwarf evergreen forest	288.7	N.A.	N.A.	N.A.	N.A.
Inundation forest	681.4	937.9	795.4	370.7	327.5
Secondary inundation forest	N.A.	N.A.	28.2	259.8	23.6
Mangrove forest	38.3	94.6	68.5	85.1	77.3
Secondary mangrove forest	57.5	N.A.	N.A.	N.A.	N.A.
Total	13,227.1	12,711.1	11,852.4	11,284.2	10,535.8

Sources: Department of Forestry and Wildlife (1999), the World Bank (1996)

The forest area decreased at an annual rate of 0.6% between 1973 and 1993. This is lower than the 1% annual decrease for the surrounding countries, including Thailand. The reason for this is considered to be the isolation from international markets due to the civil war in Cambodia. In contrast, the rate of decline between 1993 and 1997 doubled to 1.2%. The reason for this rapid decline is the cutting, including illegal felling, of commercially valuable timber that exceeded sustainable levels. This is discussed below.

A closer look at Table 7-1 shows that the forest area decreased by 70,000 ha annually for a total of 1,400,000 ha between 1973 and 1993. According to the Ministry of Agriculture, Forestry and Fisheries, most of the forests were converted into farmland. In the period 1993 to 1997, the forest area decreased by 700,000 ha, half of which was converted into farmland and the other half into scrub. Although not shown in the table, the forest area decreased by an annual 180,000 ha in the period from 1997 to the beginning of 1999 due to ongoing cutting, including illegal felling, and the increase in the demand for household fuelwood and charcoal.

Evergreen forests are roughly divided into two types: hilly evergreen forest and tropical rainforest. They are distributed in mountainous areas near the border with Thailand, Laos and Vietnam and in the southwestern part of the country. Deciduous forests are distributed throughout the eastern side of the Mekong River and the area surrounding the Tonle Sap Lake below an altitude of 500 m. Coniferous forests are found only in the Kiri Rom district. Inundation forests in the areas surrounding the Mekong River system and the Tonle Sap Lake have unique ecosystems and are important as the spawning grounds and habitat of fishes.

The ratio of the area of evergreen forests to deciduous forests is approximately one to one. The demand for cutting is higher in the evergreen forests than the deciduous forests. In addition, only 6% of the total forest area is protected.[6] The decline in the inundation forests is also serious. Slash-and-burn agriculture has not caused a serious reduction in the forest area, which is in contrast to the situation in other developing countries.

Mangroves are cut to produce charcoal, and there are more than one thousand charcoal kilns along the seacoast, including Kaoh Kong, Kampot, and Sihanoukville. The products are exported to Malaysia, Singapore, Thailand and other countries as a cooking fuel. The sites where the mangroves have been cut are utilized for shrimp cultivation.[7]

Timber production in Cambodia amounted to 4,250,000 m^3 of log equivalent in 1999. Only 6% of the timber was produced under legal felling concessions, and all the rest was the result of illegal felling operations.[8] The Cambodian government approved felling concessions for mainly foreign companies to cut seven million hectares of forest over ten years up to 1999. Commercially-cut timber is exported mainly to Thailand, Vietnam and Laos.

[6] The World Bank (1999a).

[7] Based on a fact-finding mission by the authors during a visit to Cambodia in 1996.

[8] The World Bank (1999a).

Table 7-2 The Annual Harvest of Fish in Cambodia

(Unit: tons)

Year	Freshwater fisheries	Marine fisheries	Freshwater aquaculture	Shrimp farming	Total
1980	18,400	1,200	N.A.	N.A.	19,600
1985	56,400	11,178	3,000	N.A.	70,578
1990	65,100	39,900	6,400	N.A.	111,400
1992	68,900	33,700	8,550	N.A.	111,150
1993	67,900	33,100	7,400	500	108,900
1994	65,000	30,000	7,640	560	103,200
1995	72,500	30,500	8,779	731	112,510
1996	63,510	31,200	9,000	600	104,310
1997	73,000	29,800	11,534	266	114,600
1998	75,700	46,300	N.A.	N.A.	122,000
1999	231,100	52,900	N.A.	N.A.	284,100
2000	245,600	50,452	N.A.	N.A.	296,052

* While the statistics in and before 1998 exclude the hauls of small-scale fisheries, such as artisanal fisheries and fisheries in paddy fields, the statistics in and after 1999 include the estimated hauls of such small-scale fisheries.

Sources: Department of Fishery, the Ministry of Agriculture, Forestry and Fisheries (1998)

1-2-3 The state of fishery resources

(1) The importance of fishery resources

Fisheries account for as little as 3.1% of the GNP of Cambodia. The population, however, depends on fish for more than 70% of the animal protein in the diet. According to a study by the Mekong River Committee and DANIDA in 1998, fish consumption per capita amounted to 25-30 kg in Cambodia, and for people living near the Tonle Sap Lake it amounted to 86.6 kg. Fish consumption in Japan amounts to 70.6 kg per capita, and the world average is 15.9 kg. The study, therefore, indicates the vital role of fish in the Cambodian food supply.

Table 7-2 shows the trend in the annual catch of fish. Annual fish catch rapidly increased in the 1980s, and fluctuated between 100,000 and 110,000 tons in and after 1990. The quantity of catch from freshwater amounted to 70,000 tons and that from marine 30,000 tons. In recent years, aquaculture has been promoted to produce approximately 10,000 tons of fish, including catfish, snakehead, tilapia, carp, sand goby, and grass carp. Fishery statistics, however, were so limited that they excluded production from small-scale fisheries. The Mekong River Committee and DANIDA surveyed the small-scale fisheries between 1994 and 1998, such as artisanal fisheries and fisheries in paddy fields. Based on the survey, they estimated that the harvest from small-scale fisheries amounted to 160,000-250,000 tons per year. In accordance with this estimation, the lowest value of 160,000 tons is added to the figure for 1999 and 2000 in Table 7-2.

Fish catches from the Tonle Sap Lake account for 60% of the total for freshwater fisheries, since the productivity per hectare of the lake is extremely high. The freshwater fisheries are also prospering in the floodplain of the Mekong River system. There are people who live on the Sap River, which is part of the Mekong River system, for whom fishing is their means of livelihood. More than half of them are Vietnamese.[9]

The fish haul cannot be kept fresh due to the lack of a means of storage, including the unavailability of ice, and undeveloped transportation systems. The fish is therefore chiefly consumed within the household or supplied to neighboring districts. The number of species of freshwater fish is approximately 500. The fish fauna of Cambodia is similar to that of Thailand, Laos and Vietnam. Marine fisheries are prospering in Sihanoukville, Kaoh Kong, and Comport, where shrimp farming has been in operation in recent years.

[9] This section is based on a fact-finding survey by the authors at the Department of Irrigation and Meteorology, the Ministry of Agriculture, Forestry and Fisheries in November 1995.

(2) The fishing season and fishing concessions[10]

Some freshwater fish migrate according to the season. In the monsoon season, they ascend the Sap River where the water runs upstream during this season. When the water flows downstream at the end of the monsoon season in October, the fish from inundated areas begin to return to the river. At this time, the fish are caught through the construction of barrages across river inlets and the nets are s*et al*ong the barrages. The fishing season is therefore between October and June. A law stipulates that all the nets must be removed in June.

In January, many people make Pro Hok, which is salted fermented fish, with people gathering along the river, stamping on the fish in baskets to extract the guts from the fish, and adding salt to the fish.

Fishing concessions are classified according to the net type and the net size. Marine fisheries are also based on a concession system. Fishing concessions for large-scale fishing are purchased through a bidding process every other year. Lakes, rivers and inundated areas are separated into 239 lots as of 2000. The fishing rights are then established according to the divisions and sold at auction. The rights for medium-sized fisheries are also purchased, but the price is not set through auction.

(3) River dolphins[11]

River dolphins travel up the Mekong River around the Chinese New Year in February in pursuit of small fish. This is therefore referred to as the Chinese New Year Migration. Subsequently, they move downstream, and again ascend the river to give birth to their young after the first inundation.

River dolphins have previously been observed in the Tonle Sap Lake. They were also observed in the Sap River in front of the royal palace in the capital up the 1960s.[12] They were, however, overharvested to extract blubber under the Pol Pot regime, and are currently rarely seen. It is considered that they no longer inhabit the lower reaches of the Tonle Sap River. According to some reports, however, they inhabit the lower reaches. When they have been observed, it is considered that they are migrating between Tonle Sap Lake and the Tonle Sap River.

Formerly, Cambodian people buried river dolphins in the ground when they caught them. Vietnamese people buried or cremated them, or extracted blubber from them. Currently, Cambodian people eat them when they catch them because they have become poor. Muslims eat river dolphins as dried meat.

(4) Water pollution

In recent years, pollution in fresh water areas has become serious. The reasons for this pollution are: i) deforestation in the areas along the upper reaches of rivers, including cutting and topsoil damage due to ruby mining, ii) the influx of household wastewater as a result of urbanization, iii) the conversion of forests along rivers, lakes and marshes into farmland and housing sites, and iv) the use of agrochemicals. The following have been indicated as areas where the water contamination of wetlands is so serious as to significantly affect fisheries.[13]

Firstly, the lower waters of the Tonle Sap Lake are identified as polluted water area. Fish are cultured here in fishponds from February through June and July until the fish are transported to urban areas after the influx of water in the river increases in the monsoon season. Rainwater at the beginning of the monsoon season in April and May stirs anaerobic bottom sludge, which elutes ammonium ions into the river water. Sometimes, 300 tons of fish die in one or two days due to the presence of ammonia.

Secondly, the waters where the Tonle Sap Lake connects with the Tonle Sap River are indicated. In the inundation area of these waters of the River, the monoculture of beans and other crops is carried out with the use of agrochemicals, including DDT. Since the inundation area is bounded by towns, wastewater and other wastes flow into the river. Rainwater at the beginning of the monsoon season flows into the river through the towns and the fields to kill fish under culture. Once, all the

[10] Study Group for Basic Research on the Cambodian Environment (1996).

[11] *Ibid.*

[12] This description is based on a fact-finding mission in 1998 with Mr. Phay Mondara, then the second secretary of the Cambodian Embassy in Japan.

[13] Based on fact-finding studies by the authors at the Ministry of Agriculture, Forestry and Fisheries in 1995.

fish died. As a result, fishery is hardly ever practiced in these waters any longer.

Thirdly, the reaches of the river up to 10 km above the capital are indicated. People live along the river, and there are 200 to 300 fenced aquaculture sites in the river. Fishery activities peak in December and January, when approximately 100,000 people gather to make Pro Hok. At this time, the guts and blood of fish flow into the river and settle on the bottom. This waste stays at the bottom. Through February or March the precipitate does not flow downstream. As time passes and the temperature rises, the precipitated fish waste begins to decompose, consuming dissolved oxygen and raising the level of ammonium ions. Fish under culture sometimes die due to this level of ammonium ions twice a year, around February to March and April to May. Consequently, only snake heads and pangages, which are resistant to pollution, are cultured.

Fourthly, Pursat and Leuk Dek in Kandal Province are indicated. Snake heads and pangages are cultured here. However, they are susceptible to parasites and become cankered. Consequently, a solution of DDT is poured into the river to exterminate the parasites.

Lastly, the western waters of the Tonle Sap Lake are indicated. Near the western waters of the lake, the topsoil is washed away by ruby mining, and silt and clay flow into the lake. As a result, the turbidity has increased and the depth of the lake has reduced.

In addition, extremely poor people who live along the banks of the river throw waste into the river. Cambodian law stipulates that no one should live within 50 meters of a river, which is not abided by. The restaurants along the river also throw their waste into the river. Oil from boats sometimes pollutes the river. Water systems of the Mekong, Tonle Sap, and Bassac are also being contaminated through industrialization, which has just begun in Cambodia. The number of factories has been increasing along the river in the vicinity of the capital. Although laws have been established to prevent this, the validity of regulations on industrial wastewater has not been assured. (Refer to 1-3-2(2))

1-2-4 The state of biodiversity

Since Cambodian biodiversity was not studied during the long period of civil war and the post-war confusion, only old data is available. The figures, therefore, are not necessarily accurate, but it has been reported that there are 212 species of mammals, 720 species of birds, 240 reptiles, the number of vascular plants is 2,300, marine fish species number 450, while the number of brackish and freshwater fishes is approximately 500. Incidentally, in Japan, there are approximately 200 mammals, 700 birds, 97 reptiles, brackish and freshwater fishes number approximately 300, and there are 7,087 species of vascular plants.

The fact that the number of species of vascular plants identified in Cambodia is less than in Japan is due to the lack of research. The World Conservation Monitoring Center estimates that there are 15,000 species of plants in Cambodia, including vascular plants as well as fungi and ferns, for example. One third of these species are assumed to be indigenous to Cambodia. The flora in the Cambodian lowlands belongs to the Indochina vegetation zone, and that in the highlands belongs to the Indo-Malaysia vegetation zone.

It has been estimated that Cambodian flora is more diverse than other neighboring countries, but its fauna is not as diverse. Table 7-3 lists the endangered species of fauna based on the data from the World Conservation Union, former “International Union for the Conservation of Nature and Natural Resources” (IUCN). Further study will identify more species.

In Cambodia, vast wetlands extend over the inundation area of the Mekong River and the Tonle Sap Lake. The wetland area of 36,500 km^2 accounts for 20.2% of the total land area of the country. The wetlands regulate floods, moderate the climate, provide the habitat for a wide variety of animals and plants, and provide people with resources necessary for daily living, agriculture, and fisheries. In addition, rare species of animals and plants range over the wetlands. In recent years, however, the wetlands have been decreasing due to urbanization and the development of farmland. As water contamination, soil erosion, sedimentation, and siltation have worsened, these functions of wetlands have become significantly impaired.

1-2-5 The state of Tonle Sap Lake

Tonle Sap Lake, or the Great Lake, located in the middle-western part of Cambodia is the largest freshwater lake in Asia. The Tonle Sap River originating from the lake joins the Mekong River in Phnom Penh. The administrative districts related to the lake involve the six provinces of Kampong Thum, Siem Reab, Banteay

Table 7-3 Endangered Species of Fauna

Name	Scientific name
Asian Elephant	Elephus maximus
Black gibbon*	Hyllobates concolor
Douc langur**	Pygathrix nemaeus
Javan rhinoceros	Rhinoceros sondiacus
Kouprey***	Bos sauvelli
Pileated gibbon	Hylobates pileatus
Sumatran rhinoceros	Rhinoceros sumatrensis
Tiger	Panthera tigiris
Batagur	Batagur baska
Green turtle	Chelonia mydas
Hawksbill turtle****	Eremochelys imbricata
Bengal florican	Eupodotis bengalensis
Black-faced spoonbill	Platalea minor
Greater adjutant stork	Leptoptilus dubius

Notes: * The gibbon is a kind of the ape that ranges over Southeastern Asia.
** Slender monkeys ranging over Southeastern Asia.
*** Wild cattle living in Cambodian forests.
**** Tortoiseshell is made from the shell of this turtle.

Source: Prepared by excerpting the endangered species of fauna from the data of the Ministry of Environment in 1997.

Mean Chey, Battambang, Pousat, and Kampong Chhnang. The approximately three million people living around the lake are mainly engaged in fishery and agriculture. In addition, the inhabitants of approximately 170 communities actually live on the lake and make their living from fishing.

Tonle Sap Lake has a critical hydrologic function in that it regulates the flooding of the main stream of the Mekong River in the monsoon season. In the dry season, water flows from Tonle Sap Lake to the Mekong River through the Tonle Sap River, but in the monsoon season, water flows in reverse from the main stream of the Mekong River to the Tonle Sap Lake through the Tonle Sap River. Consequently, the size of Tonle Sap Lake varies considerably according to the season and the year. Its total area increases from 250,000-300,000 ha in the dry season to 1,100,000-1,200,000 ha in the monsoon season. The depth also varies from 1-2 meters in the dry season to 8-10 meters in the monsoon season. It is estimated that in the monsoon season, 62% of the water volume is derived from the reverse flow from the Mekong River, and the remaining 38% is from the basin of the lake. However, only fragmentary data on the hydrology, hydraulics, and water quality are available.

Cambodia has approximately 500 species of freshwater fish. There are 215 species of freshwater fish in the Tonle Sap Lake. Nineteen species are commercially important. The fishery productivity of the lake is estimated to be 65 kg per hectare per year. This is quite high compared with the productivity of the normal 12 kg per hectare per year for tropical freshwater areas. The harvest of fish in the lake amounts to 35,000-56,000 tons, which accounts for 70-80 percent of the total catch of freshwater fish in Cambodia.

As mentioned above, in the Tonle Sap Lake the amount of suspended matter has been increasing, water quality has deteriorated, and the depth has been decreasing due to the urbanization of the surrounding areas, the conversion of forests into farmland and housing sites along the lake, the cutting of forests in its basin, and ruby mining. The lake has deteriorated as a habitat for aquatic life. With regard to the catch of fish, some report that it has decreased, and others report that it has not decreased. This issue is considered in 3-9-2.

1-3 The state of the daily life environment

1-3-1 Drinking water and water for daily living

One of the authors has analyzed the quality of drinking water and water for daily living at nineteen locations around the capital, nineteen locations in the vicinity of the capital, and 53 locations in eleven provincial capi-

Table 7-4 General Conditions of the Waterworks in Cities

Name of city	Population (thousands)	Population supplied	Construction (aid country)	Start of rehabilitation	Water sources	Purification method/ chlorine disinfection	Charge riel/m^3	Inspection month and year
Phnom Penh		140,000m^3/d	1895	1994 (Japan, France)	River water	Rapid sand filtration A		1995.11
Battambang	132	39,600 persons	1960s		River water	Rapid sand filtration A	1,400	2000.5
Siem Reab	91	18,000 persons (7-22:00 supply)		1999 (SIDA)*	Well water	Direct distribution N		1999.12
Sihanoukville		1,500-2,000 m^3/day		1987 (Soviet Union)	Reservoir	Rapid sand filtration N		1999.1
Kampong Cham	48	14,400 persons			Well water	Direct distribution N	300	1999.12
Kampon Chhnang	40	800 persons (50m^3/hr×5hr)	1960	1997 (SAWA)	River water	Rapid sand filtration A	1,000	1999.1
Kampong Thum		500 households (200m^3/d)	1962 (France)	1982	River water	Rapid sand filtration N	700	1999.12
Sisophon (private)	32	1,700 households 850-1,000m^3/d	1998	–	River water	Rapid sand filtration A	1,500	2000.5
Pousat	25	1,200 households 50m^3/h 17hrs in the dry season, 5hrs in rainy season		1990s (SAWA)	River water	Rapid sand filtration N	800	2000.5
Svay Rieng	21	210 households out of 3,840	1950	1979 (Oxfam) 1996 (SAWA)	Well water	Direct distribution N	600	2000.12
Prey Veaeng	15	300 households out of 2,700	1960	1979 1996 (SAWA)	Well water	Direct distribution N	900	2000.12

* Swedish NGO

Source: Prepared by the author

tals since 1995. Based on this analysis, the state of drinking water and water for daily living are discussed.[14] Figure 7-1 and Figure 7-2 show the quality of piped water supply in the capital and the provincial capitals.

(1) General conditions

Residents are classified into two groups: residents who use tap water for drinking and daily living, and those who use water from the nearest water sources. In the latter case, residents use rainwater in the monsoon season, and water from the nearest pond, well or river in the dry season. They sometimes buy water.

Rainwater is collected in pots from the roof and waterspouts. It is reported that the number of pots reflects the level of the household economy. People know well that rainwater is the best quality since it forms through the condensation of evaporated water. They therefore give first priority to rainwater as a source of drinking water. When they build a house on high stilts, they dig a pond in front of the house to provide water for all the purposes of daily living.[15] Water for sale includes tap water, water after the removal of suspended matter by the addition of coagulants, the top clear layer of river water after precipitation, the river water itself, and other water.

(2) The state of water supply

The locations of waterworks were confirmed in the capital and ten other cities, including Battambang and Sihanoukville, which are shown in Table 7-4. All these cities have rehabilitated and maintained water treatment plants and water distribution systems that were constructed before 1970. The aging of these facilities, therefore, has been undoubtedly accelerating. The scale of the facilities of Phnom Penh is predominant, followed by that of Battambang, Siem Reab and Kampong

[14] Takeuchi, T. *et al*. (1997) pp.95-103. Sato, T. *et al*. (2000) VII-94.

[15] Ohashi, H. (1997) p.187.

Cham. The scale of facilities in the other cities is extremely small with a water supply of 1,000-2,000 m^3 per day at the most.

There are three water treatment plants in the capital, two of which are operating. In the large-scale system of the Pump Reck Water Treatment Plant, particularly Japan and France have been providing assistance to rehabilitate and expand the water treatment plant, the elevated water tanks beside the Olympic Stadium, and the main water pipes.[16] Although NGOs, including SAWA,[17] rehabilitated some waterworks in other cities after the civil war, old and dilapidated facilities have hardly been repaired in general. Most of them have almost ceased to operate.

More specifically, the equipment, materials, electricity, and treatment chemicals, such as chemicals for purification and chlorine for disinfection, are inadequate for the proper operation of the water treatment plants. The chemicals for purification are not administered according to the degree of turbidity due to the absence or loss of know-how in the administration. There are few areas where water as clean as Japan's tap water is being supplied. In addition, water is insufficiently disinfected in most cities due to the irregular supply of chlorine or insufficient purchasing of the required chlorine due to the lack of funds. Furthermore, deterioration in the piping, including the corrosion of pipes and the breakage of connections, has become so serious as to cause water leakage. This leakage lowers the hydraulic pressure, which allows the intrusion of foul water from the soil surrounding the pipes. This foul water includes household wastewater and urine and feces collected from buildings that are leaking from the dilapidated septic tanks used to hold them. The contamination of tap water is an everyday affair. In addition, not a few households and offices install pumps at the tap to extract the water, which accelerates the deterioration of the quality of the tap water.

One of the authors inspected water quality from the tap, and the findings showed that the concentration of organic substances was very high in all tap waters inspected, which is bad for health. In addition, coliform bacteria were detected in all samples.[18] The water standards of WHO and Japan specify that coliform bacteria should not be detected. Coliform bacteria, therefore, are absent in Japan's running water supply. Refer to Figure 7-1 and Figure 7-2.

In the capital and Battambang, several staff members have been assigned, and water quality control units have been established in order to maintain clean water. Both the water control units, however, are poorly equipped and staffed, with only three staff in Battambang, and the area of the room being 10 m^2 in the capital, and that of Battambang being 15 m^2.[19] The water quality in Sihanoukville is good, although a young technician controlled the treatment process using only one uncalibrated pH meter in January 1999.

(3) The state of water other than tap water

One of the authors inspected water quality at nineteen locations in the vicinity of the capital and 43 locations in eleven provincial capitals where tap water is not supplied. The water quality varies according to the water sources and the conditions surrounding the sampling locations. All the sampled water was, however, judged to be unfit for drinking because coliform bacteria were detected (Refer to Figure 7-2). Although rainwater is the best, its quality at the point of use depends on the maintenance of storage tanks or pots. There are many ponds, and they are widely used. Their water, however, is unfit for drinking due to high concentrations of organic matter.

With regard to groundwater, many wells are contaminated with organic matter and nitrates[20]derived from urban wastewater in the vicinity of the capital. Contamination with sodium chloride was detected in the capital of Kampong Chhnang Province. The concentration of calcium or degree of hardness is high in the capital of Siem Reab. Nitrates were detected in Kampong Thum, Sisophon, Battambang, and Pailin. Contamination with sodium chloride in Kampong Chhnang is caused by

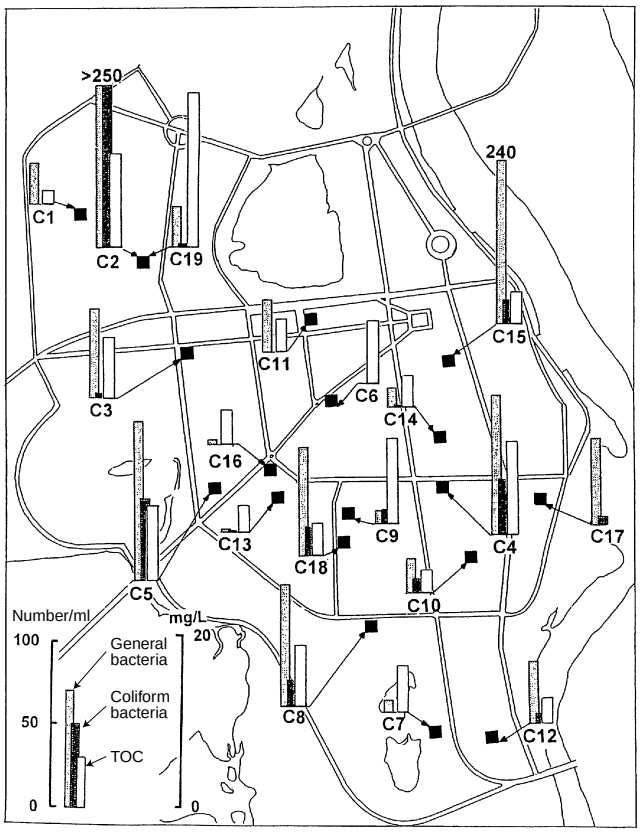
[16] Yamamoto, K. (2000) pp.10-11.

[17] The headquarters is located in the Netherlands, and the local office is located in Phnom Penh. (http://www.sawa.nl/home.htm) Recently, SAWA has become a company, SAWAC, because financing from European countries and multilateral donors stopped. (sawacam@bigpond.com.kh).

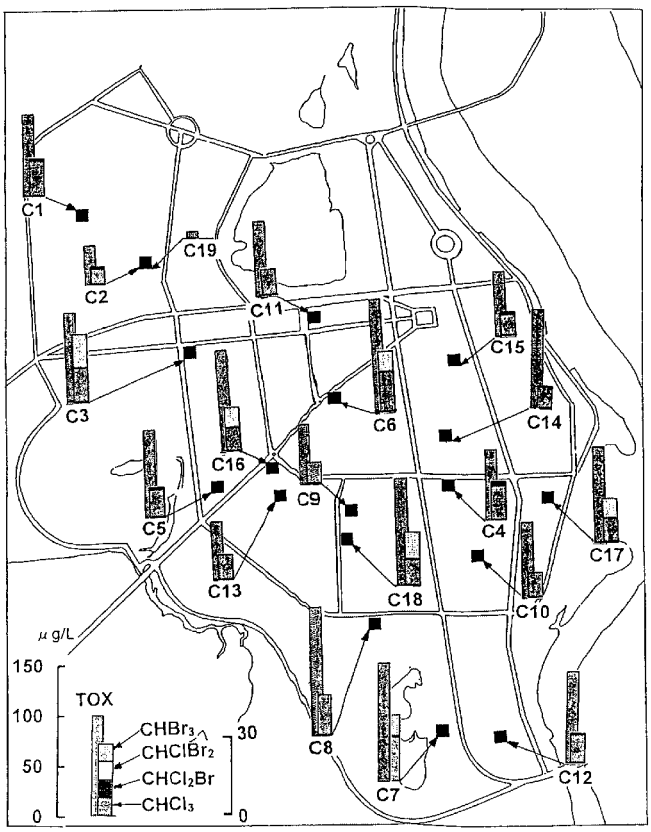
[18] At the water treatment plant in the capital, water is sterilized using chlorine. However, this water is contaminated while it is being distributed through the pipes.

[19] One member of the Japan Overseas Cooperation Volunteers is stationed at the water treatment plant in the capital.

[20] Nitrates cause methemoglobinemia in babies. The standards of WHO and Japan accept its presence up to 10 mg/L.



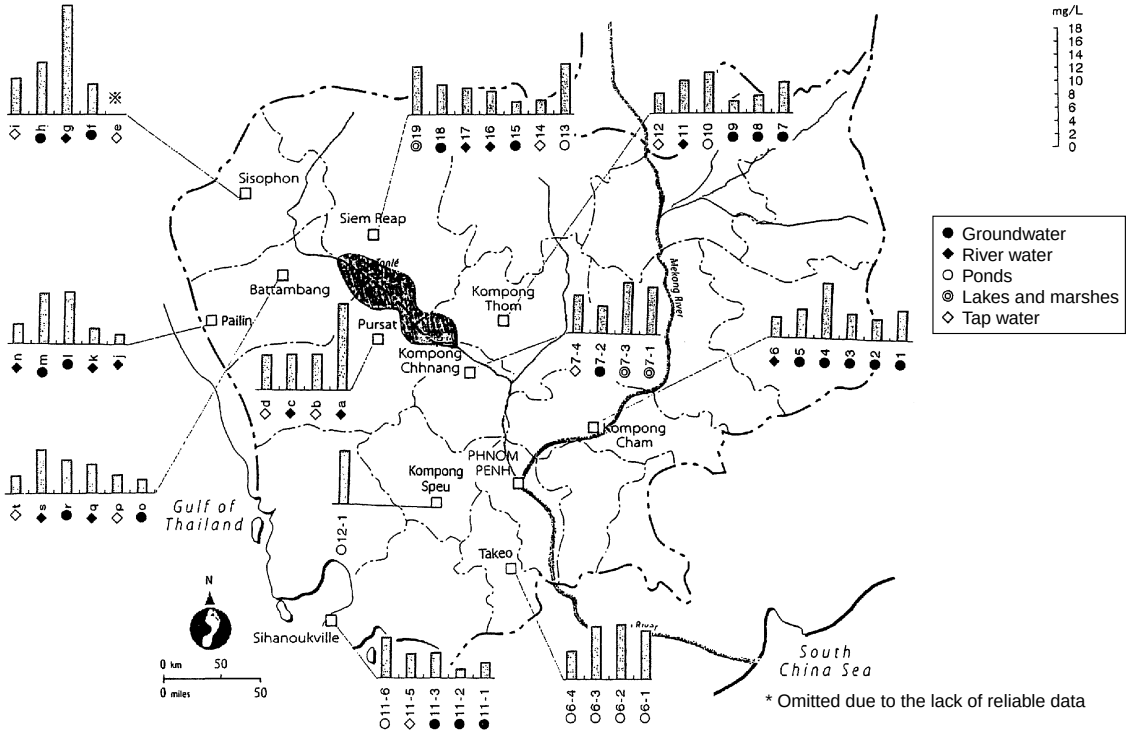
The quantity of organic substances
- total organic carbon (TOC), general bacteria, and coliform bacteria



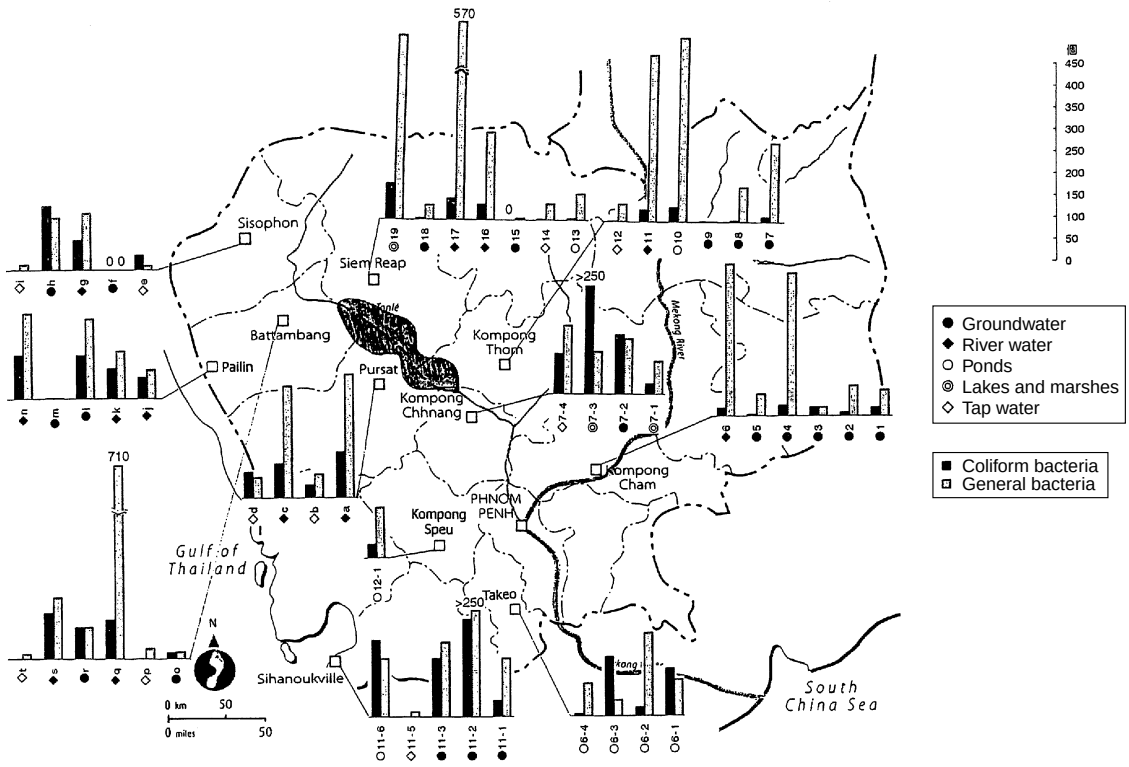
Organochlorine compound (TOX), trihalomethane

Figure 7-1 Water Quality at the Tap in the Capital

Sources: Prepared by the author based on inspection conducted in 1996



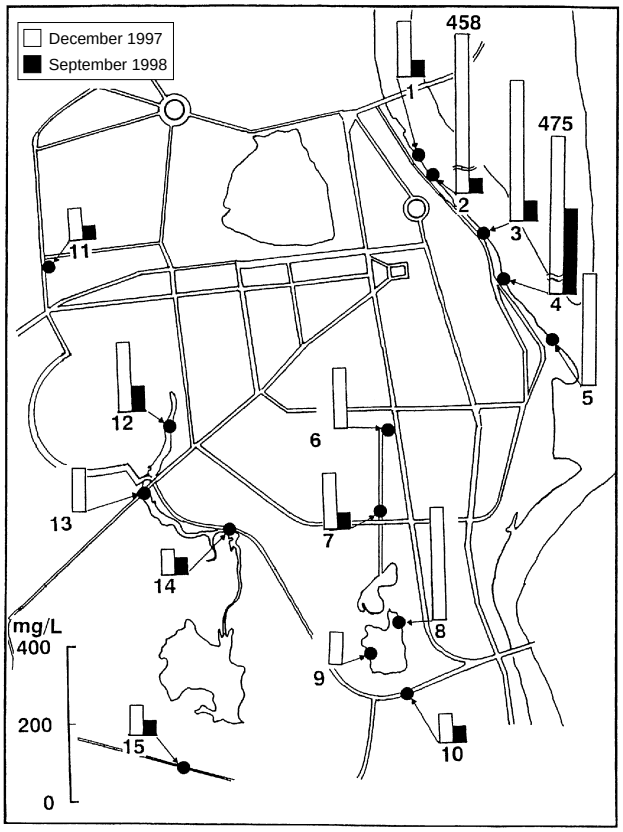
The quantity of organic substances - total organic carbon (TOC)



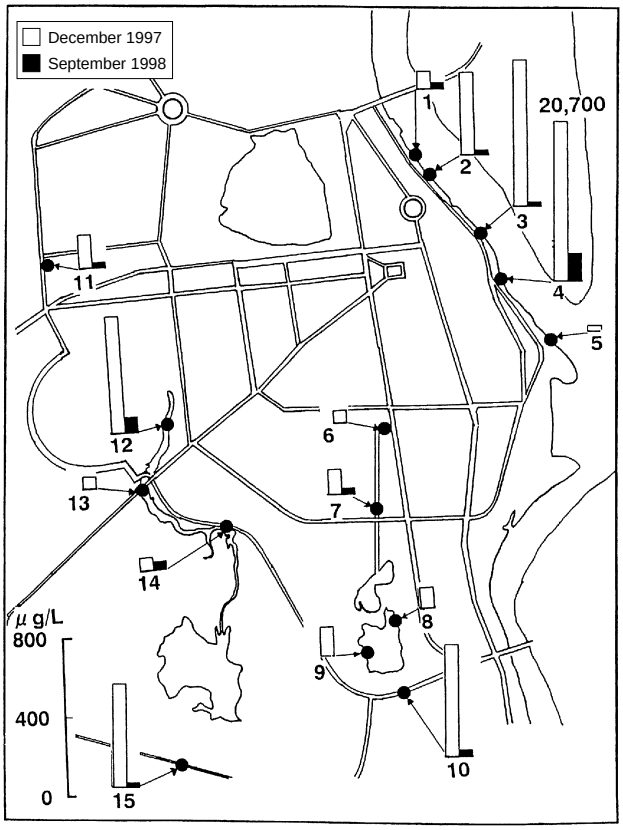
General bacteria and coliform bacteria

Figure 7-2 The Quality of Drinking Water in Provincial Capitals

Sources: Prepared by the author based on inspection conducted in 1999-2000



The quantity of organic substances - chemical oxygen demand (COD)



Organochlorine compound (TOX)

Figure 7-3 Wastewater Quality in the Capital

Sources: Prepared by the author based on inspection conducted in 1997-1998

leakage due to its use as a refrigerant in the ice plant. The contamination in Siem Reab is caused by natural calcium. The contamination in Kampong Thum is caused by ammonia used in rubber plantations. In general, groundwater is considered to be cleaner than river and pond water. Close examination is, however, required to judge water quality as drinking water sources.

1-3-2 Urban discharged water

(1) The state of the sewer system in the capital[21]

The sewer system that was laid before the civil war extends under the ground through the center of the capital.[22] The system, together with sewer channels that are waterways for wastewater, serves as drainage for wastewater and rainwater, which is referred to as combined sewerage. There are two types of sewer pipes: one type with a diameter of 30 cm, and the other type with a diameter of 150 cm. They extend for 240 km in total.

In the dry season, wastewater in the eastern wards of the central area of the capital along the Bassac River is drained into this river through sewers, while wastewater in the other wards flows to the south or to the west through sewers, urban sewer channels and streams, and through pumping stations, and is finally drained into wetlands on the outskirts of the capital. In the monsoon season, since the water level of the Bassac River rises, all water gates to the river are closed. All wastewater then flows to the south or the west, and is drained into the surrounding wetlands.

The sewer pipes as well as water pipes are extremely dilapidated, including breakages and blockades, because they have not been maintained or managed for more than 30 years. The sewer channels are open ditches with small cross sections. Many houses have been constructed over the sewer channels and the wetlands. The flow capacity is therefore limited to a low level, so that the water floods out over the streets in many areas in the monsoon season.[23] The flooding interrupts urban transportation as well as endangering the sanitary conditions of the capital.

(2) Industrial wastewater

There are approximately 750 factories and 4,000 domestic workshops. Most of these are involved in light industry, including beverage and food processing 28%, textiles and apparel 20%, non-metal mining 30%, timber 10%, chemicals and rubber 5%, and other industries 7%.[24]

The majority of these factories were constructed in the 1950s and 1960s without environmental consideration, which was based on standard technology in those days. Even factories that have been constructed in recent years are mostly located along the channels without wastewater treatment facilities. Both old and new factories discharge their effluent into the channels without treatment. In parallel with industrial development, the volume of industrial effluent has been increasing, and the water quality has deteriorated, which has begun to draw the attention of the public.

At the beginning of the 1990s, problems were centered on effluent containing sodium chloride and ammonia used in the process of ice manufacture, and wastewater produced from soft drinks manufacture. Recently, effluent from the textile dyeing industry has been increasing in quantity and deteriorating in quality, which has been raising public concern. The Ministry of Environment, through coordination with the Ministry of Industry, Mining and Energy, has persistently demanded that factories discharging a large quantity of effluent with high levels of contaminants should install wastewater treatment facilities. The number of factories that have installed such facilities, however, remains very few. Although the government has established standards for wastewater quality, they have been ignored due to the weak system of monitoring and enforcement.

(3) The quality of discharged water

There is no sewage treatment plant in the capital. All wastewater from households, offices and industries, as

[21] Takeuchi, T. *et al*. (1998), pp.310-311.

[22] The central part of the capital includes the first four wards out of seven wards of the capital: Toul Kork, Prampin Makara, Don Penh, Chamcar Mon, Russy Keo, Dangkor, and Mean Chey. The system covers an area of 29 km^2 out of the total of 284 km^2, and a population of 640,000 out of the total of 1,080,000 in 1995.

[23] In the monsoon season, since the water level of the Bassac River exceeds the level of other rivers in the capital, the water flows in reverse in some rivers.

[24] Cina, C. (1996) p.22.

well as rainwater is discharged into the channels without treatment (Refer to Figure 7-3). With regard to wastewater quality, the concentration and the discharge quantity per day per person of organic substances, total nitrogen and total phosphorus are almost at the same level as in Japan. Anionic and nonionic surfactant among synthetic organic substances behaves in almost the same manner as organic substances, in terms of total nitrogen and total phosphorus. Total organic halogenated compounds and bisphenol A, which is an endocrine disruptor, were detected in extraordinarily large quantities at several locations. It is considered that they are being discharged from specific factories, hospitals and other sources.[25] It is reported that the World Bank has recently invited the submission of proposals for sewage treatment plants that will treat part of the sewage in the capital.

(4) The state of local cities

In 1994, SAWA, financially assisted by the EU, constructed a sewer system with pipes and oxidation ditches in Battambang, which is often referred to as the only sewage treatment plant in Cambodia. This sewerage system covers 25% of the area of the city. The International Development Research Centre (IDRC) extended financial and technical assistance from December 1994 through March 1996. After the withdrawal of the IDRC, however, the plant was suspended due to a shortage of funds.[26]

In May 2000, one of the authors visited a treatment plant in Battambang with a treatment capacity of 150 m^3 per day through the oxidation ditch method. This plant is considered to be the above-mentioned plant. In this system, wastewater flows from the sedimentation pond to an oxidation ditch, where wastewater remains for twenty days, and then to a fish culture pond, where the wastewater stays for ten days. The quality of the water is not controlled, and the degree of purification is extremely low. In conclusion, it can be stated that the sewage in Battambang is discharged directly into channels. It is reported that river water is drawn for tap water in the reaches of the Sangkar River downstream from the outlet for the wastewater.[25]

In general, sewer channels are constructed in the wards of large cities to separate wastewater from clean water. There is, however, no sewage treatment plant to purify the wastewater, so that wastewater without treatment mixes with the clean water in the lower reaches to contaminate it. In local cities and their neighboring farm villages, wastewater and river water easily mix, so that people use and drink contaminated water to different degrees.

1-3-3 Solid waste

(1) Urine and feces, and toilets

Customarily, Cambodian people do not have toilets installed in their houses. The installation rate of toilets was approximately 16% in urban districts in 1995.[27] The rate has been increasing recently. Cambodian toilet bowls are usually a little smaller than those in Japan. Feces and urine are washed away with water scooped from a water tank with a pail, and penetrate into the soil under the ground. This is a kind of a flush toilet, so that the location is limited to areas where such water is available. One type of Cambodian toilet bowl is similar in shape to the Western-style toilet bowls, but the size of the toilet seat is too large for people to sit on, so that they crouch with their feet up on the seat. There are also Western-style flush toilets. In both cases, however, the septic tanks for purification in old buildings are broken and foul water is discharged directly into the soil. When houses are located near wetlands and rivers, piers are constructed with fences for use as toilets. Toilets are constructed over ponds in the same manner, and human waste sometimes provides feed for cultured fish. Feces and urine were utilized as fertilizer during the Pol Pot regime. Since the collapse of this administration, they have rarely been used as fertilizer.

(2) The generation and collection of solid waste

Cambodian people keep the insides of their houses very clean, as far as the authors know from experience. However, they throw their waste away in the street with-

[25] Takeuchi, T. *et al*. (1999), pp. 44-45.

[26] Wright (1999).

[27] Based on the survey in1995.

out hesitation.[28] Consequently, the streets are full of refuse, and under houses on stilts over wetlands, waste is piled up.

The waste, most of which is household waste, is generated at a rate of 1,300 m^3 or 500-650 tons per day in the capital. Pacific Asia Development (PAD), which was a French company, was contracted to collect the waste. Since the company went bankrupt, Phnom Penh Municipality l has collected the waste directly. The municipality collects all types of waste, including waste from households, schools, hospitals, restaurants, and industries. The collection started in 1979, when most of the waste was collected manually. In addition, the collected waste was dumped at various places in the city. At present, the capital is divided into seven districts to collect waste. The collection is carried out with more than 50 trucks. The collected quantity of waste accounts for approximately 60% of the generated quantity, and the remaining waste is left in the city. The waste is not classified before collection. All the collected waste is carried to a dumping site in Stung Mean Chey, which is located next to the western part of the capital.

In principle, major hospitals, including the six public hospitals, dispose of all their medical waste in individual incinerators. Medical waste from small clinics is carried to Stung Mean Chey. Waste pickers take away used syringes, hypodermic needles, and other medical instruments from the pile of medical waste from large and small medical facilities.

The disposal of industrial waste is usually left to the discretion of the industry. However, waste that has a major environmental impact and waste for which the government demands careful disposal are dealt with separately. For example, approximately one hundred drums of slag containing zinc and lead was stocked at the zinc galvanizing plant of a joint company between Japan and Cambodia. The Ministry of Environment demanded construction of a temporary shed to keep the slag until analysis of the constituents was completed. The plant hoped to pack the slag into empty agrochemical containers and dispose of them at a quarry after the quarrying. Finally, Niigata University analyzed the constituents twice. Based on the findings of these analyses, the plant decided to export the slag as industrial material to Malaysia, which was implemented.

(3) Waste disposal

The quantity of waste that is disposed of at Stung Mean Chey amounts to 500-560 tons per day, which is equivalent to the volume of 110-120 dump trucks. The quantity varies according to the season. The maximum is in the monsoon season, and minimum in April and May at the end of the dry season. The reason for the peak in the monsoon season is that fruit and sugar cane are harvested and their residues increase the waste load. The final disposal site at Stung Mean Chey has already been used for 70-80 years. The accumulation of waste covers an area of 4,800 m^2 up to a height of seven meters. Since people who live around the site dig the ground to sell earth in Phnom Penh, they welcome waste that fills the holes. Consequently, the boundary of the site is indefinite, and waste is accumulating outside the designated boundary.

In order to control the decomposition of the waste and the proliferation of vermin, the staff members of the city burn the waste as it is after five to six days from the day the waste is carried in. During this open burning period, water in the waste is drained out. Burning often occurs spontaneously. Since the waste contains plastics, dioxin is also generated.[29] Trenches are dug on the surface of the piled waste to rapidly drain the rainwater. However, no measures are taken to treat the contaminated water, which is generated by rainwater passing through the waste.

There have hardly been any complaints from neighboring residents. The municipality considers that the reason for lack of complaints is that the disposal site has been located there for a long time. The complaints have been received from people who live along the roads through which the waste is carried. The complaints concern the smell, the smoke from open burning, and dust raised by the dump trucks. Abnormalities of the limbs have been detected in many people who live around the disposal site, which has given rise to concern over the relationship between these conditions and environmental chemicals at the waste disposal site.

[28] It is necessary to consider that people throw away their waste because waste is already on the street due to the inadequate collection services provided by municipalities.

[29] Information from Professor Shinsuke TANABE of Ehime University. The authors conducted a quantitative examination in the laboratory and confirmed the presence of dioxins.

(4) Waste pickers at the dumping site

There are hundreds of people, including children, who collect valuable waste from which they earn a living at the disposal site. Near the entry to the disposal site, NCAO, which is a German NGO, has established a private school for children who do not go to elementary school. Lessons were provided for two hours in the morning and for two hours in the afternoon, including the Cambodian language, arithmetic, and art as of December 1999.

The waste pickers collect rubber, plastic, paper, metals such as iron and aluminum, and coconuts. They burn the coconuts to make ash that is sold as fertilizer. Syringes and other medical waste are collected, which indicates that medical instruments are repeatedly used in Cambodia. Plastic were sold at 500 riel per kilogram, and metals were sold at 1,500 riel per kilogram in 1995. Children earned 5,000 riel per week in 1995.[30] The children handed all their income to their parents, and were given 200 riel per day as an allowance.

(5) The state of other cities

In Battambang, a private company collects solid wastes and discards them at a site four kilometers from the central area of the city. More specific information is not available. Since the city is densely populated, the state of this city is considered to be almost the same as that of the capital. The problems of other cities that have a low density of population are considered to be less serious than those of the capital. Basically, however, the same problems as those of the capital have probably arisen. It is necessary to confirm the actual situation.

(6) Hazardous waste carried in from foreign countries

In November 1998, 3,000 tons of by-products generated when sodium hydroxide is produced through the mercurial method were brought in from Taiwan after twenty years of storage. The by-products were shipped to Sihanoukville without the permission of the governments of Taiwan or Cambodia, and discarded in a suburban area of Sihanoukville, eight kilometers away from the center of the city.[31] The citizens took away many of the products as a substitute for concrete and to fill hollows in the ground. However, a stevedore and a young man who slept on the container of waste died suddenly. Ten thousand indignant people demonstrated in the city and four people were killed. Finally, the waste was repacked in drums at the discarded site, stocked in containers, and entrusted to the military.

The Cambodian government demanded that the Taiwanese company responsible for the waste should remove it. Finally, all the waste was transported to the US in April 1999. The bringing into Cambodia and the transportation to the US were possible because Cambodia, Taiwan and the US have not yet acceded to the Basel Convention, which regulates the transboundary movement of hazardous waste. Such situations may occur again in future.

1-3-4 Air pollution

Air pollution is conspicuous in urban districts due to exhaust gas emissions from old and new, large and small independent power generators, motorbikes, and automobiles. Coarse particulates also cause problems along unpaved roads. The number of automobiles and motorbikes has been increasing. In 1998, cars numbered 57,200, trucks numbered 5,400, buses numbered 530, and motorbikes numbered 451,000. Sixty percent of motorbikes and ninety percent of cars were being used in urban districts, particularly in the capital.[32]

According to the survey of air pollution that has been carried out in the capital since 1998,[33] the total concentrations of nitrogen dioxide (NO_2) per day did not differ at sixteen survey locations. The total concentrations of carbon monoxide (CO) per day were high at locations where traffic was heavy. Both indices were on the same level as that of the WHO guidelines or lower, and it was therefore considered that there was no immediate harm

[30] A dollar was equivalent to 2,500 riel in1995, and 3,800 riel in May 2000.

[31] Yukio TAKAHASHI of Niigata University and others confirmed the site in January 1999, and sampled the drinking water used by the surrounding inhabitants. Shinsuke TANABE of Ehime University and others subsequently visited the site, and sampled the hair and mother's milk of the inhabitants.

[32] Sokha, C. (2000) p.78.

[33] Kashima *et al.* (2000) pp. 528-529.

to health. The concentrations of NO_2 and particulate matter, which is smaller than 10μm: PM_{10}, are high from 7:00 to 9:00 and from 17:00 to 18:30 during the days when people commute. The PM_{10} was ten times as dense as the level specified by the WHO guidelines as the urban level, and lead contained in PM_{10} exceeded the level of the WHO guidelines at one location. The reason for this is that leaded gasoline is still used in Cambodia.

1-3-5 Chemical pollution

(1) Phnom Penh and its suburban area

In order to study concentrations of total mercury, fifteen species of edible fish with a total of 69 samples were purchased at stores in the capital and its suburban areas. The concentration was lower than that in freshwater fish, which had already been reported. The quantity of total mercury in the hair of print shop workers in the capital was at the same level of that of the Japanese who like consuming tuna and other fish that have high concentrations of methyl mercury. The reason for this is not that Cambodian people eat fish that has a high mercury concentration, but that they depend for much of their protein intake on fish in general.[34]

A survey was conducted on heavy metals in fish that inhabit the waters surrounding the four districts of the central part of the capital,[35] including chromium, total mercury, manganese, cadmium, arsenic, and lead. The fish in waters where there are inflows of sewage and industrial wastewater had high values for heavy metal contamination. When these fish were consumed, the weekly quantity of total mercury intake accounted for 21% of the WHO provisional value, and weekly intake for other metals was as low as 0.9 to 5.2% of this value. The quantity of weekly mercury intake was almost the same as that of the Japanese.[36]

(2) Rural areas

The levels of PCBs and organochlorine pesticides in fish, shellfish and birds that inhabit the sea along the coast, the Tonle Sap Lake, and the Mekong River were less than those of the surrounding developing countries.[37] High concentrations of DDT, however, were detected in some of the freshwater fish and resident birds. This is due to the use of DDT for the prevention of parasites and canker in cultured fish. DDT is probably still also used to control malaria.

In the northern part of Kampong Thum Province, near the borders of Preah Vihear Province and Stueng Traeng Province, gold is mined illegally and mercury is produced during its processing. The mercury is released into the environment and its impact has raised public concern.[38] Fifty to sixty poor people are engaged in the mining, using strong acid to extract the gold. Abnormalities in cattle have been reported, and complaints from people who live along the lower reaches of the river were collected. It was reported, however, that the site is too far in the interior to get access. It is necessary to assess such industrial pollution developments.

The use of chemical substances throughout rural and urban districts in Cambodia has been limited to extremely small quantities due to the long period of civil war. It can be stated that a clean environment with few chemical substances has been maintained in Cambodia. Many people, however, point out that agrochemicals are used in large quantities to grow vegetables and other cash crops in suburban areas. Continuous monitoring of the agrochemicals is required.

1-4 Administrative organization related to the environment

1-4-1 General conditions

The main Ministries responsible for environmental management and conservation are shown in Table 7-5, with their roles and functions, and the relevant established laws.

Cambodia has signed and ratified international conventions concerning environmental protection. The conventions related to nature conservation include the

[34] Study Group for Basic Research on the Cambodian Environment (1996) p.59.

[35] Refer to Footnote 9.

[36] Kashima *et al*. (1999) pp.372-373.

[37] Tanabe *et al*. (1999a) pp.604-612. Tanabe *et al*. (1999b) pp.363-370.

[38] Based on fact-finding at the office of the Ministry of Environment in Kampong Thum in December 1999. The mercury concerned is not used for extracting the gold, but is produced as a byproduct.

Table 7-5 Main Ministries Responsible for Environmental Management and Conservation

Ministry	Role and functions	Law*
Ministry of Environment	- Formulation of national environmental management plans and policies - Management of protected areas and natural resources - Management of the treatment of waste generated from pollution sources - Monitoring and assessment of environmental quality - Management of data related to the social environment - Environmental education and diffusion of environmental knowledge - Review of environmental impact assessments (EIA)	- Law concerning environmental conservation and natural resources management (1996) - Royal decree concerning the establishment and designation of protected areas (1993) - Law concerning environmental impact assessment (1999)** - Royal decree concerning guidelines for the preparation of EIA reports - Law concerning the control of water contamination (1999)** - Law concerning solid waste management (1999)** - Law concerning the prevention of air pollution and noise**
Ministry of Industry, Mining and Energy	- Permissions and approvals related to factories - Supply of running water to urban areas - Permissions and approvals related to mining rights - Management of hydroelectric power plants	
Ministry of Agriculture, Forestry and Fisheries	- Supply of irrigation water - Hydrologic monitoring - Management of forests and fisheries - Management of agrochemicals and fertilizers	- Law concerning fishery management (1987) - Law concerning forest management (1998)
Ministry of Public Works and Transportation	- Management of ship navigation - Drainage and treatment of sewage	
Ministry of Rural Development	- Supply of running water to rural areas	
Local governments	- Permissions and approvals related to construction - Collection and disposal of solid waste - Management of sewage drainage	- Law concerning land management and urbanization (1995) - Notice concerning permissions and approvals for construction (1997)

Notes: * Laws in the column for the Ministry of Environment are presented in full in the *Seminar on Environmental Impact Assessment, 27-28 March 2000, Organized by Ministry of Environment, Sponsored by JICA.*

** Sub-degree and detailed rule under the law

Sources: Prepared based on a table of Chea Sina (1996) and adding new information.

Convention on Biological Diversity (CBD) ratified in 1995, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), or the Washington Convention, ratified in 1997, and the Convention on Wetlands of International Importance Especially as Waterfowl Habitat, or the Ramsar Convention, ratified in 1999. Three areas were designated as wetlands covered under the Ramsar Convention in June 1999. In addition, the International Tropical Timber Agreement was ratified in 1994, and the Convention to Combat Desertification was also ratified.

The conventions related to the ocean and wastes include the International Convention for the Prevention of Pollution from Ships (MARPOL) ratified in 1996, the United Nations Convention on the Law of the Sea ratified in 1996, the Agreement on the Seas of Southeast Asia ratified in 1996, and the London Dumping Convention, which is concerned with the prevention of marine pollution by the dumping of wastes and other matter. In addition, Cambodia ratified the Convention Concerning the Protection of the World Cultural and Natural Heritage in 1993, leading to the listing of Angkor Wat as a world heritage site. Cambodia adopted the United Nations Framework Convention on Climate Change (UNFCCC) in October 1996.

1-4-2 Ministry of Environment

The Ministry of Environment was established in November 1993, and was vested with broad authority to conserve natural resources and to prevent environmental degradation. The role of the Ministry is to fulfill its responsibilities with regard to the conservation of natural resources and the maintenance and preparation of social infrastructure alone or in cooperation with other relevant Ministries, including the Ministry of Industry, Mining and Energy, the Ministry of Agriculture, Forestry and Fisheries, the Ministry of Public Works and Transportation, the Ministry of Rural Development, and local governments.[39] The Ministry consists of seven Departments and its local offices.[40] The Ministry has 350 staff members throughout the country, of whom 60 are engineers.[41] The budget of the Ministry amounted to 800,000 dollars in 1995,[42] and 970,000 dollars in 1997.[43]

Laws and ordinances have been gradually established. The Law Concerning Environmental Conservation and Natural Resources Management, which is the equivalent of the Basic Law on the Environment in Japan, was established in November 1996 with the assistance of UNDP and other organizations. With regard to national parks and nature reserves, seven national parks, ten wildlife sanctuaries, three protected landscapes, and three multiple-use areas have been designated, based on the Royal Decree Concerning the Establishment and Designation of Protected Areas in 1993. Their total area covers 3,300,000 ha, which accounts for 18% of the national land area. There are also wildlife protection areas under the jurisdiction of the Department of Forestry and Wildlife of the Ministry of Agriculture, Forestry and Fisheries. The role sharing is unclear.

In 1999, many laws were established, including the Sub-decree on Environmental Impact Assessment, the Sub-decree on Water Pollution Control, and the Sub-decree on Solid Waste Management. The Sub-decree on Environmental Impact Assessment provides that environmental impact assessment reports should to be prepared in four sectors; industry, agriculture, tourism, and social infrastructure. In the industry sector, this law is applied to the operation of nine industrial categories, including food, beverages and tobacco, and tanning and textiles. For example, this law is applied to food processing operations with an annual production of 500 tons or more in the sector of food, beverages and tobacco. This law is, however, applied to the production of orange juice at any level of annual production.

The Sub-decree on Water Pollution Control specifies fifteen types of hazardous waste, 52 indices for effluent standards, and lists 67 industries that are required to obtain permission from the Ministry before discharging wastewater. With regard to biodiversity, this law provides five to eight indices for rivers, lakes and marshes, and sea areas, and with regard to human health protection this law also provides 25 indices for environmental standards.

The Sub-decree on Solid Waste Management provides regulations for household waste and for hazardous waste. This law specifies 32 types of hazardous waste. The National Environment Program 1998-2002 was formulated as a set of policies with the assistance of UNDP in 1998.

1-4-3 Ministry of Agriculture, Forestry and Fisheries

This ministry consists of eleven Departments, one public corporation, one agricultural research institute, one agricultural college, and local technical offices.[44]

(1) Department of Forestry and Wildlife

This Department has jurisdiction over forest resources. In this connection, the establishment and management of protected areas including national parks, environmental impact assessment, and biodiversity are under the jurisdiction of the Ministry of Environment. The Department consists of six divisions and 22 sections, including the Forest Management Division, the Forestation Division, and the Wildlife Protection Division, the Forestry and Wildlife Research Institute, and the Kamforexim Public Corporation. The Department

[39] Cina, C. (1996) p.16.

[40] Cambodian Office of JICA (1997)

[41] Based on a fact-finding mission in December 1995.

[42] Sina, C. (1996)

[43] Refere to note 36.

[44] Refere to note 36.

has approximately 800 staff members, including two members who received doctorates, thirteen members who received master's degrees, and 272 graduates of four- or two-year colleges. Approximately 30 students graduate from the forestry course of the Agricultural College every year.

The Law on Forest Management was established in 1988, and reestablished in June 1998. However, there are some problems with the law, including that i) it is not based on a scientific study of forest resources, ii) practical governmental management in accordance with the law is impossible, and there is a large gap between the law and current forest resources management, iii) there are no stipulations related to the procedures for conceding cutting rights, iv) the penalties for illegal felling, etc. are insufficient, and v) the authority and obligation of the Ministries responsible for the forest resources management are not clear. Amendments to this law are in preparation.[45]

There are also problems with the provisions concerning forest cutting rights, including a lack of transparency in the process of conceding cutting rights, environmental impact assessment, the price of conceded rights, and sustainability. The formulation of the provisions is, therefore, in preparation, based on the recommendations of the Forest Concession Review implemented in 1999 and 2000 with the assistance of the Asian Development Bank, in parallel with the preparation of a Forest Management Law. The existing concessions for cutting rights are under review.

(2) Department of Fishery

This Department is the equivalent of the Fisheries Agency of Japan. The Department has jurisdiction over fisheries in general, including the conservation and management of fishing waters, the rehabilitation of damaged drainage canals, the protection of spawning fish, the increase in the utilization of fishery resources, and management of fish cultivation. The Department has approximately 1,500 staff members, including eleven staff who have received a master's degree and approximately 200 staff who have graduated from four- or two-year colleges. Approximately 30 students graduate from the fishery course of the Agricultural College every year. A freshwater fish experiment station is located near Phnom Penh.

The Law Concerning Fishery Management was established in 1987 and regulates fishing periods, fishing rights, fishing methods, the species of fish, and protected waters. However, there is inadequate enforcement of the law due to the lack of funds and human resources. In addition, the law is not in accordance with the present state of fisheries, so amendment of the law is required. Fishing rights, which are the equivalent of the lot-based fishing rights of Japan, have been created with regard to the Tonle Sap Lake and the basin of the Mekong River. Through a bidding system, successful bidders obtain exclusive rights. Revenue of three million dollars obtained through this system goes to the national treasury, of which 200,000 dollars is allocated as the budget of the Department of Fishery. As regards this system, a social problem has arisen because the bidding process lacks transparency, and this system excludes farmers and fishermen who catch fish for their own consumption. Farmers and fishermen have held protest demonstrations in relation to this problem.

(3) Department of Irrigation, Meteorology and Hydrology

This Ministry has jurisdiction over water resources. Specifically, the Ministry deals with water resources related to groundwater and runoff, formulates policies for water source development, plans, constructs, repairs, maintains and manages the facilities for irrigation, meteorology and hydrology, and collects and compiles hydrologic and hydraulic data. There are approximately 800 staff members in this Ministry.

1-4-4 Ministry of Rural Development

This Ministry has jurisdiction over health care, education, the promotion of agriculture, and the promotion of culture. The Department of Rural Health Care is responsible for public health, and the Department of Rural Water Supply is responsible for the supply of safe drinking water.

The Department of Rural Health Care has implemented a project for the diffusion of toilets since 1980 in cooperation with communities.[46] For poor households, the Department provides cement and other mate-

[45] Japan Environment Corporation and the Global Environment Fund (2000) p.22.

[46] Based on a fact-finding survey at the end of November 1995.

rials equivalent to 40 dollars, while the community provides labor and sand. To an ordinary household, the Department provides pipes of cement and other materials equivalent to ten dollars. In addition, the Department provides sanitary education, explaining the necessity of toilets and providing instructions for their use.

The Department of Rural Water Supply has jurisdiction over water supply for communities. Specifically, the Department is responsible for sinking wells, constructing pipelines and pumps, and maintaining and managing waterworks. There are approximately 120 staff members in this Department.

1-4-5 Phnom Penh municipality

(1) Water supply authority

This administrative body is responsible for water supply to the capital. The coverage of this authority reaches as far as the tap of individual houses through meters as well as the receiving tank of buildings. Since there is no construction contractor, the authority directly assumes the construction. The facilities for water supply were constructed before 1970 and are still used through repair and renewal, as discussed above.

A fact-finding survey was carried out at the end of 1995, shortly after the water charge collection system had been established. The forty thousand water meters made in China were installed. The charge for foreigners was 0.21 dollars per cubic meter, and that for Cambodian people was 166 riels per cubic meter. It was reported that the charges were not paid between governmental bodies, that is, the Water Supply Authority did not pay electricity charges to the Electricity Supply Authority, and the latter did not pay water charges to the former.

(2) Public works office

This office has 1,309 provisional staff members and 744 regular staff members.[47] The office is responsible for cleaning operations, sewerage, electricity, parks and green zones, roads and bridges, and buses and other public transportation, boats and ships. A total of 680 staff members are engaged in cleaning operations, including 39 regular members who work in the office, 64 regular members who work on site, and 22 provisional members who work in the office, and 555 provisional members who work on site. They collect waste, manage the final disposal sites, and clean roads. They work from 7:00 in the morning for seven hours per day. There are seven members at the final disposal site, two of whom are always at the site. They work for eight hours per day and for approximately thirteen days per month. The collection and disposal of waste is described above.

The number of staff members who are engaged in sewage disposal is 396, including 264 regular members and 132 provisional members. There are several sections, including planning, accounting, workshop, vacuum vehicles, pipe manufacturing, and pumping stations.

1-4-6 Governmental agencies that have jurisdiction over water supply and those that have laboratories for water quality analysis

Several governmental agencies have jurisdiction over water supply for drinking and daily living. The Water Supply Authority discussed above has jurisdiction over the water supply of the capital. The Ministry of Industry, Mining and Energy has jurisdiction over local cities, including Battambang, Sihanoukville, Kampot, Prey Veaeng, Kampong Cham, and Kampong Thum. The Local Water Supply Department of the Ministry of Rural Development has jurisdiction over rural communities. The Ministry of Agriculture, Forestry, and Fisheries has jurisdiction over some rural communities.

One of the authors confirmed the existence of the laboratories for water quality analysis of the Ministry of Environment, the former Irrigation Department of the Ministry of Agriculture, Forestry, and Fisheries, and the Water Supply Authority of Phnom Penh City. In addition, the Ministry of Rural Development, the Fisheries Department of the Ministry of Agriculture, Forestry, and Fisheries, and the Local Water Supply Department of the Ministry of Industry, Mining and Energy have their own laboratories.[48] In local districts, the Water Supply Authority of Battambang City and the water treatment plant of Sihanoukville City have laboratories.

Every laboratory is short of budget, human resources,

[47] Refere to note 42.

[48] A report of the Cambodian Office of JICA (1997).

and equipment. Among the laboratories, however, those of the Water Supply Authorities of the capital and Battambang, and the Irrigation Department of the Ministry of Agriculture, Forestry, and Fisheries are systematically managed. A member of the Japan Overseas Cooperation Volunteers is working at the laboratory of the capital. The Ministry of Environment has been striving to improve the laboratories in accordance with the Law Concerning the Control of Water Contamination. These efforts, however, has been unsuccessful.

The Ministry of Environment plans to utilize these laboratories in the near future as sites where college students concerned can practice water quality analysis. The laboratory of the water treatment plant of Sihanoukville, which was constructed by the Soviet Union, has modern facilities and is sufficiently large, but has become deteriorated through lack of use. These laboratories are worth drawing attention to because they might become core facilities for environmental measurement in Cambodia.

1-5 The achievements and trends of assistance from multilateral and bilateral donors

Assistance in the management of the environment is classified into three fields: i) the management of the environment, including forest resources, aquatic resources, and biodiversity, ii) the management of living conditions, including waterworks, sewers, and solid waste management, and iii) environmental administration. These are shown in Table 7-6.

The focus of assistance in environmental management is placed on forest conservation and the water supply for the capital. The number of projects for forest conservation has been increasing, partly because forest conservation has been adopted as an important issue at the conferences of donor countries since 1999. Specifically, assistance has been provided for the monitoring of illegal felling, the formulation of the forest management law, and improvement of the system of timber extraction.

The priority related to assistance for water supply has been given to the rehabilitation of the waterworks in the capital. Japan, the World Bank, France and the Asian Development Bank have been providing assistance for this waterworks. Japan has constructed an intake tower gate and water pipes between the Sap River and the Pump Reck Water Treatment Plant, rehabilitated the operation of the water treatment plant, begun to supply from a water tower,[49] and renewed the main distribution pipes.[50] As a result, water has become clean and sterilized at the outlet of the water treatment plant at least. In addition, the pressure and quality of water within the renewed distribution pipes and in the periphery of the water tower have been greatly improved.[51] The plan for the expansion of the Pump Reck Water Treatment Plant has been implemented with the assistance of Japan. When the plan has been accomplished, running water will be supplied to almost all the citizens of the capital.

Donors and NGOs have developed the supply of drinking water in cities other than the capital and rural districts since the second half of the 1980s. These developments have been promoted through projects for well sinking on both large and small scales. UNICEF and NGOs have played leading roles in rural areas. Japan has carried out a development study concerning water supply and groundwater in southern provinces and Siem Reab City, which is an international sightseeing city with Angkor Wat in its suburbs. The Asian Development Bank has implemented projects for waterworks, sewers and sanitation in Sihanoukville and other local cities since 1999.

The Asian Development Bank surveyed the drainage and sanitary situation in the capital for their improvement. It is reported that the World Bank plans to improve drainpipes and sewage treatment in a limited number of districts of the capital.[52]

France once provided waste collection vehicles for Phnom Penh. Phnom Penh municipality has requested assistance from Japan over three years in the formulation of mid- and long-term plans for waste management and in the relocation of the final disposal site in Stung Mean Chey. The Ministry of Health and Welfare, the

[49] The water tower stands beside the Olympic Stadium in the capital. Although the tower was constructed in the 1960s by France, it had not supplied water until the rehabilitation.

[50] Based on the fact-finding mission and water quality inspection by one of the authors, and Keiko YAMAMOTO (2000).

[51] Water supply has not improved yet in the peripheral parts of the piping system. Water is sometimes supplied intermittently or ceases to be supplied at the end of the system.

[52] Information obtained on a visit to Phnom Penh in December 2000.

Table 7-6 Assistance in Environmental Management Provided by Japan and Other Donors

	Japan	Other donors
The improvement of living environment	• Phnom Penh waterworks master plan (grant aid) • Secondary Phnom Penh waterworks master plan (grant aid) • Study on Drainage and Flood Control for the Municipality of Phnom Penh in the Kingdom of Cambodia (development study) • Study on groundwater development plan in Southern Cambodia (development study) • Study on water supply system for Siem Reap region in Cambodia (development study) • Short-term individual experts Waterworks (sanitary engineering, public health and the environment) 1991 • Short-term individual experts Urban planning two experts 1994 • Short-term individual experts Urban administration two experts 1998 • Short-term individual experts Management of water supply one expert 1999 • Short-term individual experts Management of water supply one expert 2000 • Japan Overseas Cooperation Volunteers Water quality analysis one expert 2000	• Cambodia - Urban water supply project (World Bank) • Phnom Penh water supply (Asian Development Bank) • Rural water supply and sanitation Development (Asian Development Bank) • Phnom Penh drainage, sanitation improvements (Asian Development Bank) • Provision of solid waste collection vehicles for Phnom Penh (France)
Management of the natural environment	• Short-term individual experts Forestation two experts 1999 • Short-term individual experts Forest conservation policy one expert 1998 • Long-term individual experts Forest resource conservation one adviser 1999 • Long-term individual experts Aquatic resources one expert 2000 • Long-term individual experts Fishery systems one expert 2000	• Forest resources monitoring in the Mekong River basin (GTZ, Mekong Committee) • Sustainable forest management, including felling concession appraisal (Asian Development Bank) • Formulation of the forest management law (Asian Development Bank, FAO) • Monitoring reports on forest crimes (FAO, UK, Australia, UNDP) • Aquatic resources management (DANIDA) • Natural resources management of Tonle Sap Lake (FAO)
Environmental administration	• Long-term individual experts Environmental resource management one advisor 1999	• Formulation of an environmental action plan (UNDP, World Bank) • Formulation of the law on environmental protection and natural resources management (UNDP) • Environmental impact assessment, water quality conservation (Asian Development Bank) • Management of Tonle Sap Lake (UNESCO) • Assistance for national parks (UNDP, WWF, EC)

Sources: Original

predecessor of the Ministry of Health, Labor and Welfare of Japan, dispatched short-term experts in October 2000. In addition, some groups of Japanese companies have started operations concerning a new final disposal site and waste incineration.[53]

UNDP, the Asian Development Bank and other donor organizations assisted in preparing environmental white papers, formulating national environmental action plans, formulating environmental basic laws, and implementing environmental impact assessments to reinforce the organizational functions of the Ministry of Environment from 1994 to 1998.

2. Main issues

2-1 Natural environment

2-1-1 Issues related to forest resources

Illegal felling has been accelerated since 1993 when Cambodia rejoined the international community through the general election. Urged by the possibility that forest resources in Cambodia would be depleted in several years, Global Witness and other NGOs raised international awareness in order to change Cambodian policies concerning forest resources.

[53] Ibid

In response, donor countries and organizations requested the Cambodian government to improve policies concerning forest resources in exchange for their assistance. Consequently, as discussed above, the Prime Minister Hun Sen became committed to tightening controls over illegal felling and improving policies concerning forest resources in January 1999. The donor countries and organizations have been monitoring the conditions for any improvement since February 1999. UK, Australia, UNDP and FAO implemented a project for reporting the results of the monitoring of illegal felling during the period 1999 and 2000. Global Witness participated in the project as a monitoring group. At the end of 1998, many donors considered that the change in policies for forest resources and the control of illegal felling, in particular, were impossible. Conditions regarding forest issues, however, have rapidly improved, and donor countries, organizations and NGOs evaluated highly the efforts of the Cambodian government at the conference held among donors in 2000. This is an example where international opinion and assistance policies have led to the promotion of good governance in a developing country.

Future issues include the establishment and operation of a sustainable and transparent system of felling concessions, the amendment of the Law on Forest Management that serves as the basis of policies for forest resources, the organizational operations of the Department of Forestry, the promotion of forestry by communities, and forestation. In actuality, assistance projects have already begun in response to these issues.

2-1-2 Issues related to fishery resources

In the same way as in the case of forest management, amendment of the Law on Fishery Management and reform of the fishing rights system are required. The concessions for felling in floodwater forests, which are under the jurisdiction of the Department of Fishery, are closely related to the forestry system reform in progress. There are some problems in the fishery field similar to the forestry field, including that the inadequate fishery statistics do not reflect the actual state of the fisheries, and that illegal fishing and overfishing, such as fishing with dynamite, are hardly regulated.

Since international awareness is directed at forest issues, assistance from donor countries has been insufficient in the fishery field, which has resulted in a delay in the reform of the fishery system. Since poor people depend on fish for protein through fishing themselves, assistance in the fishery field is urgently required as a means to alleviate poverty.

2-1-3 Issues related to biodiversity

During the long civil war, plants, animals, birds, reptiles and amphibians were not studied systematically, including their habitats, but disordered development was less serious in Cambodia than in the surrounding countries. However, in line with the increase in felling, including illegal felling since 1992, there has been a decline in the habitat for endangered species. Poaching of endangered species, the export of which is prohibited by the Convention on International Trade in Endangered Species of Flora and Fauna (CITES or Washington Convention), has increased, and they have been exported to Thailand and other countries. Recently, permission for felling in the Cardamom Mountains was canceled based on an understanding of the importance of its biodiversity after a study as made of the mountains.

The priority is not given to policies for the protection of biodiversity but to policies for poverty reduction and the preparation of infrastructure. There is therefore hardly any national budget allocated in this field, so Cambodia depends on assistance from donor countries for funds and technology. For example, even though the government designates national parks, the protection and management of the parks are not functioning. The government works only when donor countries and organizations extend assistance to it.

2-1-4 Issues related to Tonle Sap Lake

According elderly people, many crocodiles inhabited Tonle Sap Lake in the past, so that when people sailed on the lake, they beat drums to turn away the crocodiles, and when people were in a boat on a calm lake and tapped the side of the boat, fish jumped into the boat. The lake has certainly lost such richness.

From the environmental perspective, the most serious problem for Tonle Sap Lake is the disordered development of its basin. The forest, including inundation forest,[54] has been indiscriminately cut, which has resulted in the expansion of housing sites along the coast, and an

[54] The study concerning the decline in inundation forests surrounding Tonle Sap Lake is unavailable. It can be estimated, however, that the inundation forests have decreased by half over the past 30 years, based on Table 7-1.

increase in bare land and scrub. A large amount of earth and sand has flowed into the lake through rivers within the basin, raising the turbidity of the lake, increasing the sedimentation, and thus making the lake shallower. Boats have had difficulty in navigating and it has been difficult to maintain the species and numbers of aquatic life, including waterfowl.[55]

The second most serious problem is the influx of household wastewater due to the expansion of housing sites in Siem Reab City, Battambang City and other urban districts surrounding the lake. In addition, eutrophication has become serious due to the increase in the number of fenced aquaculture sites in the lake and excessive feeding of fish.

The third most serious problem is the lack of an intergovernmental organization responsible for the management of Tonle Sap Lake and the absence of comprehensive plans for its utilization and conservation.

There are different views on the sedimentation and the harvesting of fish. Accurate judgment of the situation is required based on immediate and adequate studies.

2-2 Living environment

2-2-1 Issues related to drinking water

All sources of drinking water, including surface water and underground water, are contaminated with coliform bacteria, and therefore unsuitable for drinking as it is. Providing a solution to this is the most important issue with regard to drinking water. In addition, the problems of tap water include a large quantity of suspended matters, and old and dilapidated water treatment plants and distribution pipes. In order to maintain the good quality of rainwater, storage pots must be kept clean. River water has a high level of turbidity. Pond water contains a large quantity of organic substances. Groundwater is clean in many cases, but often contains dissolved substances that make it unsuitable for drinking.

2-2-2 Issues related to household and industrial wastewater

The quite low rate of toilet installation adversely affects the sanitary conditions of dwelling areas. Cambodian toilets are a kind of flush toilet, but feces, urine and washing water go into the earth under the ground. While Cambodian toilets cause this wastewater to diffuse into the environment, Japanese pit latrines do not.[56] Cambodian toilets also cause a deterioration in the sanitary conditions of dwelling areas through contamination of the soil, groundwater and surface water.

All household wastewater other than feces and urine is discharged without treatment in both urban and rural districts.[57] In urban districts, wastewater is discharged from offices and factories in addition to households. Industrial effluent has been increasing in type and quantity along with the rehabilitation of industry, and almost all of it is discharged without treatment. All the wastewater from households, offices and industries contaminates drinking water and water for daily living. In the monsoon season, rainwater is added to the wastewater. In cities, in the same way as for waterworks, sewers that were constructed before 1970 have become very dilapidated, including breakages and blockages that lower the capacity of the flow. In the monsoon season, in particular, rainwater cannot drain away properly and cities are often flooded. The treatment of household and indus-

[55] In this connection, there is a problem concerning the Battambang River. The river flows through Battambang City, which is the second largest city in Cambodia and is located in western part of the country. A large amount of soil generated by ruby mining around Pailin flow into the river, turning the river yellow. The intake of river water for tap water of the city is in a critical condition. This is based on the report of the Cambodian Office of JICA in 1997. The authors surveyed the site in May 2000.

[56] Middle-aged and elderly people know that Japanese pit latrines were a source of flies, but feces and urine were stored in the tank, so that contamination was limited to within the tank. Along with the diffusion of Johkaso, or on-site feces and urine treatment facilities, in the period of high economic growth of Japan, the contamination of river water begun. Almost all of them were only for the treatment of feces and urine and excluded other household wastewater from the kitchen, laundry room, bathroom, and so forth until recently.

[57] In Japan, the household wastewater of 56% population is treated together with feces and urine at wastewater treatment plants under the jurisdiction of several Ministries. The household wastewater of the remaining 44% is discharged without treatment. Of the remaining 44% of the population, 22% use pit latrines, and their feces and urine are extracted from the latrines and treated at night soil treatment plants. The other 22% of the population use on-site feces and urine treatment facilities. The purification of the facilities is inefficient, so that effluent is discharged almost as influent is, as of the end of March 1997. As a result, approximately 40% of household wastewater is discharged without treatment and there are also many unsolved problems concerning sewage and other wastes in Japan. It is necessary to consider the problems of developing countries in light of this state of Japan.

trial wastewater is required, including feces and urine.

2-2-3 Issues related to solid waste

Individuals throw waste away in public spaces without hesitation, while municipalities cannot collect all the waste. Waste is therefore observed everywhere in towns. The functions of a waste disposal site are limited to receiving waste and open burning of the waste. Smoke damage, the generation of dioxins and water contamination caused by infiltration into water systems surrounding the disposal sites are everyday incidents, threatening the health of waste pickers and people who live in the vicinity of the sites.

The disposal of solid waste generated from industries is hardly regulated. Medical waste is, in particular, problematic. The Sub-decree on Solid Waste Management specifies the categories of hazardous waste, but does not specify regulations on quantity. In addition, hazardous waste may be brought into Cambodia from foreign countries again in future.

2-2-4 Issues related to air pollution

The supply of public electricity needs to be increased, while the use of privately owned power generators needs to be regulated. Gas emissions also needs to be regulated. In addition, the use of recycled gasoline and alternatives to gasoline, and hazardous additives, including lead, should be regulated. Concurrently with the tightening of the regulations, the Sub-decree on Air Pollution and Noise Control must be effectively enforced.

2-2-5 Issues related to chemical pollution

There are signs of pollution caused by hazardous chemicals in the capital as a result of human activities. In general, in urban and suburban districts in Cambodia, wastewater flows into their surrounding wetlands. Vegetables and fish grow in the wetlands, taking in organic pollutants as nutrition. These vegetables and fish are sold in cities and eaten by citizens. Thus, a small food chain is established. Currently, chemical pollution remains only in traces, but hazardous chemical substances may infiltrate into this food chain in the near future as industrial activities expand. On the other hand, in areas other than urban districts, there is no sign of chemical pollution in relation to fish, shellfish and birds. These conditions need to be maintained. DDT, however, has been detected in freshwater fish and resident birds, which has raised concern over the excessive use of agricultural chemicals in the suburbs. The government must establish a monitoring system.

Since most manufacturing industries use chemicals to some extent, environmental impact assessment must be undertaken in the planning phase of plant construction. In addition, business operators are required to manage plants in environmentally sound conditions and provide occupational health and safety services for workers. This should also apply to foreign companies that establish businesses in Cambodia.

2-2-6 Issues related to environmental awareness and education

Public sanitation awareness must be enhanced, including refraining from defecation and urination where there is no toilet, the construction and use of toilets, washing the hands with clean water after using toilets, and keeping public areas in towns clean. In order to achieve this, children must be thoroughly educated in hygiene at primary and secondary school, and adults should be provided with information through active use of the media.

Environmental education should be provided at primary and secondary school in order that children can understand the relationship between the environment and people from a broad perspective. Furthermore, institutions of higher education need to train professionals to monitor and assess environmental quality, as well as to formulate measures for environmental management.

2-3 Issues related to the central government

Firstly, although laws have been established, there is clearly a lack of sufficient organization, human resources, funds, equipment and materials for effective enforcement of the laws. In addition, the enforcement systems within the Ministries concerned with the environment have not been established yet, which is an urgent issue to overcome. In the case of the Ministry of Environment, the Sub-decree on Water Pollution Control has been established, but it obliges only certain factories to be monitored and the inspection covers only basic items, which cannot satisfy the purpose of the Law. There is little equipment and there are few re-

agents available to measure items regulated by the Law. There are no funds to buy them either. To make matters worse, there are few skilled analysts, instructors for analysis, companies that repair the equipment and supply consumables, or companies that supply the reagents.[58]

Secondly, the capacity of human resources is low. The number of people in the second half of their forties or older in the prime of life is abnormally small due to the serious decimation of the population in the 1970s, which has resulted in increasing the instability of Cambodian society. Even the central government is not excluded from this situation. The quality of higher education has not been restored, and therefore, the staff members of the central government who graduated from such institutions of higher education are not fully qualified. In addition, the number of the staff members is not so high.

Thirdly, the assignment of human resources is inappropriate, and in addition, coordination and cooperation between senior staff is insufficient. Primarily, there are few experts in each Ministry. Most staff members of the Ministry of Environment, for example, have studied forestry, fishery, construction, and law. There are no environmental experts. In the second place, the capabilities of the members are limited, as stated above, so that they lack practical knowledge of the required operations. As a result, many Ministries are organizationally ineffective.

Fourthly, staff members cannot dedicate themselves to their services. This is a vital issue. They need side jobs to supplement the low salaries, which have stayed at twenty dollars per month for five years. Staff members other than senior members disappear soon after they arrive at work. Improved working conditions must be urgently established through the payment of salaries that meet their living expenses.

3. Direction of development based on the experience of Japan and other countries

3-1 Basic perspectives: sociopolitics of environmental issues

Technology has an important role in the generation of hazardous pollutants and its resultant disruption of the natural environment and damage to human health. It is, however, insufficiently understood that the society itself and its management have great importance for environmental pollution and health damage since these were caused by human activities. In other words, not only technology but also sociology, politics and economics each has an important role in causing environmental pollution and the resultant health hazards.

In Japan, pollution frequently caused serious health damage from the late 1950s through to the late 1960s, in the prefectures such as Kumamoto and Niigata (Minamata disease), Mie (Yokkaichi asthma), and Toyama (Itai-itai disease). In those days, Japan was emerging from the status of a developing country. The infant mortality rate is well known as an index of the development of a country or as an index of the health status of a society, and it was at 40 to 1000 births in 1955. There were distortions and conflicts resulted from the transition from a society where primary industry was dominant to a society in which more advanced industry is thriving. These distortions and conflicts, together with the structural deficiencies of Japanese society, placed a considerable burden on vulnerable people, who were the main ones to suffer from these diseases. These pollution incidents provide valuable lessons in foreseeing the future relationship between development and the environment in developing countries.

3-1-1 Poverty and insufficient infrastructure aggravate the damage

Minamata disease, which is representative one of Japan's foremost pollution-induced diseases, was caused by methyl mercury. Inorganic mercury had been used as a catalyzer at an acetaldehyde plant in the Minamata Factory of the Chisso Fertilizer Corporation. Methylmercury compounds were produced as chemical by-products in the process and discharged into Minamata Bay. Fish and shellfish in the Bay became contaminated with the methyl mercury, and fishermen and their families were afflicted with Minamata disease through eating the fish and shellfish.

However, if the circumstances had been so simple, Minamata disease could have been prevented through the prohibition of fishing in the polluted waters and the transportation of safe fish and shellfish to the people in

[58] JICA is dispatching Mr. Hiroshi NISHINOMIYA of the Ministry of the Environment as an advisor to the Cambodian Minister to strengthen the enforcement system. He is scheduled to stay for three years.

polluted area. The implementation of these measures, however, required an appropriate infrastructure, which Minamata City lacked at the time.

The people who were engaged in fishing needed to be compensated for their loss of livelihood due to the prohibition on fishing. The central and prefectural governments did not control fishing at the early stage of the incidence of the disease. Only the local fishermen's association voluntarily controlled fishing. The fishermen in Minamata became unable to sell their fish and shellfish catches, and as a result had difficulties in living and were faced with no alternative but to eat the fish and shellfish they had caught themselves. The damage was thus compounded and became more serious. Japan was not sufficiently rich to enable the central and prefectural governments to allocate public funds to compensate the fishermen in the second half of the 1950s.

Currently, it is not difficult to transport safe fish and shellfish to people in a polluted area, since roads and railways have been established, refrigerator and freezer trucks and railcars are available to transport them, refrigeration and freezing works have been established to store them, and municipalities are prepared for cooperation in emergencies. In those days, however, it was very difficult to safely transport and store fish and shellfish for consumption even in Minamata itself. Even if the physical infrastructure had been established, the fishermen could not have bought safe supplies of fish because they could not obtain an income through selling their own fish catch. In addition, the Shiranui Sea, or Minamata Bay, which extended before them, was abundant in fish. There seemed to be no reason for the fishermen not to catch the fish to feed their own families.

At the end of June 2000, nearly 80 people were poisoned by freshwater blowfish and seven people died in Siem Reab Province in Cambodia. It took nearly one month to identify the cause even though international information systems were fully utilized, including ProMedmail[59] and PubMed.[60] The reasons for this delay were the inability to fully grasp the situation and the symptoms of poisoning due to the lack of physicians to make an accurate diagnosis, and the lack of all the physical conditions necessary for risk management in emergencies, including overcoming the blocking of transportation and the suspension of telephones and facsimiles due to serious flooding in the region in the vicinity of the area concerned.

3-1-2 Manmade disruption and pollution of the environment adversely affect daily living that depends on the diversity and abundance of nature

In the 1950s, fishermen in Minamata exchanged fish and shellfish for rice and vegetables, and shared food and commodities with relatives and among the neighbors. Children gathered shellfish on the beach to eat with their families. Before mercury contamination, their means of living outside the monetary economy was richness itself, which it is now difficult to imagine since people are so used to modern lifestyles.

The mercury contamination of the Shiranui Sea drastically disrupted the lives of the area's inhabitants. This parallels the fate of the Japanese Crested Ibis, which has been brought to the verge of extinction by being deprived of its natural habitat. Uncontrolled development of the areas and excessive use of agrochemicals contaminated their habitats and food chain. In recent years, nature has been transformed for the purpose of mass production based on monoculture to increase yields and profits. Since biodiversity involves sensitive interrelationships among species, this transformation has disrupted stability, and resulted in a decline in the number of species or genetic resources. This pattern of environmental disruption can be observed throughout the world, and Cambodia is no exception.

3-1-3 Discrimination worsens the situation for the victims

The Minamata disease reflected the social and economic position of the fishermen and their families concerned. Many citizens of Minamata City were related in some way to Chisso Corporation, whose operations were the source of the contamination. For example, a number of Minamata citizens got jobs in the Chisso Minamata Factory, and more than 60% of the revenue from property taxes for Minamata City was derived from the Chisso Minamata Factory in FY 1953. In contrast to this, the socioeconomic position of the fishery and fishermen was very low. In addition, discrimination against the fishermen and their families became worse

[59] http://osi.oracle.com:8080/promed/promed.home

[60] http://www.ncbi.nlm.nih.gov/PubMed/

based on the fact that many of them came from Amakusa, which was poorer than Minamata.[61] Claims for compensation for health damage and applications for the designation of victims as Minamata disease patients were regarded as actions to cause Chisso to collapse. Victims of the disease and their families faced obstructions in finding marriage partners and jobs.

When faced with a crisis such as the Minamata disease, Japanese communities have survived since the Edo period (1603-1867) by abandoning minorities and vulnerable people. Basically, this strategy for survival was led by the upper structures of society. Conflicts have also repeatedly arisen between the minorities and vulnerable groups themselves, thus resulting in socioeconomic breakdown for all those involved.

Cambodia consists of various ethnic groups that have different religious and cultural backgrounds. Many fishermen belong to Vietnamese groups. In the nation, which has not yet recovered from a state of exhaustion after the long period of civil war, there is thus the strong possibility that social, political and economic discrimination will occur if an incident such as Minamata disease emerges.

3-1-4 Disparities in access to information increases the damage

Food poisoning occurred in Iraq from the end of 1972 through 1973. Farmers who could not earn money to buy bread instead ate wheat for sowing that was treated with methylmercury fungicide. Nearly 6,000 residents were hospitalized and 500 of them died. These figures are limited to the numbers of hospitalized patients. Some estimates indicate that the number of victims was ten times higher.

The farmers knew that the wheat was toxic. They then fed the wheat firstly to chickens, but the chickens did not die. Later they also ate the wheat after grinding it. The farmers did not know that the true character of the methylmercury's toxicity is chronic. They therefore continued to eat the wheat until neurological signs and symptoms appeared. They knew about the toxicity, but it was too late.

This incident reveals that insufficient information is dangerous. At this time, the toxicity of methylmercury compounds had already been fully proven scientifically. If the farmers had been better informed of its toxicity, they would never have eaten the toxic wheat.

In the Minamata incident, information was manipulated to mislead people who wanted to obtain accurate information. Information without scientific evidence was provided, including that the cause of the incident was explosives discarded by the former Japanese Navy, and that the cause was toxic amines from rotten fish. The Research Group of the Faculty of Medicine, Kumamoto University concluded that an organomercurial was the cause of Minamata disease through long and earnest efforts, and internal experiments by Chisso Corporation itself showed results that supported the conclusion of Kumamoto University. This fact, however, was concealed while compensation was arranged between Chisso and the victims and their families. Subsequently, the damage continued to expand.

These facts indicate that accurate information is important and that who has access to information is also important. In addition, even if scientists are able to obtain accurate information, the information is useless if the people who need the information have no access to it, cannot understand it, or cannot take action based on it.

3-2 Specific directions for development

As a result of the more than 25 years of civil war, nature that had been inherited and the society that had been built up in Cambodia over a long period became exhausted and disrupted so seriously that Cambodia has not yet reached the point at which it can recover by itself. This is the reason for its need for assistance from developed countries. Any assistance, however, must be extended in consideration of the environmental conditions, that is, assistance should be implemented with minimal environmental impact.

In the environmental field, developed countries should assist Cambodia until it can deal with environmental problems by itself. This assistance should extend to repair work and new construction in terms of both intellectual and physical resources. The following are the specific directions for this development, based on the study discussed above.

The first priority for assistance needs to be given to waterworks, sewerage, and waste management that are the basis of a healthy life.

The second priority for assistance should be to nature

[61] Ishimure, M. (1969).

conservation that is necessary for maintaining and enhancing living systems, including human beings. The first priority replaces the second priority in comparison with the order in the discussion above. It is considered to be appropriate that the living conditions of human beings should precede the conservation of nature since Cambodia has not yet overcome its critical state.

The third priority for assistance should be reinforcement of the system for enforcing laws and regulations in environmental administration.

The fourth priority for assistance should be to raising awareness concerning public health and environmental conservation. Assistance also needs to be extended to environmental education at primary and secondary schools and training experts through higher education.

3-2-1 Water supply, sewerage and solid waste management

(1) Water supply

Firstly, waterworks, including water treatment plants and pipelines, need to be repaired, renewed, and newly constructed in the main cities. In the capital, Japan has been cooperating in the construction of an additional water treatment plant, which should be further promoted. This repair and renewal is also required for the peripheral and terminal parts of the distribution network that have already constructed. The expansion of water service areas must be planned in accordance with the growth in the population and the expansion of urban areas.

The same assistance as that provided in the capital should be urgently extended to the waterworks of Battambang City, where little assistance has been available but where the organizational basis is sound. Forests have been increasingly denuded in the river basin that provides a water source to the City. As a result, the degree of suspended solids of raw water has risen rapidly, which has caused a serious problem. Water service charges are substantially higher in this City. Donors should not abstain from extending assistance due to the high charge.

Secondly, repair and renewal of waterworks are required in provincial capitals other than Battambang. The waterworks of the provincial capitals were constructed before the 1950s and 1960s. European and US NGOs, including SAWA, repaired them to a basic level of operation in order to resume services during and after the Heng Samrin regime. Most of the provincial capitals have only maintained the work of these NGOs. Without repair or renewal, the waterworks will cease functioning and be abandoned sooner or later.

The provincial capitals are not so large, except for Battambang City. The capacity of all the waterworks of the provincial capitals other than Battambang is in fact very small. The service coverage is 25% at the most, and in many cities the coverage is 10% or less. (Refer to the second and third columns of Table 7-4.) Since the improvement of the functions of waterworks in local cities will be essential in future, waterworks should be planned to supply water for all the citizens in the provincial capitals. A master plan should be formulated first from a nationwide perspective, and based on this, construction needs to begin in several provincial capitals.

Thirdly, technology transfer is also required for the construction and maintenance of waterworks. Specifically, the technology that is required is for the management of waterworks, the repair and construction of pipelines, and the construction and maintenance of water treatment plants in cities other than the national capital. Chlorine for disinfection, coagulants, electricity, petroleum, and the materials for water pipes need to be provided under efficient management, for which assistance is needed as soon as possible.

Fourthly, assistance needs to be extended to enable Cambodia to develop the technology to ensure clean and safe drinking water in farming and fishing villages. Water purification units for use in each community and water purifiers for use in each household should be developed. It is recommended that the slow filters that were previously used in Japan be remodeled to provide water purification units. It is also recommended that the water purifiers that were used in Japan up to the 1950s be remodeled. They should be remodeled to suit to the current living conditions in Cambodian rural areas. The Japanese model of water purifier consisted of a barrel of approximately eighteen liters filled with the fibers of palm trees, sand and charcoal.

(2) Sewerage and industrial wastewater

Firstly, assistance needs to be provided for the time being to improve the current types of toilet and increase their use. Since the current type of toilet allows the dif-

fusion of contaminants, they need to be changed to closed systems. It is recommended that individual toilets should be equipped either with a tank from which feces and urine can be collected to be treated at treatment plants,[62] or the toilets should have a tank in which organic materials such as rice straw and dry grass can be laid to absorb feces and urine to make compost. Since the current types of toilets are still effective in maintaining public health if they are installed taking into account the surrounding sanitary conditions, the installation of such toilets should be obligatory, and at the same time, the system of subsidies and provision of materials needs to be improved.

Secondly, assistance needs to be provided for the renewal and construction of sewerage and the construction of sewage treatment plants. Since the capital and Battambang and some other cities are densely populated, they require sewage treatment systems that combine sewers and sewage treatment plants in the same way as those of developed countries. In the capital, the repair and renewal of sewers is required. Since most of the sewers are seriously damaged, they will have to be renewed. However, since the flow of wastewater is under control to some extent even at present, sewage treatment plants should be constructed before the repair and renewal of sewers has been accomplished. The same applies to Battambang.

Thirdly, assistance needs to be provided for the development of on-site treatment facilities for the use of communities and each household. In recent years in Japan, people have been obliged to install combined type private sewage treatment systems that treat both night soil and other household wastewater, when they install private sewage treatment systems. In China, there has recently been an attempt to install treatment facilities of this type. It is recommended that the treatment facilities of this type be developed in accordance with the conditions in Cambodia in order to apply them in areas other than large cities.

Fourthly, assistance needs to be provided for the validation of regulations on industrial wastewater and the establishment of regulations on the location of factories. Although the Sub-decree on Water Pollution Control sets effluent standards, the Ministry of Environment has been unable to establish a monitoring and guidance system. Assistance should be provided for the immediate establishment of such a system. It can be considered that in the first place, sewers in cities ought to be improved and then wastewater containing hazardous substances can be discharged into the sewers. Such a claim, however, should not to be adopted. In principle, wastewater should be treated using microorganisms. The difference between industrial effluent and household wastewater is that industrial effluent contains a large proportion of hazardous substances, which microorganisms cannot break down. Companies that discharge industrial effluent should be required to treat it based on the polluter pays principle (PPP).[63] In this connection, Japan has considerable experience, so assistance should be extended to bolster the required human resources capacity.

(3) Solid waste

Firstly, the collection and disposal systems for waste in large cities need to be rehabilitated or established. In order to accomplish this, policies for waste management must be formulated and implemented.

Secondly, waste disposal sites need to be restored to turn them into sites with minimal environmental impact and more of such low environmental impact sites need to be constructed. Professor Kunitoshi SAKURAI of Okinawa University introduced the fact that Professor MATSUFUJI of Fukuoka University improved a waste disposal site in Butterworth, which is opposite Penang Island in Malaysia, through technical guidance using local materials.[64] At the site, waste had always been burning, so that the smoke hindered visibility. Such improved practices should be introduced into Cambodia.

Thirdly, immediate measures need to be taken to prohibit the repeated use of medical instruments, including syringes, and to establish a system in which medical waste is disposed of separately from other waste. Medi-

[62] Pit latrines are less comfortable to use than flush toilets, but they are superior in that they have less environmental impact and the treatment system is compact.

[63] In Japan in the 1970s, when sewers were being constructed, some researchers and citizens asserted that industrial effluent should not to be discharged into sewers. The movement to oppose the discharge of industrial effluent into sewers intensified in various places throughout Japan, which is a fact that is not well known to the public. As a result, although the Sewerage Law stipulated that industrial effluent could be discharged into sewers, local governments hesitated to allow such discharges. Thus the use of urban sewerage as a means to dilute industrial effluent with household effluent is avoided.

[64] Kunitoshi SAKURAI (1999) pp.73-82.

cal waste must be completely incinerated. The generation of dioxins is inevitable in the course of medical waste incineration, but measures for the gradual reduction of dioxin can be taken. Physical assistance and assistance for human resources development are required in this field.

Fourthly, the enforcement of the Law Concerning Solid Waste Management needs to be improved. To achieve this, assistance needs to be extended for i) the development of measures to implement regulations on hazardous waste at the point of discharge by companies, ii) determination of the appropriate technology for waste disposal, and iii) the establishment of specification standards for such technology.[65]

Lastly, health checks are urgently required for people who live in the vicinity of the waste disposal sites. There is an urgent need to find out the actual state of the relationship between the quantity of dioxin and physical abnormalities among the inhabitants, together with epidemiological studies.

3-2-2 The natural environment

Firstly, the actual state of the environment must be accurately analyzed. There is little scientific information on the present state with regard to the protection of forests, the protection of fishery resources, the protection of biodiversity, and Tonle Sap Lake. As a result, the assessment of actual conditions and the formulation of policies depend to some extent on the experience and subjective views of the persons concerned.

Specific and detailed surveys are required on a regular basis with regard to the species, their distribution, their numbers, and trends in the increase or decrease of forest resources, fishery resources, and flora and fauna. As for forest resources, the present state of trees as well as the felling of trees must be accurately assessed, and the flows and stocks of timber must be precisely analyzed on a regular basis. As for fishery resources, the stocks and harvest levels of fish and shellfish must be monitored accurately, based on which the relationship between the volume of stocks and the catch must be discussed. As for flora and fauna, inventories need to be prepared urgently.

Secondly, production must be under control in forestry and fishery, including forestation and aquaculture. Water contamination caused by fishery must be controlled. Developed countries and international organizations should provide the technology and human resources required to achieve this control.

Thirdly, strict protection must be given to rare species of animals and plants. Based on the surveys discussed first, more assistance should be provided for the protection of the endangered animals indicated in Table 7-3, river dolphins, which are discussed in 1-2-3 (1), and crocodiles in the Tonle Sap Lake in particular.

Fourthly, the actual state of ecosystems that are vulnerable to change through human activities must be assessed and protected. Specifically, the ecology and function of forests in inundation areas surrounding the Tonle Sap Lake and mangrove forests in coastal areas need to be clarified. Subsequently, strict protection needs to be given to these areas.

Lastly, the state of the relationship between human activities and nature in the basin of the Tonle Sap Lake must be clarified. Based on this clarification, a development plan needs to be formulated in order to achieve a balance between human activities and nature, which could be considered a Cambodian version of the Comprehensive Development Plan for Lake Biwa in Japan.

3-3 Environmental administration

Firstly, the most critical factor in bolstering the enforcement system will be the creation of conditions that enable public servants to devote themselves to their public service, that is, so that they can live on their income from public service alone.

Secondly, laws for the regulation of pollution need to be further improved. Since the environmental laws have been established on the model of European countries, the US and Japan, these laws have the same level of strictness as these countries. Cambodia, however, lacks the physical means and human resources to enforce such legal standards. The Law Concerning the Control of Water Contamination, for example, designates a list of hazardous waste, including agrochemicals and solvents, which is almost the same as that in developed countries. The law, however, is unenforceable since there are no means of measuring these. Therefore,

[65] In Japan, elution tests are carried out on the waste concerned to find out the content of hazardous substances. According to the results, the waste is classified into three types: waste to be dumped at inert landfill sites, waste to be dumped at controlled landfill sites, and waste to be dumped at strictly controlled landfill sites.

a simple and valid regulation system needs to be established in accordance with the actual conditions in Cambodia. Practical assistance should be provided to establish these.

Thirdly, education and training are needed to develop human resources. Programs need to be designed, including long- and short-term training in developed countries, long- and short-term technical cooperation through dispatching experts from developed countries to Cambodia, and regular training of every group within each Ministry.

3-4 Environmental education

The Cambodian public became angry over a mercury incident, in which mercury was transported into Sihanoukville without permission, and they often talk about the relationship between global warming and the uncontrolled and excessive felling of forests in Cambodia. This indicates that the Cambodian people have become aware of social and international issues. When the importance of nature conservation and public health is explained properly, Cambodian people can accept it relatively easily.

Thorough environmental education needs to be provided for children at primary and secondary schools. The active utilization of the media including TV and comics will be effective in raising the awareness of adults as well as children. Programs of environmental education need to be designed so that children can understand the relationship between the environment or ecology and human beings for each grade of primary and secondary education. In addition, higher education institutions need to be established in order to train professionals who can measure and assess environmental quality, and can formulate environmental measures.

4. Direction of Japan's assistance

4-1 Basic concept

The specific directions for development are discussed in 3-2. The basic perspectives for the determination of the directions are discussed in 3-1. The conclusion of 3-1 is that assistance should be extended through the utilization of Japan's hard experience. The following considers other important issues in relation to Japan's assistance.

Firstly, it is necessary to consider the requests from Cambodia. Quite a few requests are for the provision of equipment that is too complicated to handle and maintain. In the case of such requests, Japan must explain the reasons for declining or propose alternatives.

Secondly, based on a proper understanding of the difference in technological level between Japan and Cambodia, Japan should not provide advanced technology that Cambodia cannot handle.[66] It is recommended that techniques that require less energy and are easy to maintain be selected from among Japan's traditional techniques, with improvements to suit current conditions in Cambodia. For example, slow filtration of running water is recommended for water purification. This may also lead to technical innovation in Japan.

Thirdly, systematic technology must be in accordance with the conditions of the location where the technology is to be used. The forms and function of the technology should be determined by the natural and social conditions of the location. The technologies for waterworks, sewers, and waste management are examples. There is a significant difference between Japan's sewerage requirements and a sewerage system for a society where people wash their face with only one cup of water and can do without toilets.

Fourthly, maintenance is essential for any technology. Almost all facilities need continuous maintenance and logistics to ensure that they function properly. Assistance needs to be provided taking this into consideration.

4-2 The objectives of assistance

4-2-1 The repair, renewal and maintenance of waterworks

Assistance should be extended for the repair, renewal and maintenance of waterworks based on the first priority indicated in section 3-2 on the specific directions of development. Active assistance should begin with the

[66] In preparing the draft of this document, a Japanese questioned whether the word "provide" is appropriate. When the authors visited Cambodia in December 2000, they asked a senior staff member of a certain Cambodian Ministry what measuring equipment was necessary for environmental monitoring. The staff member answered that he wanted Japanese members to choose the best equipment because the Cambodian members did not know well due to a lack of experience. To "provide" is a reality, although the authors must pay sufficient attention to its expression. Ambiguous expression is not good.

waterworks of cities other than the capital, including Battambang first and then other provincial capitals, through a master plan that covers the whole country.

4-2-2 The construction of sewage treatment plants in the capital and Battambang

Subsequently, sewage treatment plants need to be constructed in the capital and Battambang. The treatment methods to be adopted must be low cost, low energy consuming and superior in purification capacity in accordance with the present conditions in Cambodia.

4-2-3 The construction of sanitary waste disposal sites

Waste disposal sites with minimal environmental impacts need to be constructed in accordance with a planned waste disposal system for the capital, Battambang and other cities. In the construction, the situation of waste pickers must be properly considered. In addition, urgent inspection of the impact on the health of people who live in the vicinity of existing waste disposal sites and the environmental impact of the sites is required, with the focus on inspection for dioxins.

4-2-4 Studies to prepare inventories of animals and plants

Based on the second priority indicated in section 3-2 on the specific directions of development, studies to prepare inventories of animals and plants and a comprehensive study on the Tonle Sap Lake should be implemented. The studies for inventories must be carried out cautiously since many land mines are left and security is not well assured in forest areas. While studies for inventories have been promoted in Vietnam and Laos after the long war, such studies have not been implemented yet in Cambodia.

4-2-5 Comprehensive study and development of Tonle Sap Lake

There are different views concerning Tonle Sap Lake, which were discussed above. In order to clarify the real state of the lake, natural conditions and human activities in the basin and the lake need to be studied. Based on such a study, plans for the recovery and improvement of the environment and resources must be formulated and implemented. Large-scale assistance is required for the study and the formulation and implementation of the plan.

4-2-6 Assistance for the enforcement system of the Ministry of Environment

Based on the third priority indicated in section 3-2 on the specific directions of development, assistance should be extended to the Ministry of Environment so that the Ministry can strengthen its enforcement system. The Ministry has three laboratories with a total of 50 m^2 in area, including a general analysis room of 30 m^2, a biological laboratory of 20 m^2, and a chemical storage room of 10 m^2. The Ministry has been striving to ensure effective monitoring and regulation of operations through the introduction of measuring equipment in the laboratories and through the educational development of measuring experts. These efforts, however, have not succeeded yet due to the shortage of funds. The following three assistance issues therefore require attention.

(i) Japanese experts will be dispatched and Cambodians will be invited for training so that the Cambodian staff members can acquire measurement techniques. Currently, this technical transfer is being implemented to a small extent by Yokohama City University and Niigata University.

(ii) Japan will provide equipment and materials for analysis. For a certain period, Japan must continue to supply reagents and spare parts for repairs, while Cambodia must establish a means for the procurement of spare parts and reagents by itself. Some people argue that used equipment should be provided. This argument must be rejected since used equipment often becomes out of order, but the people and parts to repair it are rarely available. New robust and durable equipment must be provided.

(iii) Facilities for the further utilization of the Internet will be provided for the Ministry of Environment. The current facilities are extremely poor. The establishment of a system that enables the Ministry to receive a quick response to questions, and advice on matters that it cannot deal with, will help to establish more effective and smoother operations, and reinforce its crisis management capability.

4-2-7 Environmental education and assistance to Japan's NGOs

Raising awareness of public health and environmental conservation is the fourth priority of section 3-2 on the specific directions of development. Since people need to change their thinking, it is appropriate for public awareness to be raised gradually through the activities of NGOs that have had long experience in Cambodia. These NGOs, therefore, will be assisted and encouraged in their activities in this field.

In order to develop human resources, assistance needs to be extended to the invitation of students for long- and short-term education and training, the establishment of institutions for higher environmental education in Cambodia, and the dispatch of experts to these institutions.

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