Case study:

Thailand

National Water Development Report: Thailand

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World Water Development Programme (WWAP)

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PREFACE

A location in Monsoon Region makes Thailand seeming to be abundant in water resources. An average annual rainfall is 1,426 mm. but 70 percent of it tends to concentrate in a wet season. Therefore, it leads to a fluctuation of run off and hence water sources. All rivers and other wetlands encounter the same situation that is an overflow of water in wet season and shortages in dry season. Such climatic situation compiling with a population growth and a socio-economic development make Thailand facing many problems relate to water such as shortages, flooding, pollution and conflict over uses. The problems will become enlarging in magnitude if no effective solution is urgently implemented.

It has been worldwide accepted that the water crisis is caused by the lack of effective water resources management system. In order to achieve the effective approach in solving the water crisis through water resources management, the status of water resources in Thailand must be clearly identified relative to all governing factors including water governance, water resources information, impacts of water to human life and well-being, and water management. The governance of water resources management and water utilization is identified by means of active policies in promoting an involvement of all stakeholders.

In this report water resources information as indicated in form of hydrologic characteristics and other available data was summarized. Impacts of water to the human life and well-being as well as the effect on various production sectors were introduced. The state of safe and sufficient water and sanitation as a basic human need, with an implication to health, an integrated water resources management to ecosystems and human settlements were reported. The uses and allocation of water in food production, industry and energy production was recognized.

The other water management issues including floods risk, droughts, pollution and related hazards, the cooperation and synergies of sharing water between different uses and users, the progress of valuing water in economic, social, environmental and cultural means, and the knowledge base of water resources were deliberated as well.

This document is prepared by the Department of Water Resources, Ministry of Natural Resources and Environment of the Royal Thai Government subjected to funding by the United Nations World Water Assessment Programme (WWAP).

LIST OF ABBREVIATION

ADB	=	Asian Development Bank
AIDS	=	Acquired Immune Deficiency Syndrome
ASEAN	=	The Association of Southeast Asian Nations
ASH	=	Action on Smoking and Health Foundation
BMR	=	Bangkok Metropolitan Region
BOD	=	Biological oxygen demand
BPR	=	Bottom Pressure Recorder
BP-RBC	=	Bang Pakong River Basin Committee
BRT	=	Biodiversity Research and Training Program
CCM	=	Country Coordinating Mechanisms
CFCs	=	Chlorofluorocarbons
DART	=	Deep Ocean Assessment and Reporting of Tsunamis
DDT	=	Dichloro-Diphenyl-Trichloroethane
DHF	=	Dengue Haemorrhagic fever
DMCR	=	Department of Marine and Coastal Resources
DO	=	Dissolved oxygen
DWR	=	Department of Water Resources
EGAT	=	Electricity Generating Authority of Thailand
EIA	=	Environmental Impact Assessment
EIRR	=	Economic Internal Rate of Return
ETZ	=	Equatorial through Zone
EU	=	European Union
FY	=	Fiscal year
GDP	=	Gross domestic product

GF	=	Global Fund
GIS	=	Geographic Information System
GWh	=	Giga Watt hour
HA	=	Hospital accreditation
HALE	=	healthy life expectancy
HIV	=	Human Immunodeficiency Virus
HPH	=	Health-Promoting Hospitals Project
IMR	=	Infant mortality ratio
IPPS	=	Independent power producers
ISIC	=	International Standard Industrial Classification
IUCN	=	The World Conservation Union
IWRM	=	Integrated Water Resources Management
JICA	=	Japan International Cooperation Agency
KPI	=	Key performance indicator
Lao PDR	=	Lao People's Democratic Republic
MCM	=	Million Cubic Meter
MDGs	=	Millennium Development Goals
MIS	=	Management Information System
MMR	=	Maternal mortality ratio
MoPH	=	Ministry of Public Health
MPNHD	=	Managerial Process for National Health Development
MRC	=	Mekong River Commission
MTCT	=	Mother-to-child transmission
MW	=	Mega Watt
MWA	=	Metropolitan Waterworks Authority
NBSAP	=	National Biodiversity Strategies and Action Plans

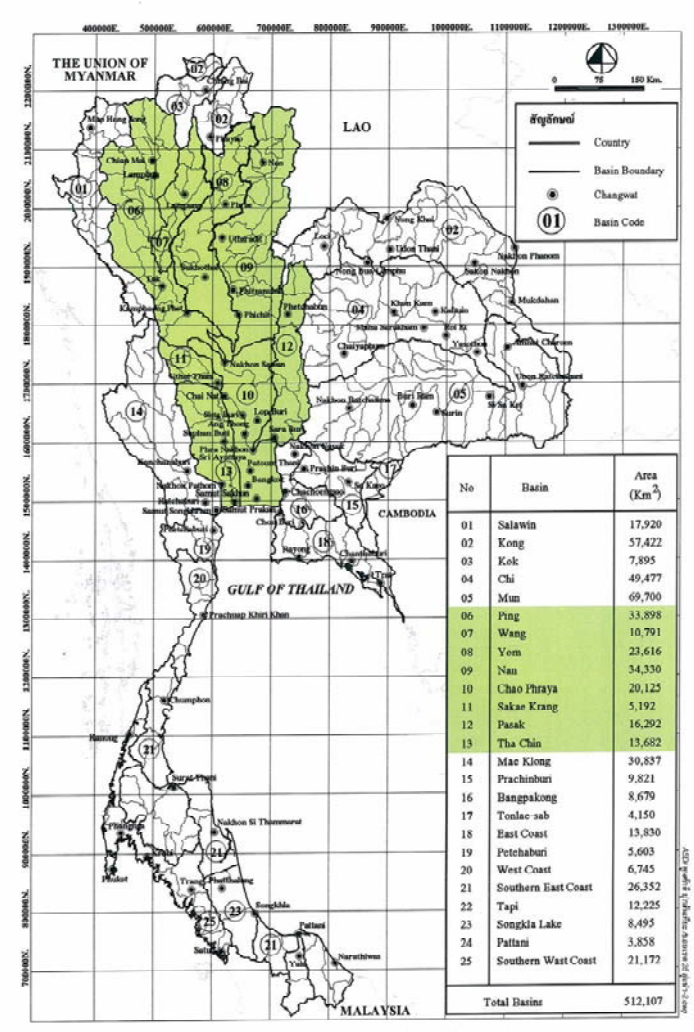
NEQA	=	National Environmental Quality Act
NESDB	=	National Economic and Social Development Board
NHSRO	=	National Health System Reform Office
NWRC	=	National Water Resources Committee
ONEP	=	Office of Natural Resources and Environmental Policy and Planning
ORT	=	Oral Rehydration Therapy
PAs	=	Protected areas
PPBS	=	Planning Programming and Budgeting system
PTT	=	Petroleum Authority of Thailand
PWA	=	Provincial Waterworks Authority
RBC	=	River Basin Committee
RCC dam	=	Roller-compacted concrete dam
RFD	=	Royal Forest Department
RID	=	Royal Irrigation Department
SCADA	=	Supervisory Control and Data Acquisition
TISTR	=	Thailand Institute of Scientific and Technological Research
TP	=	Total phosphorus
WEFCOM	=	Western Forest Complex
WHO	=	World Health Organization
WQI	=	Water Quality Index
WWF	=	World Wildlife Fund
WWMO	=	Waste Water Management Organization
WWTP	=	Wastewater treatment plants

BACKGROUND

1. General Context

Thailand is located in Southeast Asia in the center of the Indochina peninsula between latitude 6°-21° N and longitude 98°-106° E. Thailand is bordered on the north by the Lao People's Democratic Republic (PDR) and Union of Myanmar, on the east by Cambodia and the Lao PDR, on the south by the Gulf of Thailand and Malaysia, and on the west by Union of Myanmar and the Andaman Sea. The total land area is about 513,115 km^2. The length of Thailand from north to south is about 1,648 km and the widest part from east to west is about 780 km.

The hydrological characteristics of Thailand vary from region to region depending on various factors such as the geographical and climatic conditions of each region. Further, the country area can be divided into 25 river basins according to the topography as shown in Figure 1. Table 1 indicates the drainage area and annual run-off volume of each river basin. The average annual rainfall for all over the country is about 1,700 mm.



No	Basin	Area (Km^2)
01	Salawin	17,920
02	Kong	57,422
03	Kok	7,895
04	Chi	49,477
05	Mun	69,700
06	Ping	33,898
07	Wang	10,791
08	Yom	23,616
09	Nan	34,330
10	Chao Phraya	20,125
11	Sakae Krang	5,192
12	Pasak	16,292
13	Tha Chin	13,682
14	Mae Klong	30,837
15	Prachinburi	9,821
16	Bangpakong	8,679
17	Tonlac sab	4,150
18	East Coast	13,830
19	Petchaburi	5,603
20	West Coast	6,745
21	Southern East Coast	26,352
22	Tapi	12,225
23	Songkla Lake	8,495
24	Pattani	3,858
25	Southern West Coast	21,172
	Total Basins	512,107

Note: The shaded area is the Chao Phraya River Basin

Figure 1 Total Area of 25 basins and Chao Phraya River Basin

Table 1 Description of 25 river basins in Thailand

Basin No.	Name of River Basins	Catchment Area (km^2)	Average Runoff (MCM.)	Storage capacity (MCM.)	Irrigation Area (rai)	Water Requirement (MCM./year)				
						Domestic Consumption	Tourism Industry	Ecological Balance	Irrigation Agriculture	Hydropower
1	Salawin	17,920	8,571	24.00	188,948.00	11.96	4.46	1,027.81	616.93	-
2	Mae Khong	57,422	19,362	1,551.00	1,692,333.00	132.57	1.98	1,145.69	4,323.33	-
3	Kok	7,895	5,279	30.00	520,767.00	14.90	0.43	680.00	401.39	-
4	Shi	49,477	8,752	4,246.00	1,863,173.00	195.17	49.62	573.33	3,052.82	2,156.00
5	Mun	69,700	26,655	4,255.00	1,819,785.00	337.88	94.30	956.63	2,628.85	591.30
6	Ping	33,898	7,965	14,107.00	1,942,927.00	75.26	1.00	457.27	2,428.20	3,623.00
7	Wang	10,791	1,104	197.00	472,350.00	20.21	1.00	48.00	487.42	45.00
8	Yom	23,616	3,117	98.00	994,205.00	53.87	0.08	315.36	859.13	-
9	Nan	34,330	9,158	9,619.00	1,780,637.00	66.29	0.32	315.36	2,870.80	2,583.00
10	Chao Phraya	20,125	22,015	33.00	5,731,375.00	1,594.40	646.05	1,250.00	8,768.59	-
11	Sakaekrang	5,191	1,297	162.00	436,410.00	8.62	-	3.35	878.75	-
12	Pasak	16,292	2,820	124.00	661,120.00	72.32	23.28	158.00	927.38	-
13	Thachin	13,682	22,300	416.00	2,385,259.00	94.94	310.25	1,000.00	4,292.11	-
14	Mae Klong	30,837	7,973	26,690.00	3,400,000.00	20.34	-	1,577.00	4,323.33	4,670.00
15	Prachinburi	10,481	5,192	57.00	733,862.00	8.08	2.78	377.00	838.32	-
16	Bang Pakong	7,978	3,713	74.00	1,353,263.00	14.18	9.05	946.00	2,243.60	1.94
17	Tonglesap	4,150	6,266	96.00	123,720.00	12.60	-	9.80	197.00	-
18	East Coast	13,830	11,115	565.00	427,000.00	129.10	83.50	74.70	578.46	79.00
19	Phetchaburi	5,603	1,400	750.00	562,688.00	14.30	2.90	67.00	1,110.00	693.00
20	Prachuap Khiri Khan Coast	6,745	1,420	537.00	327,015.00	18.00	2.97	39.10	1,383.00	-
21	South East Coast	26,353	23,270	5.00	1,780,481.00	56.40	8.70	161.70	1,129.10	2,577.00
22	Ta Pi	12,225	12,513	5,865.00	245,970.00	25.90	10.00	3,085.20	144.60	2,596.00
23	Songkhla Lake	8,495	4,896	28.00	905,550.00	56.45	37.50	312.00	2,994.70	-
24	Pattani	3,858	2,738	1,420.00	337,878.00	31.20	2.44	670.80	441.11	1,152.00
25	South West Coast	21,172	25,540	20.00	339,273.00	53.20	18.90	74.80	253.00	-
	TOTAL	512,066	244,431	70,769.00	31,025,989.00	3,118.14	1,311.51	15,325.90	48,171.92	20,767.24

Note. 6.25 rai = 1 ha

Source: Department of Water Resources, 2005

2. Major Characteristics

2.1. Physiographical conditions

Thailand can be divided into several physiographical regions as shown in figure 2. These physiographical regions are used in classifying ground water aquifers as explain later in Chapter B – The Resource. These physiographical regions can be described as follows:

The Central Plain: Most parts of this region are in the lower Chao Phraya basin. The sediment transported from the Ping, Wang, Yom and Nan river basins in the north and from the watersheds in the east and west results in siltation in this plain. Deposition forms the largest plain of the country. The width and length of the Central Plain are about 175 km and 450 km, respectively.

The South-east Coast: The main land form of this region is a marine terrace which can be affected by the coastal climate. Topography shows micro landform of the undulating terrain. Watershed could not play important role due to their small areas and low potentials of water yield for irrigation and hydro power electricity generation. The coastal watershed provides a favorable zone of brackish water for mangrove forest.

The North-east Plateau: The undulating or rolling landforms in the north-east plateau comprise of several small watersheds which drain into the two principal rivers Chi and Mun, flowing into the Mekong River. The physiographic pattern of high plateau is typical in this region.

The Central-Highlands: The Central Highlands are connected in the east by the north-east Plateau and on the west by the Central Plain. Various landforms including hill, plateau and a number of valleys are physiographically involved in the region. Among the valleys, the most important one is the Pasak river valley, which divides the region longitudinally. Its catchments in the north, east, and west is mainly composed of hills and more or less strongly incised plateaux of various heights ranging from 1,200 m to 1,300 m above MSL. Deforestation in the catchment area causes very serious environmental problems in the region.

The North and West Continental Highlands: The region can be subdivided into the two main sub-regions which are the western mountain range and the northern hill and valleys. The northern hill and valleys sub-region starts from 18 ^{o}N latitude up to the northern border of the country. The western mountain range originates the Ping, Wang, Yom and Nan rivers. Their lower reaches join together to form the Chao Phraya river, flowing through the Central Plain toward the Gulf of Thailand.

Peninsular Thailand: The peninsula runs in the south direction starting from 11.5 ^{o}N latitude to Malaysia. The western coast is adjacent to the Indian Ocean. The eastern coast adjoins to the Gulf of Thailand with many small watersheds of flat or undulating terrains.

2.2. Climate

Thailand's climate is mainly governed by two monsoons namely: the southwest monsoon and the north-east monsoon. The south-west monsoon, in which heavy rainfalls occur, begins from mid May and lasts until mid October. The northeast monsoon, which is comparatively dry and cool, occurs from mid October to mid February. The transition period from mid February to mid May is the period in which the northeast monsoon changes to the southwest monsoon with uncertain wind direction. The two monsoons are closely associated with atmospheric pressure conditions over the whole of Asia. The boundary zone between these two monsoonal flows called the Equatorial Through Zone (ETZ) passes back and forth over the country several times during the lulls and surges of the monsoons.

2.3. Land use

Land utilization in Thailand by region in 1993, 1998, and 2003 is show in Table 2.

Table 2 Land utilization of Thailand by region

Region Area (rai)	1993	1998	2003
Rice	65,786,834	62,680,598	58,912,268
Para rubber	9,460,678	10,454,417	9,641,864
Permanent crop/forest(planted)	11,433,938	11,791,899	13,205,767
Field crop	25,319,012	20,964,906	21,547,462
Vegetable crop, herb, flower and ornamental plant	1,121,161	1,605,241	1,378,611
Pasture	1,469,709	467,252	1,199,367
Fresh water culture	-	-	1,225,545
Others	4,171,612	3,710,156	5,564,491

Note: 6.25 rai = 1 ha

Source: National Statistical Office, 2004

Forest area declined from 27.36 million hectares (53.3 percent of the country) in 1961 to 12.96 million hectares (25.28 percent of the country) in 1998 (Land Development Department, 2004 and Royal Forest Department, 1998). Declining forest area directly contributes to land degradation on sloping and headwater regions, which causes soil erosion. In addition, loss of forest area also contributes to the expansion of saline soils in the Northeast.

Desertification in Thailand is caused by soil erosion, reduction of forest area and land degradation due to land-use problems. The total area of soil loss in the country due to soil erosion, including moderate to extreme levels on both lowlands and highlands, is 17,420,302 hectares or 33.9 percent of the country area (Land Development Department, 2004).

The other type of soil problems can be identified as problem for agriculture. In Thailand this is classified into 7 types of problem soils i.e. saline soil, acid sulfate soil, organic soil, very sandy soil, sandy soil, shallow soil, and soil on slope complex areas. These soils make up 33,575,601 hectares or 65.3 percent of the country area (Land Development Department, 2004). Moreover, the ratio of average annual rainfall over potential evaportranspiration shows that some areas of the country fall within the dry sub-humid climate classification.

Under the 9th National Economic and Social Development Plan (2001-2006) emphasize has been placed on management policy and target was set by 2006, soil erosion reduction measures shall be undertaken on no less than 0.8 million hectares, and rehabilitation measures to address problems of soil quality, such as soil acidity, soil salinity, and infertility, shall be undertaken on no less than 1.6 million hectares. The guiding strategies focus on improvement of management mechanism of natural and environment by promotion of local and community participation with transparent administration system. Conservation and restoration of natural resources will be implemented to keep ecological system in balance whereas supporting economic foundation in sustainable manner. Deteriorated and problem solid will be developed by applying sustainable agriculture and organic agriculture in order to raise fertility and suitability for higher agricultural production as well as least effect to the environment.

2.4. Major socio-economic characteristics

2.4.1. Demography

Population As of 2003, the population in Thailand was 63.08 million with a growth rate of 0.7 percent. The urban population was estimated at about 18 million with high concentration in the capital and the regional centers. According to the 2004 Bank of Thailand's data out of total population 38.7 percent engages in agriculture, 15.6 percent in manufacturing, 15.1 percent in wholesale and retail trade, and 28.9 percent in other services (financial sector, education, hotels and restaurants, etc.), while these sector account to 9.2, 38.7, 13.9, and 38.2 percent to GDP respectively. According to the June 2005 Newsletter of the National Statistical Office, migration of population is mostly found in people between the ages of 15 – 24 years old. The reason in migration can be identified as follows, moving with family, moving to homeland, looking for jobs, moving houses, and further study.

Economic activities Thailand's GDP at constant 1988 price in billion Baht has been increased from 1,945.4 to 3,842.7 between 1990 to 2005 as shown in Figure 1 (Bank of Thailand, 2006). For poverty the most common measure of poverty is the head-count ratio, which is the proportion of the population with incomes below an established poverty line. The official poverty line for Thailand was established by the National Economic and Social Development Board (NESDB) in 1998. The head-count ratio of poverty, base on this poverty line, fell continuously from 1988 to 1996, but then reversed itself and increased in 1998 and 1999. All other indicators of poverty, such as the poverty-gap ratio and the severity of poverty index, also show an increase in the years following the onset of the economic crisis. They all decreased again in 2002 and this trend has remained. \

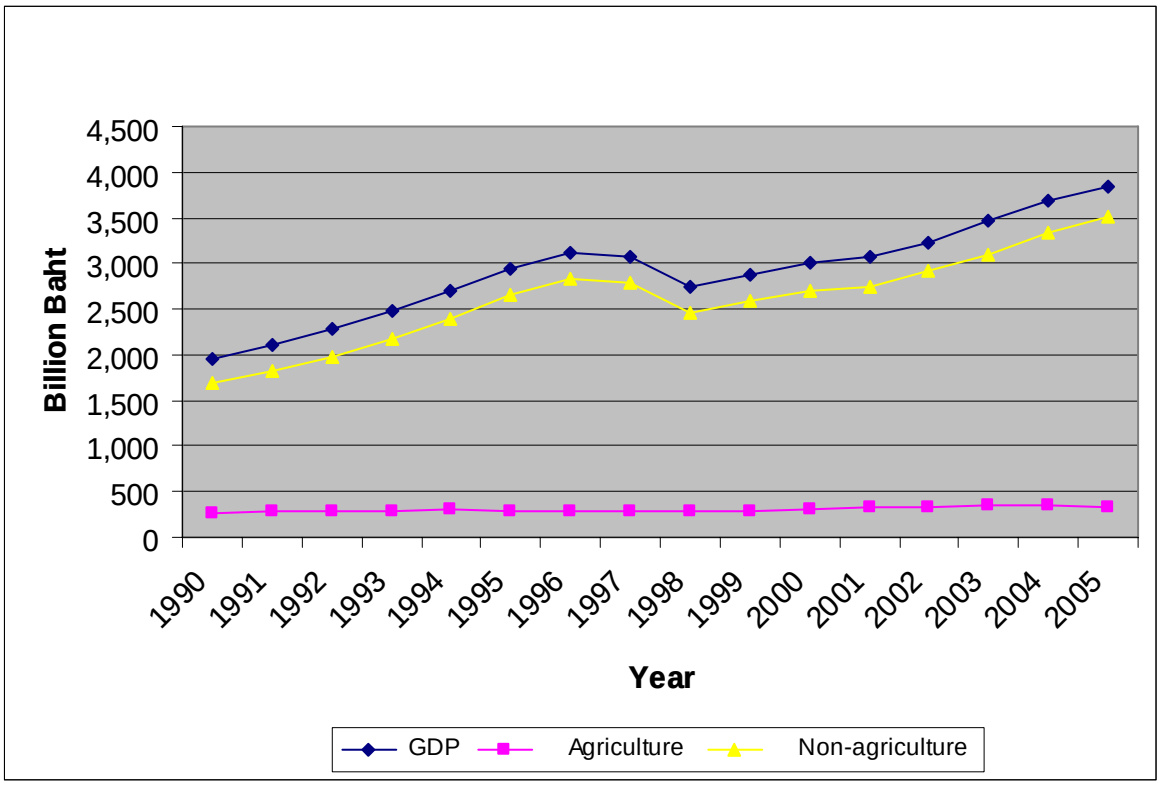


Figure 2 GDP at Constant 1988 Price

Source: National Economic and Social Development Board, 2006.

2.4.2. Education data

The following is excerpted from Thailand Health Profile 2001–2004. (Ministry of Public Health, 2005)

Literacy Rate The literacy rate among Thai population aged 15 and over rose from 78.6% in 1970 to 95% in 1997. The trend however, reversed after the economic crisis, but slightly rose to 95.7% in 2001. Yet, the rate remains much higher than the average for other developing countries (74.5%). Its illiteracy rate was recorded at 4.3% in 2001. It is estimated that the literacy rate will be as high as 97% in 2010. Nevertheless, when considering the reading rate among the Thai people, it was found that only 35.4 million people (61.2%) read regularly, and on average for 2.99 minutes per day.

Education Opportunities The rate of students continuing their education from primary to lower-secondary, from lower to upper-secondary, and from upper-secondary to higher education tended to be rising during the per-economic period. But the rates dropped during the crisis and rose again after the crisis was over.

2.4.3. Health data

The following is excerpted from Thailand Health Profile 2001–2004. (Ministry of Public Health, 2005)

Life Expectancy at Birth In 2002, the life expectancy at birth of Thai people was 69.1 years. Though higher than that of the people in other developing countries and out of the world population, life expectancy of Thai people is still lower than that of several other ASEAN countries. However, during 1964-2000, Thais life expectancy at birth substantially increased from 55.9 years to 69.4 years for males and 62.0 years to 74.1 years for females. In 2025, it is expected that the life expectancy of Thai citizens will reach 74.8 years for males and 80.3 years for females. It is noteworthy that females life expectancy is higher than males; however, the gap has been gradually narrowing from 6.1 years for the period 1964-1965 to 4.7 years for the period 1995-2000. The World Health Report 2003 also revealed that, in 2002, Thailand's healthy life expectancy (HALE) was 60.1 years: 57.7 for males and 62.4 for females, which were lower than those of several other ASEAN countries.

Maternal Mortality The maternal mortality ratio (MMR) in Thailand has declined from 374.3 per 100,000 live births in 1962 to 13.7 per live births in 2003. However, MMR estimates from several surveys are higher than the reported figure.

Infant Mortality In Thailand, the infant mortality rate (IMR, per 1,000 live births) rapidly decline from 84.3 in 1964 to 40.7 in 1984 and to 26.1 in 1996. It is expected that the IMR will drop further to 20.5 in 2020. However, although IMR for Thailand is lower than the global average, it is still higher than that of some other countries in the same region such as Singapore and Malaysia.

Mortality Rate of Children The child mortality rate (among children aged under 5 years per 1,000 live births) has not significantly changed from 12.8 in 1990 to 12.0 in 2003. It is noteworthy that during the first stage of the economic crisis the rate rose to 16.7 in 1998 and has had a tendency to drop since 1999.

3. The Policy in Water Sector

3.1. National water policy

On 25 July 2000, the national water vision, policy and other corresponding details were endorsed by the cabinet. The national water policy can be cited as follows:

1) Accelerate the promulgation of the Draft Water Act to be the framework for national water management by reviewing the draft and implementing all necessary steps to have the act effective, including reviewing existing laws and regulations.

2) Create water management organizations both at national and river basin levels with supportive laws. The national organization is responsible for formulating national policies, monitoring and coordinating activities to fulfill the set policies. The river basin organizations are responsible for preparing water management plans through a participatory approach.

3) Emphasize suitable and equitable water allocation for all water use sectors, and fulfill basic water requirements in agriculture and domestic uses. This will be accomplished by establishing efficient and sustainable individual river basin water use priorities under clear water allocation criteria, incorporating beneficiaries' cost sharing based on ability to pay and level services.

4) Formulate clear directions for raw water provision and development compatible with the basins' potentials and demands, and ensuring suitable quality while conserving the natural resources and maintaining the environment.

5) Provide and develop raw water resources for farmers extensively and equitably in response to water demand for sustainable agricultural and domestic uses, similar to deliveries of other government basic infrastructure services.

6) Include water related topics at all levels of educational curriculum so as to create awareness for water value, understanding the importance of efficient water utilization, necessity and responsibility in maintaining natural and man made water sources.

7) Promote and support participation, including clear identification of its procedures, clear guidelines on right and responsibility of the public, non-government and government organizations in efficient water management. The water management includes water utilization, water source conservation, monitoring and preservation of water quality.

8) Accelerate preparation of plans for flood and drought protections, including warning, damage control and rehabilitation efficiently and equitably with proper utilization of land and other natural resources.

9) Provide sufficient and sustainable financial support for action programs in line with the national policy, including water related research public relations, information collection and technology transfer to public.

At present, the national water policy is under the process of reviewing and assessing.

3.2. Target of the government

The government's target in achieving the Millennium Development Goals has been implemented in relevant to water resources management. To increase the opportunity for people to access to safe water, provision of safe water from village water supply system for all people in every village in Thailand has been carried out. In 2005, there are altogether seventy four thousands three hundred ninety eight (74,398) villages in Thailand; sixty three thousands seven hundred ninety six (63,796) villages have been provided with village water supply systems; ten thousand six hundred and two (10,602) villages are still need the village water supply systems. Within three-year from 2006 to 2008, the Department of Water Resources will manage to provide the village water supply system to all remaining villages.

3.3. Progress toward Millennium Development Goals (MDGs)

Table 3 Thailand's Scorecard on MDG Targets (Goals 1 through 7)

No	Target	Scorecard	Remarks
1	Halve, between 1990 and 2015, the proportion of people living in extreme poverty	Already achieved	Poverty incidence reduced from 27.2% in 1990 to 9.8% in 2002.
2	Halve, between 1990 and 2015, the proportion of people who suffer from hunger	Already achieved	Proportion of population under food poverty line dropped from 6.9% to 2.2% between 1990 and 2002, and the prevalence of underweight children under five dropped from 18.6% to 8.5% between 1990-2000.
3	Ensure that by 2015, boys and girls alike, will be able to complete a full course of primary schooling	Highly likely	Gross enrolment ratio and the retention rate indicate that it is likely that Thailand will achieve universal primary education well ahead of 2015.
4	Eliminate gender disparity in primary and secondary education, preferably by 2005, and in all levels of education no later than 2015	Already achieved	Thai girls and boys have had equal education opportunity, There is a small gender gap at the primary level. Girls are outnumbering boys in higher education.
5	Reduce by two-thirds, between 1990 and 2015, the under-five mortality ratio	Not applicable	Given the low starting point in 1990, this target is considered not feasible and therefore not applicable.
6	Reduce by three-quarters, between 1990 and 2015, the maternal mortality ratio	Not applicable	Given the low starting point in 1990, this target is considered not feasible and therefore not applicable.

Table 4 Thailand's Scorecard on MDG Targets (Goals 1 through 7) (Con't)

No	Target	Scorecard	Remarks
7	Have halted by 2015 and begun to reverse the spread of HIV/AIDS	Already achieved	Yearly new infections have dropped by over 80% since 1991. HIV continues to spread among some groups. Young people continue to be vulnerable.
8	Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases	Already achieved for malaria	Achieved for malaria. The disease is an area-specific problem, and has been effectively managed.
9	Integrate the principles of sustainable development into country policies and programs and reverse the loss of environmental resources	Potentially	Principles of sustainable development, partnership and public participation have been integrated into country policies and programs. But reversing the loss of environmental resources is still Thailand's greatest challenge.
10	Halve by 2015 the proportion of people without sustainable access to safe drinking water and basic sanitation	Already achieved	Very close to universal access.
11	By 2000 to have achieved a significant improvement in the lives of at least 100 million slum dwellers (globally)	Likely	Most Thai people, including slum dwellers, have secure tenure. Various measures have been implemented and more are underway to improve the slum livelihood.

Source: Thailand Millennium Development Goals Report, 2004

3.4. Reference

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4. World Bank, Thailand Economic Monitors, April and November 2005

5. National Statistical Office's Newsletter Volume 16, Number 6 June 2005 Summary of Population Migration 2004

6. Land Development Department, Ministry of Agriculture and Cooperatives. National Action Programme for Combating Desertification, March 2004.

7. Office of the National Economics and Social Development Board and United Nations Country Team in Thailand. Thailand Millennium Development Goals Report 2004.

8. Land Development Department, Ministry of Agriculture and Cooperatives. First National Report on the UNCCD Implementation, April 2002

3.5. Recommended Reading/Website

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2. United Nations Development Program (http://hdr.undp.org/reports/global/2003/)

3. Ministry of Public Heath (http://www.moph.go.th/ops/health_48)

4. World Bank (http://www.worldbank.or.th)

5. Land Development Department (http://www.ldd.go.th/Web_UNCCD/index.htm)

6. United Nations Development Programme, Thailand Office (http://www.undp.or.th/mdgr.htm)

7. Royal Forest Department (http://www.forest.go.th/stat/stat47/TAB2.htm)

A- GOVERNANCE ISSUES

Challenge: Governing Water Wisely

Overview: Thailand had long been encountered with many problems in managing of water resources in national and basin level. In the past, Thailand did not pay much attention to water resources management because water was abundant; anyone could get the required amount of water from rivers, lakes, canals or directly from rainfall. For national level, the causes of problems are (1) no integrated policy formulating in a holistic manner, (2) work duplications and lack of cooperation among water-related agencies, (3) less effective implementation of budget, (4) no specific legal act related to water resources management, and (5) scattering information of water resources development. For basin level, the causes of problems are (1) unclear policy, legal and institutional framework, (2) no public participation of stakeholders in decision making for large scale project, (3) no conflict management, and (4) no sense of ownership and sharing of responsibility. However, at present institutions are established to be responsible for all level of water resource management. There are Mekong River Commission (MRC) for international level, National Water Resources Committee (NWRC) for national level, and River Basin Committee (RBC). The details of the institutions, legislation, goal and programs, management approaches are described in this chapter.

1. Governing Water Wisely

1.1. Management Problems

Thailand had long been encountered with many problems in managing of water resources. They can be identified into:

1.1.1. National Level

In the past, Thailand did not pay much attention to water resources management because water was abundant; anyone could get the required amount of water from rivers, lakes, canals or directly from rainfall. Most water programs were dedicated to water development during that time. Even when population and economic activities had increased, there was still lack of proper water resources management practice. This was due to some reasons which can be identified as follows:

Policy and Plan: There was no integrated policy formulating in a holistic manner by integrating all the works of agencies concerned. The existing plans at that time did not systematically cover all factors concerned and it lacked participation from related parties at all levels.

Institutional Framework: There were more than 30 agencies in 9 ministries working in water resources development and there were 7 national committees involved in this field. This made the system complicated and even confusing resulting in work duplications and lack of cooperation among themselves.

Budgeting: Budget has been allocated to each agency upon their requests. In such process, budget duplication occurred and it causes less effective implementation. This is faced by every sector including water sector.

Legal Framework: There are several acts concerning water resources but not even one directly relates to water resources management. Therefore, it is necessary to draft such a law that can react properly to increasing problems or requirements.

Available Information: Because of too many implementing agencies, information on water resources development scatters all around. This makes it difficult to plan for efficient water management. In addition, information from public sector does not reach people who affect from government projects.

1.1.2. Basin Level

Management Mechanism: The unclear policy, legal and institutional framework governing basin areas makes it difficult to effectively implement basin management. Inadequate and sometimes conflicting legislation is a problem. Also, there are multiple agencies involved in basin management, and none of them has clear responsibility for basin management and development.

Participation of Stakeholders: Water resource development projects are planned and implemented by government agencies, hence the process starts and ends with mostly civil servants involvement. With exception of small scale projects where the local communities and local governments participate in the project identification, compilation of projects lists are submitted to various Ministries for implementation. The current process has proven to be unacceptable as local population and other stakeholders are demanding more information from line agencies and require more role in the decision making. As a result, many large scale projects do not pass this public demand and hence can not proceed.

Involvement of Stakeholders in the Development Process: All public water projects are intended to serve and benefit the users but at the same time may cause an adverse effect to some other groups as well as other resources. It is therefore important to seek the opinion of all the concerned parties or stakeholders and get their involvement from the very early stage of project formulation. Moreover a continued dialogue should be maintained throughout the development process. This is certainly an important step of change for government agencies to follow especially for the technical department. On the other side, the stakeholders from civil society have to adopt a more cooperative and objective attitude and keen interest to compromise.

Conflict Management: With the more democratic practice in involving public in water resource development, many conflicts surfaced during public hearing or consultation. The conflicts centered on environmental issues, the compensation for those affected by the projects and conflicts with interested groups. Mostly, the benefit of the projects was discussed as a counter argument to the losses, and no compromise could be reached. Other significant conflict is conflict over water use and allocation. There is a lack of mechanism for conflicts management, which can include institution, legislation, procedure, clear and mutually accepted data etc. The conflicts will increase as competition for water will no doubt increase in the near future, so conflict management is a necessity.

Sense of Ownership and Sharing of Responsibility: With water being freely accessible and the Government provide all water resource projects free of charges, the users or beneficiaries do not appreciate the projects and have little sense of ownership. The general feeling is that it is a government project; it belongs to the government and users are therefore not enthusiastic in the up - keep of the projects.

1.2. Institutions (Ownership and responsibility)

1.2.1. International

Thailand shares an international river, the Mekong with 5 other countries, Cambodia, China, Lao PDR, Myanmar, and Vietnam. Mekong River Commission (MRC) is the organization managing the river. It comprises 4 member countries namely Cambodia, Lao PDR, Thailand and Vietnam and the 1995 Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin is its framework for cooperation. More elaboration will be found in Chapter 10 Allocation of water Resources.

1.2.2. National

In an attempt to solve the problems mentioned in 1.1, the Government in 1989 issued the Office of the Prime Minister's Regulation on National Water Resources Management. The National Water Resources Committee (NWRC) was established according to Article 6 of the Regulation. It consists of the Prime Minister as chairman and other members appointed by the Prime Minister as he sees appropriate. Its members vary mainly comprises representative from agencies concerned and experts in water and related fields.

When the functions and powers of NWRC are considered, according to Article 7 of the Regulation it is responsible for the following tasks:

1) Propose to the Cabinet for approval of objectives and policies on having large, medium, and small scale water resources in response to the needs.

2) Give guidelines and direct government agencies, state-enterprises, and other organizations in planning or establishing projects for construction or development of water resources of different scales upon assignments including coordination for the said planning or establishing projects.

3) Examine and approve plan or project for construction or development of water resources of different scales of the government agencies, state-enterprises, and other organizations, and inform the Cabinet.

4) Control and monitor the implementation of the plan or project for construction or development of water resources of different scales.

5) Consider and solve urgent problem or obstacles arisen to government agencies, state-enterprises, and other organizations during the implementation of the plan or project, and inform the Cabinet.

6) Prioritize the allocation and control of water usage from different water resources appropriately and responsively to the needs from different sectors such as domestic, power generation, industry, agriculture, and etc., and inform the Cabinet, including direct and monitor the implementation to comply with the prioritization.

7) Direct, control and monitor the examination and maintaining of good water quality.

8) Report the implementation of the construction or development of water resources of different scales, water situation both in quantity and quality, and water usage in response to various needs.

9) Propose to the Cabinet the enacted or revise rules, regulations, or laws on construction or development, control, prevention and protection of both water resources and water quality.

10) Implement other tasks as may be assigned by the Cabinet.

11) Direct, control and monitor the implementation of the Office of the National Water Resources Committee.

12) Appoint sub-committees or working groups to assist the National Water Resources Committee as may be necessary.

13) Hire academics or institutes to work for the Committee only on the concerned responsibilities at the reasonable hiring rate as necessary.

14) Set up River Basin Sub-Committee to manage water resources in the river basin, selecting from stakeholders with appropriate proportion and number according to each river basin and its chairman and secretary are selected from its members.

Its secretariat office was permanently set up in 1996. The current Committee, according to the Office of the Prime Minister's Order, consists of 33 members ; a Deputy Prime Minister who is assigned by the Prime Minister as a chairman, Ministers of Agriculture and Cooperative and Natural Resources and Environment are vice-chairmen, Permanent Secretaries to the Ministry of Natural Resources and Environment and Interior, Director of Bureau of the Budget, Secretary General of National Economic and Social Development Board, Directors-General of Royal Irrigation, Waterway Transportation, Land Development, Pollution Control, Water Resources, Groundwater Resources, National Park, Wildlife and Plant Conservation, Disaster Prevention and Mitigation, Secretary General of the Office of Natural Resources and Environment Policy and Planning, Deputy Director-General of Water Resources, Director of Water Resources Policy and Planning Bureau, Governors of the Electricity Generating Authority of Thailand, Provincial Waterworks Authority, water resources experts, environment experts, 2 representatives of Local Administration Organizations and 2 representatives of River Basin Sub-Committees. The Director-General of Water Resources is its secretary. In practice now the Director General of the Department of Water Resources is appointed as secretary of the Committee.

Organization chart of NWRC and its relationship with the other agencies can be seen in Figure 3.

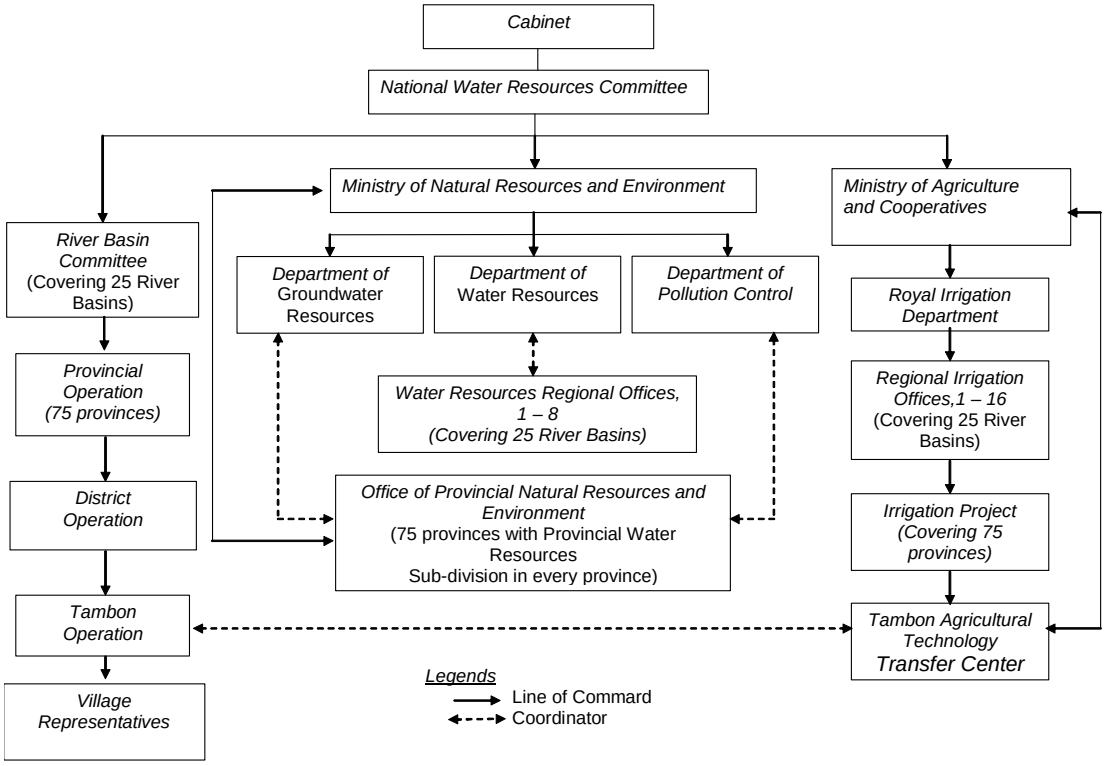

Figure 3 Water Resources Management Organization and Agencies with Water-related Mission

1.2.3. Basin Level

At the basin level River Basin Committee (RBC) has been established. It comprises members selected from government officials, state enterprise representatives, elected representatives of local government units, water user groups, stakeholders who work or live in the river basins, and qualified persons who have knowledge and experience relating to water resources management. They were appointed by the National Water resources Committee (NWRC). The appropriate number and proportion of membership depends on the local situation of each river basin. Chairman and secretary of the committee are to be elected from the committee and assistant secretaries may be included as necessary.

RBC's mandate

1) To submit to NWRC comments on policies, plans, projects, and solutions to any problems or obstacles to the development, utilization, conservation, and any other necessary implementation relating to water resources management as well as any pertinent action of the concerned agencies in river basins;

2) To formulate water resources management plans and coordinate the formulation of such plans by relevant agencies in river basins;

3) To prioritize water allocation and specify water requirements as well as equitable and efficient water allocation measures;

4) To monitor and evaluate performance of the agencies relevant to water resources in river basins;

5) To compile statistics, data, comments, and recommendations regarding water resources management, development and conservation as well as solutions to water shortage, floods, and water quality problems;

6) To conciliate conflicts and solve problems; and

7) To conduct public relations, receive comments, and promote understanding among the general public of the performance or work procedure of the RBC.

At the river basin level the first 3 river basin committees were set up in 2 river basins in 1999 as a pilot demonstration project. The main purpose of establishing the River Basin Committee (RBC) is to organize the body that will be fully responsible for water resources management in the river basin. Its mandates include activities of setting policy on water resources, planning, developing, operating of facilities, and water allocation, and it will oversee all water-related activities in the river basin including the resolution of water conflicts between various users. Each RBC consists of qualified persons drawn from public and private sectors. The lessons and experiences from the pilot project have been thoroughly studied and the RBCs are expanded to another 23 river basins. Since 2003, the RBCs have been established in the whole 25 river basins of the country and 29 RBCs are in place. The number of the RBCs are 29 because out of 25 river basins, some are regrouped for the purpose of administration take for example in 3 river basins namely Ping, Chi, and Mun, each has 2 RBCs as they comprise more provinces than the others, Khong and Kok basins have 3 RBCs, in the South 3 river basins divided into 5 RBCs, and Bang Pakong, Prachinburi and Tonlesap are grouped into 1 RBC.

While the national level agency is in charge of policy matters and supervision of water management as a whole, the RBCs will be responsible for the actual management of river basins and the implementation of associated projects and activities. The Department of water Resources (DWR) at the national level will also provide technical, research information, and financial support to the RBCs. They are funding through normal budget of DWR, the amount of budget allocated to each RBCs covers only administrative purpose. The RBCs have been given wide ranging advisory roles covering most aspects of integrated water resources management. They will be responsible for river basin water allocation and at the same time developing basin-specific programs in close consultation with basin stakeholders to incorporate their particular needs and concerns.

The organization of the RBCs comprises working groups, which represented by officials at provincial level, local government units and local communities. Figure 4 shows its organization charge.

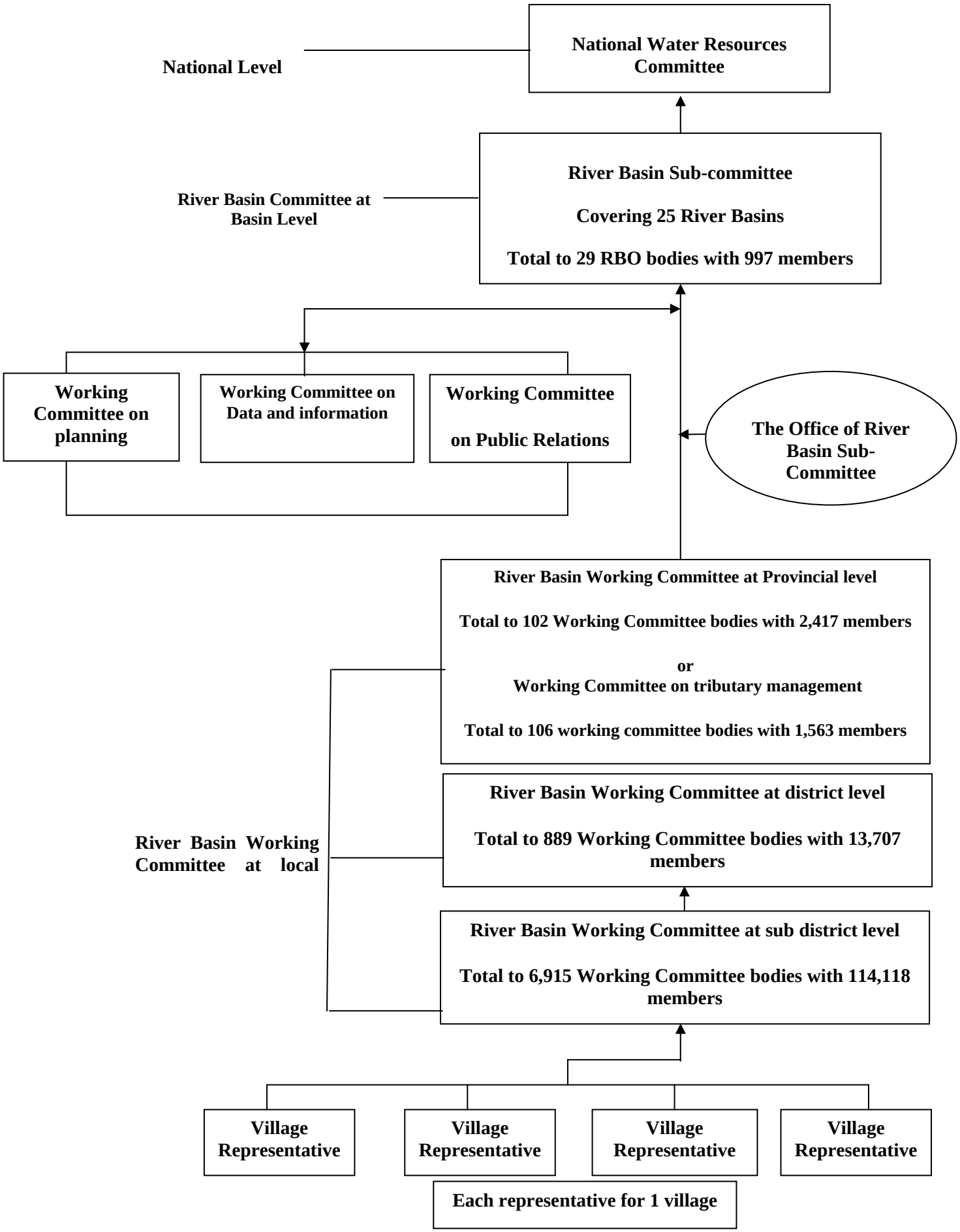

Figure 4 Organization Structure of River Basin Management in Thailand

1.2.4. Provincial and Local

At the provincial levels, the offices of Provincial Administration and District Administration (and similar agencies at local government level) have an operational role in supplying local domestic water but really have little role in the context of water resources planning and management in so far as basin wide issues are concerned.

At the local level, representatives of the local government units have been selected to attend training courses in water resources management as part of the capacity building programs in this field. Apart from the training, Thailand employs various means of capacity building programs for strengthening of IWRM implementation. Capacity building component should be one of the most important factors that would associate with the institutional framework of IWRM at all level of the institutions.

1.3. Public Sector Reform

In order to pursue decentralization policy, many activities pertaining water resources have been transferred to local government units and budget has been gradually allocated as well. In 2002, the government decided to reform its public sectors and in October 2002 the Department of Water Resources (DWR) under the Ministry of Natural Resources and Environment was established. By amalgamating the Office of the National Water Resources Committee with the other water agencies, for example, a part of the Department of Accelerated Rural Development etc, the reform was aimed at better governance in water management. DWR has its mandate as a policy and planning institution for water resources management and a promoter of IWRM. Another long establishing agency is the Royal Irrigation Department, which is responsible in operation of irrigated water.

1.4. Legislation

1.4.1. The Constitution

At the national level, a shift toward decentralization in natural resources management was significantly realized when the 1997 Constitution was inaugurated. A number of sections in the Constitution have an impact on how the government and its agencies will manage the country's natural resources. The Constitution places a strong emphasis on decentralization and on the involvement of the lower levels of the administrative structure in management decisions through requirements of participative management. This favors a good concept of IWRM, which demands a high level of community/stakeholder awareness and participation.

The role of the State in the Constitution regarding natural resources and environment is so clear the State must encourage its citizens to participate in preserving, conserving and utilizing natural resources and biodiversity in a sustainable manner. At the same time the people must be encouraged to enhance and protect environmental quality as well as to control and mitigate pollution affecting the health, well-being and life quality of people. Every cabinet must adopt this policy.

Section 79 stipulates that the State must encourage citizens to participate in preserving, conserving and utilizing natural resources and biodiversity in a sustainable manner.

This strongly implies that the government must make every effort to achieve community participation. Section 79 is supported by the provisions of Section 88, which state that these participatory and involvement principles shall be used a guideline for developing and enacting laws and in administering the country.

Section 46 declares that people in local and indigenous communities have the right to preserve or revitalize local customs, knowledge, innovation, art and culture. They may also participate in managing, conserving and utilizing natural resources and environment in a sustainable manners as proscribed by law. (i.e. provided parliament passes appropriate laws). Section 56 provides further and scope for communities to work on natural resources issues.

Section 290 states that, in enhancing and conserving environment quality, local administrations may have functions and powers as prescribed by law. The relevant law should address the following issues:

The management, conservation and utilization of natural resources and environment within the jurisdiction of local administrations,

The participation of local administrations/local government units in conserving natural resources and environment outside their jurisdictions which could affect the livelihood of their constituents,

The participation of local administrations/local government units considering initiation of projects or activities outside their jurisdictions which could adversely affect environmental quality and public health within their constituencies.

Section 290 so far has given a moral boost in the local administrations, particularly Sub-district (Tambon) Administrative Organizations, in claiming the right to manage, utilize and conserve natural resources and environment within their jurisdictions.

One major impact caused by the enactment of the Constitution is a free access to information. Section 58 states that a person may obtain public data or information which is in the possession of government agencies, state enterprises and local administrations unless the disclosure of such information will jeopardize national security, public safety or the legally – protected interests of others. The law must determine what kind of information can be disclosed and how it will be provided. The information Act passed by the Parliament to implement the Constitution in 1997 had widespread impacts the way government agencies, state enterprises, local administrations and their officials' perform their functions. For instance, in the past it was the privilege of government and its officials' to decide whether to disclose any information to the public. Now the government and its agencies can only withhold certain specified information and the rest must be accessible to the public.

In addition, Section 59 states that before government agencies, state enterprises and local administrations issue permits or undertake projects or activities, which could adversely affect environment, public health, quality of life and other interests of a community, a member of that community has the right to obtain information, answers and reasons for proposed action.

Overall scope and intent of the new Constitution provides not only for a climate of open participatory management of the natural resources, but also an obligation on government administrations to implement this approach.

This is the particularly relevant to the role and operation of the RBCs being set up under recent movement toward the Integrated Water Resources Management (IWRM). These can be no excuse for not including the basin community / stakeholders in future water resource management decisions a meaningful way – the Constitution requires it, and it will unleash a new level of commitment in the task of achieving a balance of sustainable water resource management in Thailand's.

1.4.2. Existing water laws

There is a mass of water laws, codes, and instructions etc that all have been framed for particular, and usually singular, purposes. There is no umbrella legislation to link these laws and codes, and consequently that is no legislative backing for any organization to undertake integrated water resource management.

Water permits are not issued and bulk water use by the irrigation, hydropower, domestic, town water and industry use is not properly controlled. Ad-hoc new developments occur and (even many of those are small and operate at a local level) the cumulative impacts of such development on the equitable distribution of water and on the health of the aquatic environment, is significant.

1.4.3. Draft Water Resources Law

A present draft of water resources law is under the process of preparing. Its objective bases on the reason that even there are many water related laws existed but there is no one in the principle of providing a set of tools for effectively managing water resources in an integrated way. This draft water resources law provides criteria and measures to ensure people basic rights to access to water for domestic use and also to ensure control of water uses, good management, sustainable and efficient use, development, protection, rehabilitation, and conservation including prevention and mitigation of flood and shortages. It also states formulation of water resources fund and river basin fund, decentralization and participation of the people at the river basin, and the establishment of water organizations at the national, river basin, and sub-basin levels inclusive of water user organizations.

1.5. Goals and programs

At present strategic plan is developed to achieve the goals of the national water policy. Under such strategic plan priority is given to access for rural people to clean and safe drinking water. This is an aim that has included the Millennium Development Goals and Johannesburg Plan of Implementation into its core program. Together with a government policy, a goal of increasing village water supplies from 85 per cent to 100 per cent by 2008 is Thailand's greatest challenge in meeting basic needs for all people in the water sector. These challenges can be met owing to the close collaboration that exists between villagers and government agencies, with many village water supply systems now being managed successfully by local committees. One requirement is the need to reduce physical, chemical or bacteriological water quality problems that still exist in some of the systems. In this regard indicators must be set for assessing the situation.

1.5.1. National goals and programs currently in progress

On 25 July 2000, the national water vision, policy and other corresponding details were endorsed by the cabinet. The national water policy can be cited as follows:

1) Accelerate the promulgation of the Draft Water Act to be the framework for national water management by reviewing the draft and implementing all necessary steps to have the act effective, including reviewing existing laws and regulations.

2) Create water management organizations both at national and river basin levels with supportive laws. The national organization is responsible for formulating national policies, monitoring and coordinating activities to fulfill the set policies. The river basin organizations are responsible for preparing water management plans through a participatory approach.

3) Emphasize suitable and equitable water allocation for all water use sectors, and fulfill basic water requirements in agriculture and domestic uses. This will be accomplished by establishing efficient and sustainable individual river basin water use priorities under clear water allocation criteria, incorporating beneficiaries' cost sharing based on ability to pay and level services.

4) Formulate clear directions for raw water provision and development compatible with the basins' potentials and demands, and ensuring suitable quality while conserving the natural resources and maintaining the environment.

5) Provide and develop raw water resources for farmers extensively and equitably in response to water demand for sustainable agricultural and domestic uses, similar to deliveries of other government basic infrastructure services.

6) Include water related topics at all levels of educational curriculum so as to create awareness for water value, understanding the importance of efficient water utilization, necessity and responsibility in maintaining natural and man made water sources.

7) Promote and support participation, including clear identification of its procedures, clear guidelines on right and responsibility of the public, non-government and government organizations in efficient water management. The water management includes water utilization, water source conservation, monitoring and preservation of water quality.

8) Accelerate preparation of plans for flood and drought protections, including warning, damage control and rehabilitation efficiently and equitably with proper utilization of land and other natural resources.

9) Provide sufficient and sustainable financial support for action programs in line with the national policy, including water related research public relations, information collection and technology transfer to public.

At present, the national water policy is under the process of reviewing and assessing.

1.5.2. Progress in Achieving Millennium Development Goals

The government's target in achieving the Millennium Development Goals has been implemented in relevant to water resources management. To increase the opportunity for people to access to safe water, provision of safe water from village water supply system for all people in every village in Thailand has been carried out. At the time being, there are altogether seventy four thousands three hundred ninety eight (74,398) villages in Thailand; sixty three thousands seven hundred ninety six (63,796) villages have been provided with village water supply systems; ten thousand six hundred and two (10,602) villages are still need the village water supply systems. Within three-year from 2006 to 2008, the Department of Water Resources will manage to provide the village water supply system to all remaining villages.

Thailand will achieve most if not all of the MDGs well in advance of 2015. Poverty has already been reduced by two thirds since 1990. The proportion of underweight children has fallen by nearly half. Universal access to primary school education is likely to be achieved within a few years. Malaria is no longer a problem in most of the country. Yearly new HIV infections have been reduced by over 80 per cent since 1991, the peak of the epidemic. Great strides are being made towards gender equality.

On goal 7 environmental sustainability, it is stated that to stop the unsustainable exploitation of natural resources and to halve the proportion of people who are unable to reach or afford safe drinking water by 2015. According to Thailand's water program, it aims to serve the population in every village of the rural areas with safe domestic pipe water supply by 2008. This will in turn enhance an implementation in meeting the MDGs to halve the proportion of people who are unable to reach or afford safe drinking water by 2015 and this goal will be over successfully achieved by then. The next step that should be done is to improve the quality of water in the rural pipe system to the level of the system in Bangkok.

In its attempt to stop the unsustainable exploitation of natural resources, Thailand's law enforcement and implementation are duly practices. The indicators that have been monitored show that this goal is likely be achieved in 2015 because at present, there is a good trend in all indicators, which are proportion of forest to land area, proportion of biodiversity protected area to total land area, proportion of energy use to GDP, proportion of CO_2 emission to population, consumption of ozone-depleting CFCs, and proportion of solid fuel use to population.

Resettlement for slum dweller in big cities and rural areas are gradually upgraded. In general, more than 90 per cent of Thai population own lease or rent their houses. With the exception of Bangkok and its vicinity, and industrial areas that serve as temporary residences for education and employment, most Thais own their own houses. In 2000 one-third of people who live in Bangkok and 16 per cent of population in Central region which is industrial area live in rented houses. Housing structures are in good condition with only 7 per cent of the population living in houses built with non-permanent materials.

In 2000 survey, 4,860 low-income communities (that is 1.37 million households or 6.8 million inhabitants) lived in congested areas. This represented 27 percent of urban population. About one-third were located in Bangkok and its vicinity. The Government has initiated many measures that promote partnerships with these people to develop their communities. The Government has recently launched several housing projects for low-income earners, including one that aims to build one million units of houses.

1.6. Management Approaches (Resource, Quality, Disasters, Environmental, Knowledge)

1.6.1. Demand Management

As the trend on water shortage is higher in Thailand, efficient water utilization is also emphasized. The computerized technology on Supervisory Control and Data Acquisition (SCADA) to control water gate was initiated by the Royal Irrigation Department. This could help the distribution system to the irrigated areas more effectively and reduce water loss during the process. Water user groups in irrigated land are promoted for facilitating such distribution system. In order to increase efficiency for water use in the industry, business and commercial sectors water price is applied. The industrial factories have to pay 0.125 USD per cubic meter for raw pipe water. In case of using water from groundwater facilities, users have to pay 0.75 – 0.425 USD per cubic meter.

Economical use of water supply system has been continuously campaigned and controlling of leakage from the system is operated. Recycling in industrial use has been introduced and actively undergone.

1.6.2. Stakeholder Participation

Stakeholder participation in Thailand has been practiced in Royal Development Projects since 1952. Many of these projects include participatory approach in forest protection,

reforestation, rehabilitation of water sources in high-elevated areas, and land use planning. Study in this area can be demonstrated in many Royal Development Centers. One of the centers in the North of Thailand is a very good example. The project site locates in Chiang Mai of the Ping River Basin for the upper forest rehabilitation. The forest in the upper part was studied and has been rehabilitated to benefit both as economic goods and as environmental conservation. In the reservoir, fishery is developed and other agricultural projects in surrounding areas are also studied and developed. The project demonstrates to the farmers the way such development can be replicated. At the same time, the government agencies have developed projects that would serve the purpose of sustainability development. (Office of the Royal Development Project Board, 2005)

The Constitution is the major drive for stakeholder participation. Another milestone in participation history was many technical assistance projects contributed by international organizations both governmental and NGOs. In water sector the RBCs establishment is a very important step in involving stakeholders and empowering people in water resources management in a river basin context. The national water policy was formulated in 2000 where integrated water resources management was adopted and stakeholder participation in water management was encouraged.

1.7. Policy Implementation, Financial Resources, Planning Process and Human Resources

At the national level, the vision and the national policy in water resources management were formulated in 2000 and an improvement of budgeting system in water resources sector is introduced. From 2003 the proportion of budget has been set in three categories, which are management, supply and development, and water efficiency enhancement. The budget allocated for an investment in water sector during 2001-2005 equals to US$ 950.40, 912.73, 905.66, 740.48, and 600.37 million respectively (Department of Water Resources, 2003). A decreasing amount does not mean that this sector gets less attention but it is because of reallocating or the shift of the amount to be allocated by the cabinet or emergency use.

In 2005 the government announced to invest in its four years plan with its mega project where water resource is the priority. This means the government will provide budget to the level that should be sufficient for investment in water sector and it will be integrated under the plan that link from upper watershed to downstream areas. And in 2006, an integrated plan for water resources management for each river basin in Thailand is completed. This will help solving management problems mentioned in 1.1.

During 2000-2005 many exercises in empowering and delegating stakeholders and people in communities through the RBCs have been introduced. Take for example, RBCs' members take part in formulation of an integrated plan for water resources management in their river basins, they also involve in approving the projects created from people's need to submit to the agencies concern for budget allocation and hence implementation. However, a restriction in budget allocated for managing the RBCs is still a bottleneck and the government manpower to support the objective of promoting RBCs' business are still limited and most of them need a well design training program to strengthen their capacity

1.8. Implementation of an integrated water resources management (IWRM)

In Thailand even a national IWRM plan has not been formulated but it is widely practiced at all level especially at the river basin level. Improving enabled environment for IWRM has been implemented take for example an establishment of the NWRC and RBCs as the institutions that are responsible for IWRM at the national and river basin levels, a new draft water resources law, which encompasses a unified water resources management has been drafted. Planning process for each river basin has been done on a principle of grass root level

participation through the RBC mechanism and in 2005 an integrated plan for water resources management for each river basin in Thailand is completed. An integration of different strategies for the areas from upstream to downstream of the river basin has been introduced and practiced. In the upper watershed area, land and water conservation is the center of the strategy while in low land and floodplain area it focuses around water allocation for various purposes of use, maintaining good quality of water, delivering efficient services to users, mitigating water related disaster. For large scale project such as big dam construction, it has to go through public hearing process.

1.9. Indicators

Management is not a tangible element, indicators in this area can be determined such as the measurement on how effective an apex body (NWRC) and RBCs. Therefore performance indicator should be developed for example indicators could be divided into 3 areas which reflect in the organization's mandate, activities and effectiveness. Under each area for example an active organization, indicators could be regularity of meetings, members that attend the meetings and their participating, and regularity of policy review. For each indicator, written description is needed and to compare the progress, it should be done qualitatively. These indicators for NWRC already exist in a project called Benchmarking of National Water Sector Apex Bodies Performance through a Peer Review Process sponsored by Asian Development Bank (ADB).

1.10. Conclusions

Thailand experiences show that even there has been considerable improvement in water governing, some problems still exist especially at the river basin level. To solve it and to effectively manage water resources cooperation from local stakeholders is an important factor and to enhance it, interdisciplinary skill must be applied in dealing with these stakeholders. When local participation is considered it does not mean only programming projects and consulting to these people after these projects have been planned. The participatory process has to begin with asking the local people of what are their needs and designing the projects according to it. Therefore, this will take time and to some extent it will hinder an effort of the government officials. However, it is the most important part of securing the projects in water resources to be effective and sustain and this can be the first priority in water governance.

1.11. References

1. Department of Water Resources, Ministry of Natural Resources and Environment, *Annual Report 2003 and 2004.*

2. Department of Water Resources, Ministry of Natural Resources and Environment, *Department of Water Resources and Its Role in Thailand's Water Management 2003.*

3. Office of the National Economics and Social Development Board and United Nations Country Team in Thailand. *Thailand Millennium Development Goals Report 2004.*

1.12. Recommended Reading

1. Office of the Royal Development Project Board
(http://www.rdpb.go.th/main.asp?lang=EN)
2. United Nations Development Programme, Thailand Office
(http://hdr.undp.org/reports/global/2003/)

B- THE RESOURCE

2. Water resources of Thailand

2.1. Hydrology (variation in time and space)

2.1.1. Spatial variance of water availability

2.1.1.1. Surface water

Table 5 Hydrological characteristics of 25 main river basin in Thailand

Name of Major River	Catchment Area (km^2)	Rainfall (mm)			Average Annual Runoff (mm)			
		Wet	Dry	Total	Total	Per capita	Wet (%)	Dry (%)
Salawin	19,104	997	243	1,241	9,424	20,661	73.5	26.5
Mae Khong	57,176	1,037	299	1,336	25,100	4,181	92	8
Kok	7,294	953	268	1,221	3,991	4,987	72.7	27.3
Shi	49,128	821	295	1,242	10,658	1,596	85.7	14.3
Mun	71,061	946	296	1,116	17,244	1,707	88.9	11.1
Ping	34,545	838	226	1,064	9,179	3,647	76.6	23.4
Wang	10,794	804	242	1,046	1,763	2,603	85	15
Yom	24,046	874	233	1,107	6,202	2,803	88	12
Nan	34,682	955	287	1,242	12,216	4,708	87.2	12.8
Chao Phraya	20,523	923	159	1,082	3,415	291	95.7	4.3
Sakaekrang	4,907	771	263	1,034	1,153	4,441	79.3	20.7
Pasak	15,630	808	302	1,110	5,554	3,525	86.9	13.1
Thachin	13,477	999	314	1,313	2,138	1,051	91.6	8.4
Mae Klong	30,177	1,094	300	1,394	17,980	8,362	84.5	15.5
Prachinburi	9,652	1,212	413	1,625	4,808	5,647	92.4	7.6
Bang Pakong	10,708	807	248	1,055	1,363	1,158	92.2	7.8
Tonglesap	4,093	1,125	415	1,540	2,386	7,668	83.7	16.3
East Coast	13,093	1,395	504	1,899	8,908	6,592	88	12
Phetchaburi	6,250	871	180	1,051	989	2,077	70.5	29.5
Prachuap Khiri Khan Coast	7,097	1,087	442	1,529	1,589	2,831	89.9	10.1
South East Coast	26,023	1,061	861	1,921	20,600	5,567	81.3	18.7
Ta Pi	13,452	810	826	1,636	10,305	7,966	91	9
Songkhla Lake	8,484	1,579	579	2,158	6,956	5,391	79.8	20.2
Pattani	3,685	1,155	696	1,851	2,780	6,954	76.1	23.9
South West Coast	18,937	1,105	1,968	3,073	31,222	16,962	85.9	14.1

Source: Department of Water Resources, 2005

2.1.1.2. Groundwater aquifers

1) Groundwater resources:

The groundwater system in Thailand is mainly recharged by rainfall and seepage from rivers. Previous preliminary hydrological balance studies of different regions of Thailand indicate that only about 12.5 percent to 18 percent of rainfall infiltrates the soils and only about 8.75 percent of rainfall reaches the aquifers. This estimate is however valid only for the basins under favorable geologic conditions such as those in the Northern Highlands, the Upper Central Plain and along the Gulf Coastal Plain. For the basin under unfavorable geologic

conditions such as in the Lower Central Plain where Bangkok Metropolitan Area is situated, about half of the area is covered by a thick marine clay, and in the Khorat plateau where its central part is covered by impervious soft shales, it is estimated that only about 5 percent to 6 percent of rainfall reaches the aquifers. These recharges are regarded as the safe yield of the aquifers.

The quantity and quality of groundwater vary according to local hydrological conditions. Usually large and high yielding aquifers occur in alluvium and terrace deposits. To lesser extent, groundwater also exists within crack formations in limestone, sand stones and some types of shales.

The definitive location of groundwater potential in the country is referred to in the main aquifers map of Thailand at 1:2,500,000 by Department of Mineral Resources in 1982. The groundwater yields, and its permissible yield is summarized in region in table 5. The largest sources of groundwater in Thailand are found in the Lower Central Plain, especially in Bangkok and surrounding provinces.

Table 6 Groundwater yield of important basins and permissible yield

No.	Groundwater basin	Region	Yield (million m^3/yr)	Permissible Yield (million m^3/yr)
1	Chiang Mai – Lam Phun Basin	North	485	97
2	Lam Pang Basin	North	295	59
3	Chiang Mai – Phayao Basin	North	212	42
4	Phrae Basin	North	160	32
5	Nan Basin	North	200	40
6	Upper Chao Phraya Basin	Central	6,400	1,280
7	Lower Chao Phraya Basin	Central	6,470	1,294
8	Surat Thani Basin	South	320	64
9	Nakhon Srithamarat Basin	South	420	84
10	Ranong – Songkhla Basin	South	400	80
11	Hat Yai Basin	South	175	35
12	Pattani Basin	South	340	68
Total			**15,877**	**3,175**

Source : Department of Groundwater Resources, 2004

Besides the Chao Phraya basin, groundwater is also found in the north in Chiang Mai and Lampang provinces. Groundwater is also found along the Mekong river bank in the north-east such as Nongkhai and Nakhon Phanom provinces. In the southern part, groundwater can be found along east coast adjacent to the Gulf of Thailand. In Thailand, groundwater is widely used for urban and rural domestic water supply and also for agriculture and industrial purposes. Groundwater investigation and development for village water supply has been extended to all over the country since 1964. Starting from 1982 up to 2002, more than 200,000 wells have been drilled for rural domestic water supply.

The permissible yield of the aquifer in the Bangkok Metropolitan and surrounding area is estimated to be 1.25 million m^3/d (Department of Mineral Resources, 2000). The actual extraction in the same area by far exceeds the permissible yield by more than twice causing a rapid decline in a land subsidence of about 10 – 14 cm/yr in the eastern and southern suburban areas of Bangkok. The land subsidence of more than 1 m has occurred since 1970 and the present ground level is nearly at the mean sea level. Another serious result of the over-pumping of the Bangkok aquifer is the seawater intrusion. Number of artisian wells and water quantity in Bangkok and its vicinities is shown in table 6.

Table 7 Number of artesian wells and water quantity in Bangkok and vicinities

Province	1999		2000		2001		2002		2003	
	No. of well	Water quantity (Cu.m/day)	No. of well	Water quantity (Cu.m/day)	No. of well	Water quantity (Cu.m/day)	No. of well	Water quantity (Cu.m/day)	No. of well	Water quantity (Cu.m/day)
Total	8,352	2,115,113	8,252	2,213,676	8,581	2,184,936	8,562	1,983,472	8,691	1,897,088
Bangkok	1,411	351,634	1,558	490,448	1,796	485,375	959	210,451	964	210,960
Samut Prakan	1,928	501,551	2,067	510,411	2,067	510,411	2,163	505,333	2,146	501,730
Samut Sakhon	1,394	310,897	1,104	259,876	1,209	270,356	1,370	295,431	1,593	336,290
Pathum Thani	1,698	508,638	1,585	494,320	1,526	479,410	1,816	489,674	1,806	377,290
Phra Nakhon Si Ayutthaya	724	188,691	891	235,511	903	236,004	952	228,914	952	228,262
Nakhon Pathom	709	154,064	546	118,854	629	131,133	840	170,073	765	158,620
Nonthaburi	488	99,638	501	104,256	451	72,247	462	83,596	465	83,936

Note : 1.Excluding number and quantity of artesian well on government section.

2. The water quality is only to be allowed.

Source: National Statistical Office, 2000

To control groundwater activities, the Ground Water Act of Thailand was enacted in 1977 concerning drilling for groundwater and its use as well as disposal of wastewater into the aquifers though wells. Under the provisions of the Act, no one may utilize groundwater from designated groundwater areas without an official permit. At present, the Ground Water Act is implemented in specific areas where groundwater resources are critical with respect to water quality or overexploitation. An action plan to progressively reduce abstraction has been introduced and implemented since 1983.

2) Groundwater quality problems

In general the quality of groundwater in Thailand depends largely on the type of alluvial deposits, and rocks where it originates. The main problems in groundwater quality are high concentrations of chloride, sulfate, iron, nitrate and fluoride (Ramnarong, 1985). The majority of deep groundwater in the Korat Plateau in the North-east of Thailand is highly saline due to the existence of rocksalt.

The highest chloride concentrations of sodium chloride water type vary from 2,000-10,000 mg/l. This saline water is generally found in low lying areas in the middle of the southern basin of the Korat Plateau such as Nakhon Ratchsima and Chaiyaphum provinces. However, fresh groundwater is also found in shallow aquifer at higher elevations.

The concentration of calcium in the groundwater of Korat plateau varies from place to place depending on the distribution of the sources of gypsum and calcium mineral. The concentration of calcium is generally within the limit of drinking water standards.

Dissolved iron in groundwater in consolidated rocks in the North-east and in other parts of the country ranges from 0.3 mg/l to over 100 mg/l. Most of the groundwater especially in the North – east has iron concentrations over the limit of drinking water standard of the World Health Organization (WHO).

High nitrate concentrations in the North – eastern region are mostly found in shallow aquifers due to heavy use of fertilizers. These concentrations range from 10mg/l to about 1,180 mg/l. Groundwater in the eastern part of Thailand such in Chonburi province has significant concentrations of fluoride contents up to 1.5 mg/l exceeding as an essential constituent of drinking water regarding particularly to the prevention of dental caries in children but excessive concentrations may give dental fluorosis and skeleton damages.

A study of the hydrochemical data pertaining to groundwater of Bangkok deltaic areas and the peninsular coastal aquifers reveals that salt water encroachment could be observed in the heavily pumped aquifers. The heavy pumpage in coastal regions especially in Bangkok and adjacent areas is about 1.3 million m^3/d. Such quantity by far exceeds the natural recharge of the aquifers. The depletion of groundwater due to long-time heavy pumping has caused rapid decline in peizometric heads to more than 50 m .This decline results in salt-water encroachment occurs at an alarming rate of 500 m/yr in the 150 m deep aquifer. The chloride concentrations have risen from 10 mg/l to more than 600 mg/l in the past nine years. This results in the abandonment of hundreds of wells in the southern part of Bangkok and Samut Prakarn provinces.

2.1.2. Spatial variance of water quality

Surface water quality standards were established under the Act in 1994 and were issued as National Environment Board's Notification into 5 classes depending on different beneficial uses.

- Class 1 Extra Clean for conservation purposes (under natural condition)

- Class 2 Very Clean used for (1) consumption which requires ordinary water treatment processes (2) aquatic organism conservation (3) fisheries, and (4) recreation [for example, DO>6mg/L, BOD>1.5mg/L, Fecal Bacteria < 1,000 MPN/100ml]

- Class 3 Medium Clean used for (1) consumption but passing through an ordinary treatment process and (2) agriculture for example, DO>4mg/L, Fecal Bacteria <4000 MPN/100ml)

- Class 4 Fairly Clean used for (1) consumption, but requires special treatment process and (2) industry (for example, DO>2 mg/L, BOD <4mg/L)

- Class 5 Water are not classification in class 1-4 and used for navigation (non water quality parameters requirement)

Water quality in the main rivers of the North (Ping, Wang, Yom, and Nan) generally remains in good condition especially in the upstream flow from northern mountains. Main rivers in the Northeast, which are Pong, Chi, and Mun are mainly good only the Pong, which is in fair condition. Rivers in central region are quite deteriorated especially in high densely populated areas around the four main rivers, which are the Chao Phraya, Tha Chin, Mae Klong, and Bang Pakong. In the South, which is different in geographic and climatic features, rivers are originated from mountains and are relatively shorter. Fortunately, longer period of rainy season contributes to the good quality of main rivers. Map of Thailand surface water quality can be seen in Figure 5.

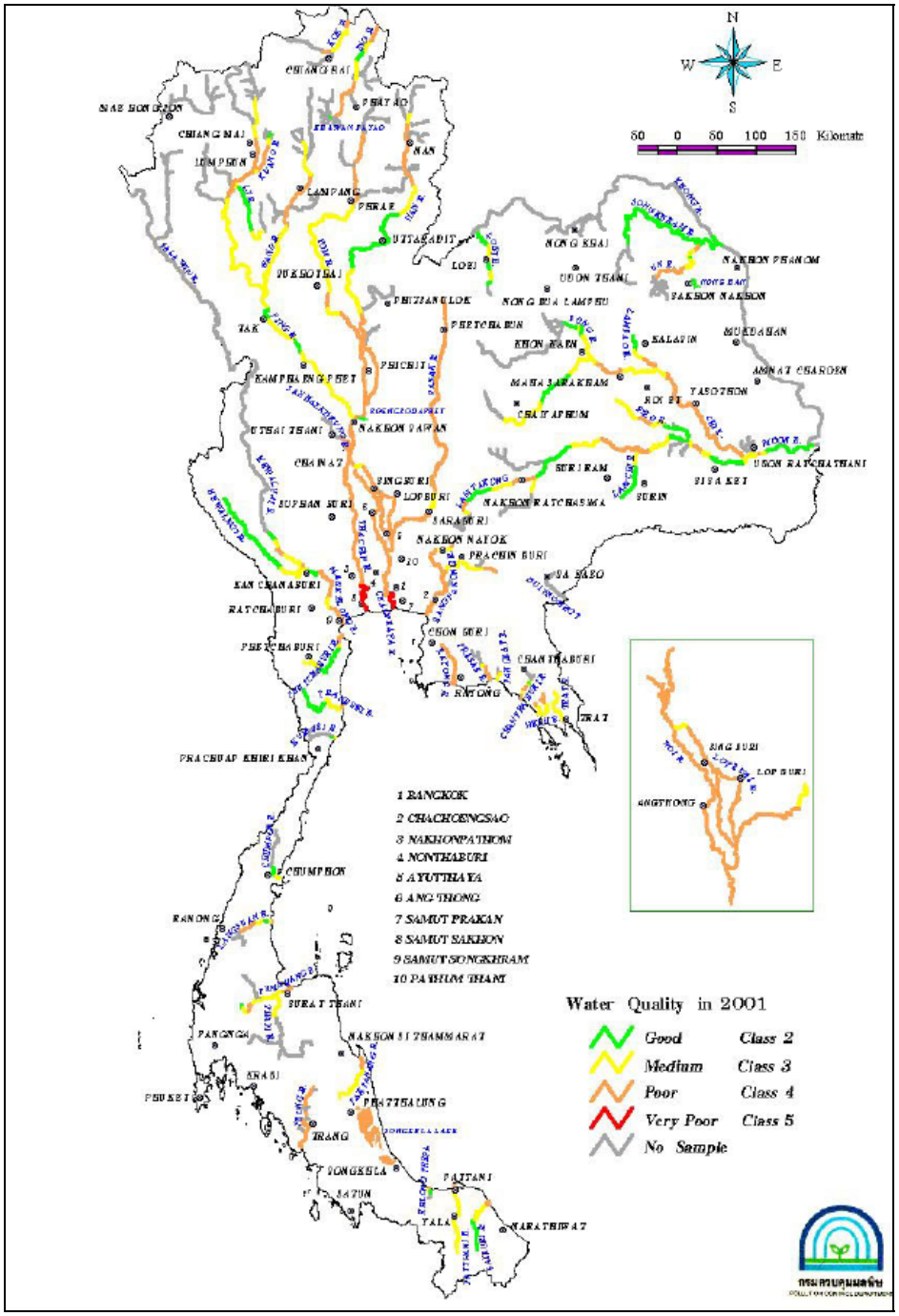

Figure 5 Thailand Surface Water Quality in 2001 (Pollution Control Department, 2005)

2.2. Data and information on water resources

2.2.1. Availability of hydrological and meteorological observation stations

2.2.1.1. Observed climatic variation and long term projections

In Thailand an effect of climate change is realized toward many dimensions. The 2000 National Climate Change Action Plan for Thailand revealed that field data on Thailand's average monthly rainfall, average annual level of water in major dams, and annual mean sea level, have been compiled and presented simply to reflect changes during 1960 – 1996 regarding these parameters. However, more investigation needed to be done before a conclusion on this matter is made. It was also stated that in 2000 the sea level records in 3

coastal areas, namely Bangkok bay, eastern coast, and southern coast showed a definite upward trend. Such trend would increase the severity of salt-water intrusion problem to the area, thus potentially lowering agricultural productivity and changed land-use patterns. The influence of predicted climate change might also affect the coastal zone, in making it vulnerable to the occurrence of more rapid erosion processes than would be normal.

Although there is a possibility that changes in rainfall patterns, sea level and coastal erosion, are caused by or related to climate change, it is still extremely difficult to come to a distinct conclusion about the truth of such an assumption in an empirical context. Whether these changes reflect "real" impacts of climate change to date for Thailand is not clear, however. The data displayed in the report are solely for presenting the possible changes. Thailand, like many other developing countries, still needs time and greater expertise, including development of local models, for an issue as controversial as climate change to be resolved. In 2006, Thailand is reviewing its guideline for implementing the international agreements to manage climate change.

2.2.1.2. Hydrological observation stations

Station relates to water in Thailand divides into measurement of meteorology, rain-gauge, water level, water level and flow, sedimentation, meteo-hydrology, and water quality with total number of 4,352 stations through out the country, responsible by more than 6 agencies. There is an attempt to readjust them into the network that can work more efficiently.

2.2.2. Human impacts on water resources

2.2.2.1. Through Surface Cover (Type of Vegetation)

Vegetation in Thailand diverse into many varieties, rice is the most uses of irrigated water and it covers large areas of irrigated land as shown in Table 7 and other major field crops are also shown in Table 7.

Table 8 Land utilization of 25 major rivers in Thailand

Name of Major River	Land Utilization (km^2)								
	Rice		Field crop		Fruits		Fish pond		Forest
	Non-irrigate	Irrigate	Non-irrigate	Irrigate	Non-irrigate	Irrigate	Non-irrigate	Irrigate	
Northern									
Salawin	414.01	10.98	2,202.83	28.73	20.8	0	0	0	15,764.99
Kok	938.47	101.93	2,290.27	25.18	62.7	5.32	14.98	8.14	3,449.86
Ping	2,625.43	856.77	4,329.50	99.31	318.28	41.5	0.1	0	25,401.77
Wang	971.48	124.18	1,355.86	24.26	117.91	8.01	0	0.03	7,425.50
Yom	5,571.08	1,095.81	3,345.67	462.26	105.01	4.91	0	0	12,740.24
Nan	5,041.83	1,462.33	9,910.91	169.39	474.4	27.91	0.09	0	14,041.27
Total	15,562.29	3,651.99	23,435.04	809.14	1,099.09	87.66	15.18	8.16	78,823.63
North-Eastern									
Mae Khong	17,795.99	838.82	14,616.92	76.45	305.39	4.38	50.69	46.17	20,473.59
Shi	18,708.21	1,253.61	11,400.83	189.09	98.89	5.32	0	0	15,084.90
Mun	36,391.34	1,265.56	13,303.61	162.92	61.09	4.94	0.13	0	15,936.25
Total	72,895.54	3,357.98	39,321.36	428.45	465.37	14.63	50.82	46.17	51,494.73
Central									
Chao Phraya	1,145.84	7,422.23	1,464.86	193.9	272.87	572.85	273.22	400.57	279.81
Sakaekrang	824	0	1,775.00	0	0	0	0	0	778
Pasak	688.85	240.03	3,354.23	27.21	35.47	0.01	0.48	0	749.17
Thachin	1,577.76	4,463.28	2,160.49	1,266.15	46.57	631.41	80.31	25.26	424.82
Mae Klong	452.86	1,004.33	5,766.22	254.32	234.65	331.6	35.4	8.53	11,630.33
Petchaburi	307.84	766.12	1,098.95	48.42	123.82	107.51	54.8	33.05	3,532.23
Prachuap Khiri Khan Coast	108	61.63	1,261.74	267.68	1,482.87	38.4	12.91	0	3,500.21
Total	5,105.15	13,957.62	16,881.49	2,057.69	2,196.25	1,681.77	457.12	467.41	20,894.56
Eastern									
Prachinburi	1,650.25	692.28	2,831.83	10.62	215.74	7.37	0	0	4,107.10
Bangpakong	1,146.54	1,864.63	3,030.77	37.02	145.28	31.82	22.59	8.62	1,958.30
Tonglesap	706.44	0	999.59	0	137.75	0	0	0	1,999.98
East Coast	784.23	157.28	4,301.45	26.06	3,487.41	40.4	245.78	1.46	2,706.88
Total	4,287.47	2,714.20	11,163.64	73.7	3,986.18	79.59	268.37	10.08	10,772.26
Southern									
South East Coast	2,080.49	2,048.08	554.21	202.03	7,317.25	1,156.15	99.82	0.55	9,008.61
Ta Pi	629.86	47.75	665.35	7.95	4,816.07	151.6	0	0	2,977.68
Songkhla Lake	1,240.58	761.08	72.64	32.53	1,400.26	142	0	0	1,201.44
Pattani	65.22	123.31	11.56	5.97	1,803.05	207.96	0	0	1,586.63
South West Coast	908.43	189.15	423.17	15.81	4,158.94	394.57	0.04	0	7,956.70
Total	4,924.58	3,169.37	1,726.93	264.29	19,495.58	2,052.28	99.86	0.55	22,731.07
Total	102,775.02	26,851.17	92,528.46	3,633.28	27,242.46	3,915.94	891.34	532.38	184,716.25

Source: **Office of Agricultural Economics, Ministry of Agriculture and Co-operatives, 2004**

Table 9 Statistics of major crops cultivation by crop: crop year 2000/01-2002/03

Crop	2000/01	2001/02	2002/03	2000/01	20001/02	20002/03
	Planted area (rai)			**Harvested area (rai)**		
Cassava	7,405,971	6,223,864	6,223,864	7,068,388	6,176,376	6,176,376
Maize	7,866,272	7,685,121	7,317,055	7,647,263	7,474,133	7,166,679
Pineapple	624,754	n/a	503,932	610,552	552,456	496,664
Soybean	1,396,088	1,154,383	1,130,047	1,343,839	1,102,786	1,092,740
Mung bean	1,898,939	1,891,949	1,830,734	1,801,339	1,845,709	1,709,267
Sorghum	574,811	534,844	460,193	533,899	520,810	446,676
Groundnut	1,403,563	521,070	448,241	1,351,172	510,743	430,476
Kenaf	109,752	208,485	152,996	102,290	203,512	148,793
	Production (ton)			**Average yield (kg/rai)**		
Cassava	19,064,284	16,868,308	16,868,308	2,697	2,731	2,731
Maize	4,461,716	4,466,174	4,229,975	583	598	590
Pineapple	2,248,375	1,978,822	1,738,833	3,683	3,582	3,451
Soybean	312,432	260,696	259,863	232	236	238
Mung bean	232,861	237,672	216,315	129	129	127
Sorghum	147,825	144,624	131,716	277	278	295
Groundnut	313,346	128,816	112,149	232	252	261
Kenaf	28,643	55,968	41,372	280	275	278

Note: 1. Average yield per rai means production harvested area.

2. 6.25 rai = 1 ha

Source: Office of Agricultural Economics, Ministry of Agriculture and Co-operatives, 2004

2.2.2.2. Through Dams and Diversions (Size, Storage Capacity etc)

New water storage has been build to support rapidly rising water demand. Recent irrigation projects are:

- The Pasak Cholasit Dam in Lopburi province (a zoned earth dam height 31.50 m, length 4,860 m) constructed from 1995 to 2002 (Economic Internal Rate of Return (EIRR) = 12.80 percent). Its main purpose is to store water for irrigating 21,600 ha and providing supplementary irrigation water for a lower Chao Phraya West Bank area of 320,000 ha. It also provides water for domestic use in metropolitan Bangkok and its vicinity, as well as providing flood protection for Lopburi and Saraburi provinces, promoting fisheries, transport waterways and water pollution control;

- The Khlong Tha Dan Dam in Nakhon Nayok province is a roller - compacted concrete structure with a height of 93.0 m, a length of 2,720 m and a capacity of 224 million m^3. Built from 1997 to 2004 (EIRR = 10.85 percent), its main purpose is to store water for irrigating an area of 29,600 ha, to provide flood control for the upper Nakhon Nayok basin, to reduce soil acidity and for domestic water supply of approximately 16.0 million m^3/year;

- Bang Pakong Diversion Dam, Chachoengsao province, is built of reinforced concrete, at a length of 166.0 m with a gate electronically controlled by computer. Built from 1996 to 2001 (EIRR value of JICA study is outdated), its main purpose is to provide water storage for irrigating 14,720 ha, providing protection from salinity intrusion,

for fisheries, and domestic water supply of 18.90 million m^3/year, 69.70 million m^3/year for industrial use and to maintain waterway levels and clearance for local transport;

- Pak Phanang Diversion Dam, Nakhon Si Thammarat Province, built from 1995 to 2002 (EIRR = 13 percent) has as its main objective salinity control, storage of 70 million m^3 of fresh water, irrigating 83 360 ha, providing flood protection in the Pak Phanang basin, reducing soil acidity and managing freshwater and saltwater irrigation areas;

- The Kolok River Improvement Project in Narathiwat province, includes 30 breakwaters and groins of 750 m. Built from 1996 to 2002 (EIRR = 16.60 percent), its main purpose is protection of 22 km of shoreline, conservation of ocean resources in the economic zone, fisheries promotion, aquatic animal nurseries in the lower Kolok and Tak Bai rivers and flood protection in the lower Kolok Basin.

2.2.2.3. Pollutants

Water pollution from land-based activities is largely associated with urbanization, industrialization, and agricultural activities. Thus the major sources of pollution are domestic sewage, industrial wastes, and agricultural wastes. The main pollutants that pose to water quality problems are organic wastes, bacteria, nutrient, heavy metals, pesticides, and other chemical substances. The major water quality problems were high coliform bacteria (in term of total and fecal coliform bacteria, 34 %), total phosphorus (TP,15%), ammonia-nitrogen (NH-N, 6%), low dissolved oxygen (DO, 12 %), and high organic matter (in term of biochemical oxygen demand :BOD, 2 %), and nutrients (12 %) as shown in Figure 5 (Simachaya, 2002). Generally speaking, these problems were perceived to be most serious during summer low flow periods when there is minimal dilution capability available. Once water quality problems have been identified, it is necessary to develop targets for restoration to undertake the planning exercise on a basin-wide basis.

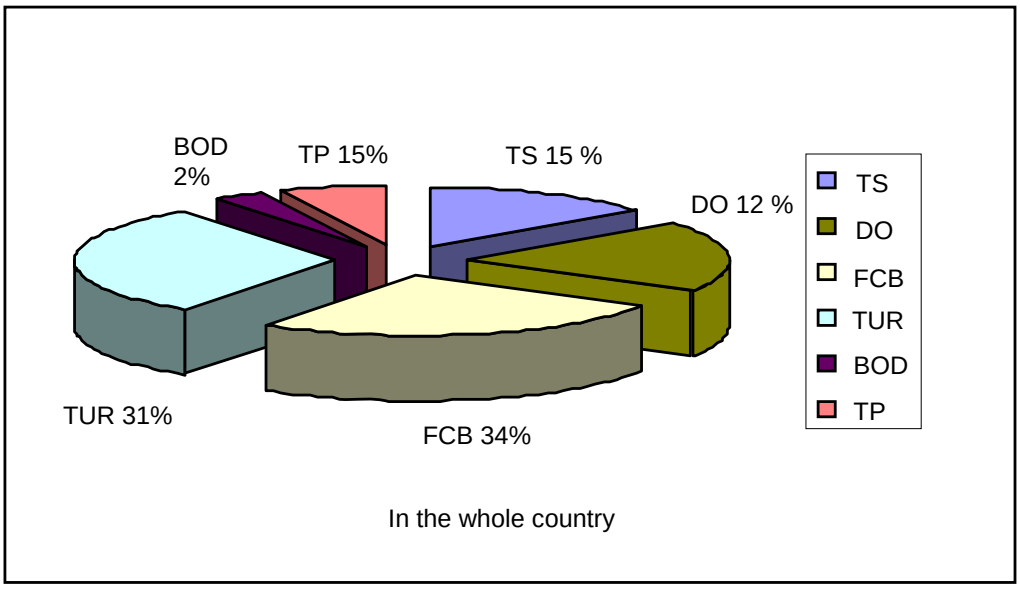

Figure 6 Water Quality Problems in Thailand's Surface Water in 2001

Source: Simachaya,2002

Note: FCB = Fecal Coliform Bacteria, TUR = Turbidity, DO = Dissolved Oxygen, TS = Total Solids, TP = Total Phosphorus, BOD = Biochemical Oxygen Demand

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C- CHALLENGES TO LIFE AND WELL-BEING

Challenge: Water and Health

Overview: The importance of a safe, reliable water supply and an effective sanitation system has been recognized in Thailand since King Rama V first foresaw the link with the prevention of disease in the early 19th century. The country had developed the sector for over 50 years and they first became an integral part of the National Economic and Social Development Plan, which began in 1961.

Since that time, there has been a marked increase in the socio-economic development and hence the quality of life of the Thai people, particularly in education and health. This has been reflected in a continuous upward trend in the Human Development Index, despite occasional setbacks due to economic conditions. Much of this success can be attributed to the successful implementation of community participation at the grassroots level, as a very strong facet of Thai culture.

Traditionally, some 5% of the national budget is allocated to water supply and sanitation and this has resulted in sufficient quantities of water being available to the population, although not always of a satisfactory quality due to a variety of environmental and behavioral factors and some unresolved management issues.

In 2002 in urban areas access to safe drinking water was accounted to 95 percent of the population, but in rural areas, which accounted for 85 percent of the population, there are still many quality problems particularly microbiological, and increasingly, chemical problems due to contamination of both ground and surface water sources. (Globalis, 2002)

Sanitation has also reached nearly universal coverage and is backed up by ongoing promotion of sanitary behaviors, but problems remain particularly with disposal of excreta and other solid and wastewater management issues again resulting in contamination of the water supply.

3. Water for basic needs and health

Thailand has high levels of access to safe drinking water as well as sanitation facilities. The MDG targets have been achieved. The proportion of population having access to safe drinking water increased from 80 percent to 94 percent from 1990 to 2000. Improvement was made in both urban and rural areas. The increase in access to safe drinking water was more prominent in rural areas rising 76 percent to 91 percent over the decade. The regional disparities that previously existed have been effectively closed.

3.1. Average water consumption per capita

Water use depends on available amount of water supply and it varies according to seasonal change. The 2002 Study on the 9th Master Plan on Water Management of the Royal Irrigation Department revealed the demand of water in 2002 for every purpose of use, which equals to 76,700 million m^3. The average water demand per capita per year then equals to 1,217.5 m^3 and water demand for domestic use alone is 55.9 m^3. According to the Bureau of Water Resources Policy and Planning of DWR, designed criteria for domestic water use are 50 and 150 liter/person/day in rural and urban areas respectively.

3.2. Quality and quantity of water

1. Access to safe drinking water and sanitation

It should be noted that in rural area although 91 percent of population have access to safe drinking water only 16.7 percent have access to piped water, which means they must rely on nature (rain water) and improved water storage. The proportion of households using bottled water also increased significantly from 9.7 percent to 24.5 percent between 1990 and 2000 – a result of higher income and prosperity. The population and housing census of the National Statistical Office in 1990 and 2000 shows an interesting figure of urban dwellers behavior in consuming drinking water. They prefer to drink bottle water more than pipe water even they have access to it and know that it is saved to drink.

2. Quality of drinking water

Surveys show that piped water in Bangkok meets official quality standards. However, those living in rural areas have slightly lower quality drinking water. For example, in the provinces 68 percent of piped water met physical standards and 87 percent met bacterial standards. (Department of Health, 2002)

Table 10 Access to safe drinking water by source, 1990 and 2000

Sources of drinking water	1990 (%)		2000 (%)	
	Urban	Rural	Urban	Rural
Total safe drinking water	96	76.4	97	91
Piped water	62.2	10.9	37	16.7
Rain water	11.6	35.9	15.8	50.8
Bottled water	17.4	2	39.8	9.2
Protected wells	4.8	27.6	4.4	14.3

Source: National Statistical Office, Population and Housing Census, 1990 and 2000

Data here in table 9 is cited from the last Population and Housing Census Survey in 2000, the next Survey will be in 2010. However, there is the other survey which called indicators for living necessity done by Community Development Department it was shown that in 2005 number of households for the whole country that access to save drinking water increased to 97 percent. (Website, http://www.cdd.go.th/bmn/bmn48/region_r.asp, in Thai only)

3.3. Existence of monitoring mechanisms and standards

According to the government's public sector management policy, which emphasizes the results-based management system, goals, targets and strategies of all government agencies are to be set up in response to the needs of people. As a result, the results-based budgeting system has been adopted since fiscal year 2003. And the related agencies have to revise their major programs according to their strategic plans, using key performance indicators (KPI) in the monitoring and evaluation of water services, sanitation and health development programs so as to meet the national development goals.

For health matter, in order that Ministry of Public Health (MoPH) 's monitoring and evaluation system is undertaken systematically in a unified manner, agencies relevant to program inspection and evaluation have been merged as the Bureau of Inspection and Evaluation under the MoPH's Office of the Inspector-Generals. The Bureau is assigned to be responsible for monitoring, inspection and evaluation of health programmes according to the mandate of the MoPH.

3.4. Basic services

3.4.1. Drinking and sanitation coverage (Actual and future targets)

In 2005 the number of households that access to save drinking water was 97 percent. Drinking water from pipe system will be covered for the whole country in 2008.

Between 1990 and 2000, the proportion of households using a sanitary latrine increased from 86 percent to 98 percent. In rural areas, access to quality sanitation increased from 83 percent to 97 percent. Regional gaps have been closed, except for a small proportion in the Southern provinces. In urban areas, access to latrines increased from 99 percent to 99.5 percent. Slum communities have also achieved 99 percent access, except for those in some southern provinces where the rate remained at 94 percent.

3.4.2. Affordability of water services

3.4.2.1. Provisions for poor and minorities

To increase the opportunity for people to access to safe water, provision of safe water from village water supply system for all people in every village in Thailand has been carried out. In 2005, there are altogether seventy four thousands three hundred ninety eight (74,398) villages in Thailand; sixty three thousands seven hundred ninety six (63,796) villages have been provided with village water supply systems; ten thousand six hundred and two (10,602) villages are still need the village water supply systems. Within three-year from 2006 to 2008, the Department of Water Resources will manage to provide the village water supply system to all remaining villages.

3.4.2.2. Social expectations

Construction of pipe water system for the rural poor is financially supported by the government, the process of construction is done by local administrative body and it has been managed by water user groups. Within such a system, the target set should be effectively achieved with an affordable price of water especially for the poor because local water user groups manage their own village water supply system.

3.5. Water related diseases

3.5.1.1. Public health problems with decreasing trends

Malaria Thailand has succeeded, to a certain extent, in its malaria control efforts, leading to a considerable reduction in incidence and mortality rates. However, in some regions particularly the Thai-Myanmar and Thai-Cambodian border areas, the problem remains critical, especially drug resistance. It is noted that during 1997-1999 the malaria incidence rose slightly but the mortality rate was stable. This phenomenon is postulated to be involved with the discontinuation of DDT spraying, EI Nino phenomena and the restructuring of communicable disease control programmes. As a result, Malaria Units were upgraded to be "Vector-borne Disease Control Units", which are extensively responsible for the prevention and control of dengue hemorrhagic fever, filariasis and encephalitis. In the beginning, there

might be some problems, but since 2000, the incidence and mortality rates have been declining. (Figure 7)

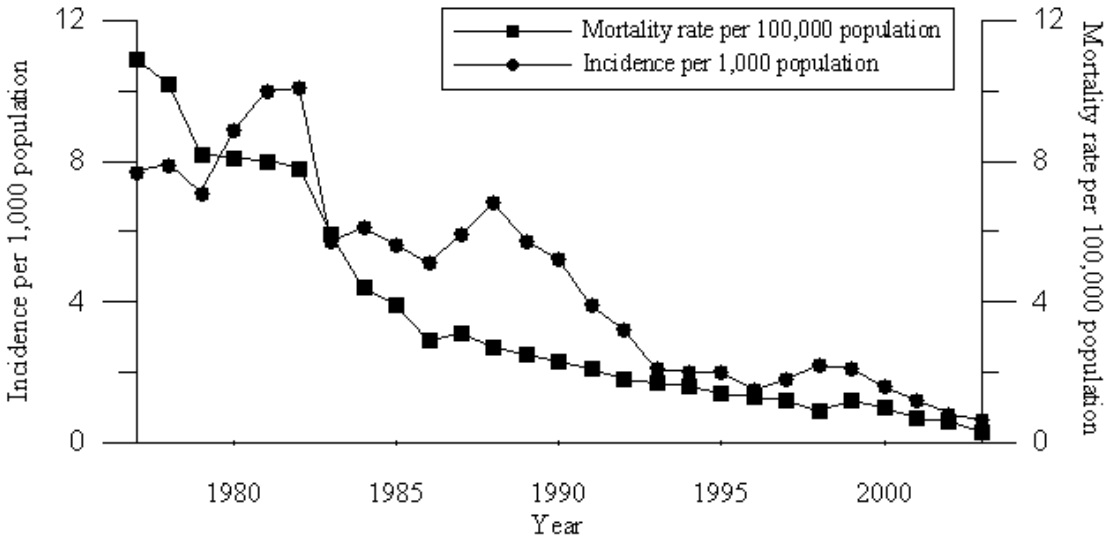

Figure 7 Incidence and mortality rate of malaria

Source: Ministry of public heath, 2005

Helminthiases: Overall, the prevalence of intestinal parasitic diseases has been declining, except for liver fluke whose prevalence is relatively increasing in the North (Table 10). A survey on liver fluke situation, using the modified Kato-Katz method of faecal examination, revealed that 90.6% of those who had liver fluke infestation had a parasitic egg count of less than 1,000 eggs per gram of faeces.

Table 11 Prevalence Rate of Common Helminthiases

Helminthiasis	Prevalence, percent			
	1981	1991	1996	2001
Hookworm diseae	40.56	27.69	21.6	11.4
Ascariasis (roundworm)	4.04	1.46	1.9	1.2
Trichuriasis (whipworm)	4.46	4.34	3.9	1.5
Liver fluke-whole country	14.7	15.2	11.8	9.6
-Liver fluke,Northeast	34.6	24.01	15.3	15.7
-Liver fluke,North	5.6	22.9	29.7	19.3

Source: Ministry of Public Health , 2005

3.5.1.2. Public Health Problems with Minimal Changes

Diarrhea: Acute diarrhea is still a crucial public health problem with a relatively slight change in incidence among both children and adults, particularly among children under five years of age whose incidence is higher than that in adults. A provincial health status survey revealed that the diarrhea incidence in children has been declining over the five years from 6.0 episodes/person/year in 1995 to 3.6 episodes/person/year in 2001. Nevertheless, the

incidence is still higher than the target of not exceeding 1 episode/person/year (Table 11). However, the mortality rate has been declining considerably due to improved health services and extensive coverage as well as the success of the campaign on Oral Rehydration Therapy (ORT). (Figure 7)

Table 12 Episodes of Illness with Diarrhea among Children under 5 Years of Age, 1995-2001

Illness (episodes/person/year)				
Type of areas	**1995**	**1996**	**2001**	**Target, 8th Plan**
Municipality	4.9	3.1	3.4	
Non-municipality	5.2	3.4	3.9	
Total	**6**	**3.4**	**3.6**	**Not exceeding 1**

Source: Ministry of public health, 2005

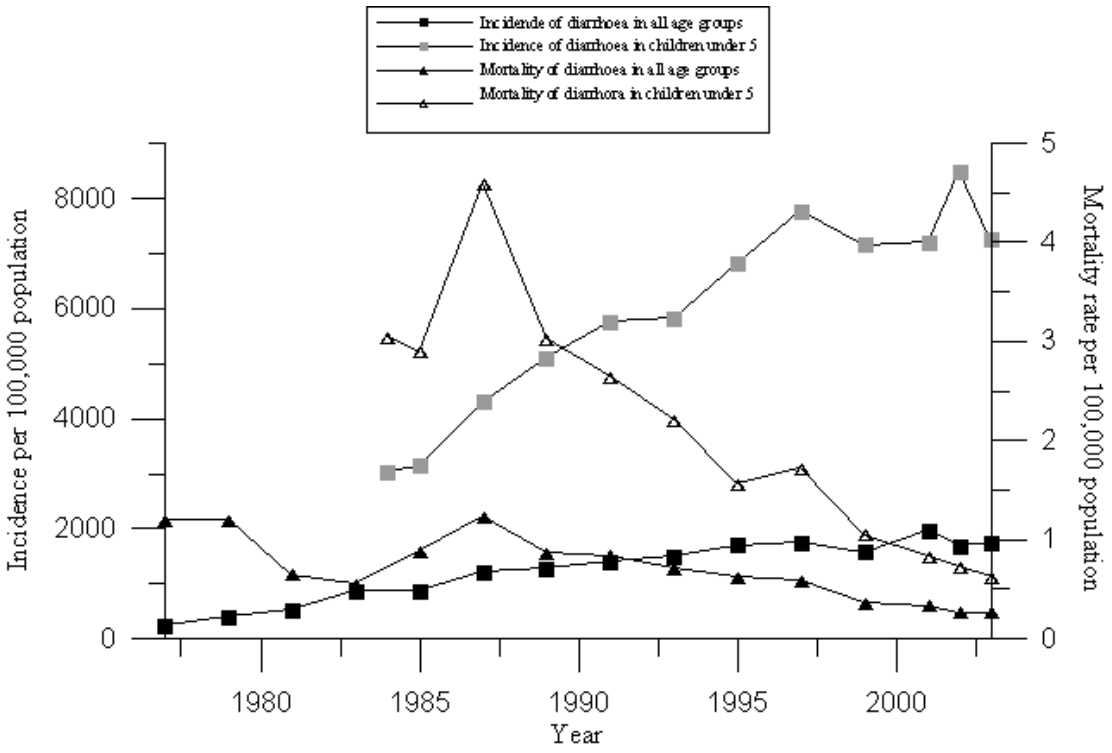

Figure 8 Incidence and mortality rate of diarrhea

Source: Ministry of public health, 2005

Dengue Haemorrhagic Fever: Dengue haemorrhagic fever has been a major public health problem of the country over the past 30 years without a declining trend. In particular, in 1997, 1998, 2001 and 2002, there was a rising trend with an epidemic occurring every two years. However, the DHF case-fatality rate has been declining (Figure 9 and 10).

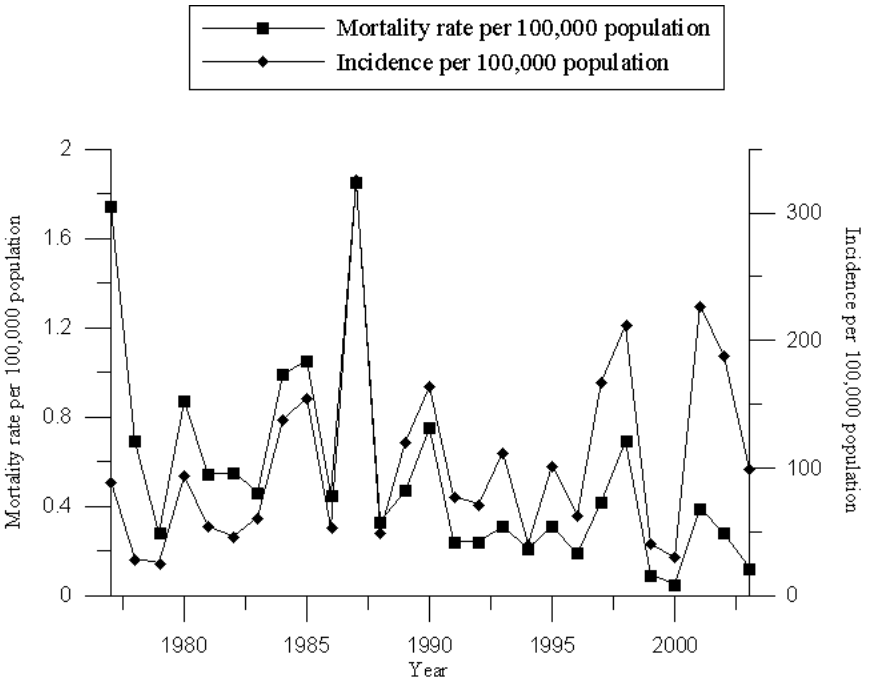

Figure 9 Incidence of mortality rate of Dengue Haemorragic Fever

Source: Ministry of public health, 2005

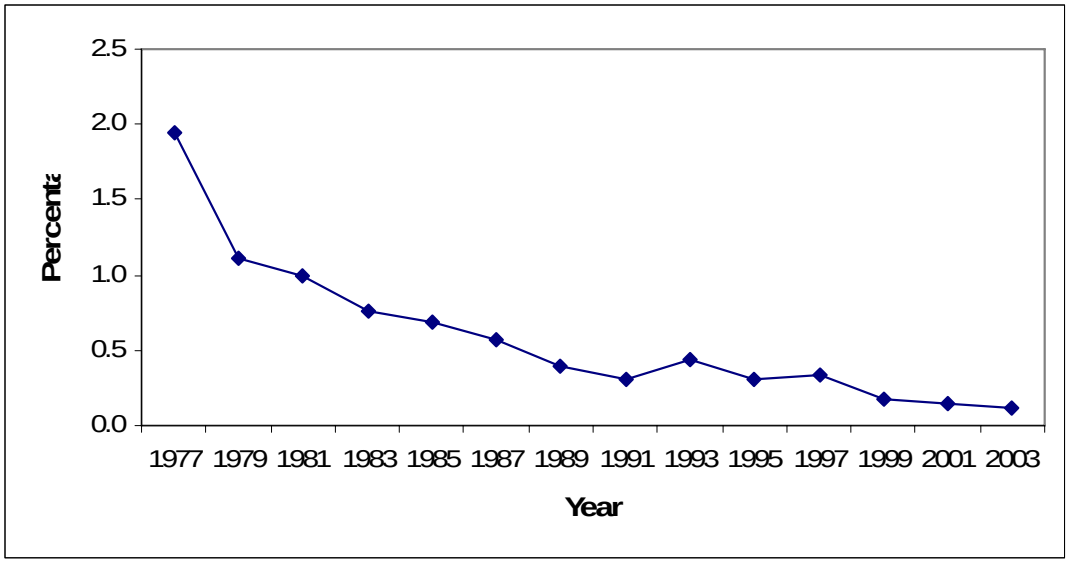

Figure 10 Dengue Haemorragic Fever case-fatality rate

Source: Ministry of public health, 2005

3.6. Civil Society and Health Development in Thailand.

3.6.1. State efforts in establishing civil society.

Before the modernization era, health was the responsibility of individual, families and community based on local wisdom. Development in modern medical sciences had taken away the capacity for self-reliance and also delayed the development of local health wisdom. In the two decades of health for all movement, new forms of people participation were developed. Village health volunteer, traditional birth attendance and village sanitary craftsmen are example of some lay health manpower created in that era. Many community health funds, e.g., Village Drug Fund, Village Nutrition Fund, and Village Sanitary Fund were developed. These are group activities set up through vertical manipulation by the state. They lacked strong civic consciousness and could not be considered as real civic organizations. Their sustainability were quite low. Most of the village health funds have totally disappeared. Nevertheless, they created a certain level of community participation and became part of the mechanisms used by the state to improve the access to essential drugs, sanitation including the communicable disease control.

3.6.2. Real Civil Society in Health Development

In the last two decades, there are mushrooming of civil society organizations devoted themselves to health development. These are in addition to existing philanthropic organizations. These newly created organizations may have very narrow and specific or wider objectives. Some of the examples are: -

3.6.2.1. Civic movement on HIV/AIDS

The Social crisis from epidemic of HIV/AIDS started in late 1987s. During that period, there were more than 100,000 cases of new infection per year. Although the government is very active and the Prime Minister himself chairs the National AIDS Committee, the crisis is so severe than even the whole government cannot hope with the problems. More than 100 civil society organizations on HIV/AIDS have been created. In 1989, a coordinating committee for AIDS NGO was established at the national level. In addition, the same kind of committee among AIDS NGO in the northern provinces (with highest prevalence of HIV/AIDS) was also created. These NGOs work on different aspects from prevention campaign to community support of AIDS patients. In 1993, and association of business sector against HIV/AIDS was originated. The purposes are to mobilize resources from member companies to collectively tackle AIDS epidemic among their employees. More than 100 companies become its member in 2000. These AIDS NGOs received strong support from the government. Each year the Ministry of Public Health provides around $US 2 million to support their activities. These budgets are managed and allocated by the public-private coordinating committee. The civic network on HIV/AIDS has participated actively in the Country Coordinating Mechanism (CCM) under the Global Fund to Fight AIDS, Tuberculosis and Malaria (GF). One of the NGO (The Care Thailand) has been accepted as the Principle Recipient of the Global Fund.

3.6.3. The way forward

It is clear that there is a very rapid increase in the number, size and roles of civic organizations for health development. In the recent movement toward total health system reform, the draft of the National Health Bill includes the creation of a National Health Committee. One-third of the members of this committee are from civil societies. A National Health Assembly will also be convened at least once a year. This is mainly the forum for people and civil societies to express their views and demands for health development policies. Hopefully this bill will be approved by the parliament and promulgated as a people Health

Constitution in 2005. It will then be the solid foundation for the sustainable development of civic organizations on health development in Thailand.

3.7. Health Policy and legislation

3.7.1. Health Policies and Plans

The Thai health system (particularly in the public sector) has been developed in accordance with the Health Development Plan, which is part of the National Economic and Social Development Plan.

During the past four decades (1961-2006), Health Development Plans have been implemented continuously in the following phases:

3.7.1.1. The 1st - 7th Plan period (1961-1996)

During the 1st-7th Health Development Plans (1961-1996), numerous efforts were mainly made for making people healthy and for enhancing national capacity in economic development. During the first period of the 1st-3rd Plans, there were investments in infrastructure development. The 4th-6th Plans were the transitional phase of adopting a more systematic national health development planning process by using the Country Health Programming technique and Managerial Process for National Health Development (MPNHD) - the systematic process, including problem analysis, policy and strategy identification, as well as the Planning Programming and Budgeting System (PPBS) technique. The primary health care concept was applied, aimed at encouraging people to realize the problem and causes of problem as well as to allow them to learn and apply new knowledge to solve the problems. Consequently, the "Health for All by the Year 2000" goal was established as a long-term target emphasizing people and community participation in health development.

As a result, health development programmes were expanded extensively during the 7th Plan, and efforts were made on quality assurance, resulting in health facilities, quality development at all levels, effective management system, new technology application, health manpower training and development of health centres to serve as the coordinating centre for health for all. Thus, the 10-year project on health centre development (1992-2001) was initiated and expanded to provide services covering two-thirds of the population.

3.7.1.2. The 8th Plan period (1997-2001)

During this period, the emphasis on economic development was shifted to people-centred development focus, as people were regarded as the key to successful development. As a result, health development plans was aimed at holistic development. However, in the beginning of this Plan's implementation, the economic crisis occurred, which led to a requirement for the plan adjustment so as to reduce investment budget and maintain basic health services provided for the poor.

During 2000-2001, the movement of health care reform was initiated, resulting in the issuance of the Office of the Prime Minister's regulation pertaining to health care reform, the establishment of the health care reform committee and the establishment of the National Health System Reform Office (NHSRO). At that time, it was expected that within the following three years, a National Health Act will be enacted (by 31July 2003). However, the timeframe was extended for two years, with an expectation that the law will be proclaimed by 8 August 2005.

Moreover, the government laid down a policy on universal coverage of healthcare scheme in February 2001, which has been implemented and covered the entire country since 2002.

3.7.1.3. The 9th Health Development Plan (2002-2006)

During this period, the emphasis is still placed on people-centred development approach, as well as the "self-sufficient economy" principles directed by His Majesty the King. Such philosophy has been used to guide the formulation of the national health development plan aimed at improving the public health and the overall health system. The strategies adopted include the creation of balances in the individual, social, economic, and environmental systems, based on active participation of all sectors concerned.

Moreover, the government has placed emphasis on other health programmes such as food safety, exercise for health, and road safety management.

3.7.2. Health Laws

Laws related to health include acts, ministerial regulations, orders and procedures as follows:

Acts under the responsibility of MoPH (four categories, 37 acts) are listed in Table 12.

Table 13 Acts under the Responsibility of MoPH

Categories	Act
1	Acts related to health service systems
	1.1 Medical Facilities Act,1998
	1.2 Health Systems Research Institution Act,1992
	1.3 Thai Traditional Medicine Protection and Promotion Act,1999
	1.4 Government Pharmaceutical Organization Act,1966
	1.5 Thai Health Promotion Foundation Act,2001
	1.6 National Health Security Act,2002
2	Acts related to disease prevention and control
	2.1 Public Health Act,1992
	2.2 Communicable Disease Act,1980
	2.3 Zoonoses Act,1982
3	Acts related to consumer protection in health
	3.1 Food Act,1979
	3.2 Drugs Act,1967;Amendment No.2(1975),No.3(1979),No.4(1985), and No.5(1987)
	3.3 Cosmetics Act,1992
	3.4 Hazardous Substances Act,1992
	3.5 Psychoactive Substances Act,1975;Amendment No.2(1985), No.3(1992) and No.4(2000)
	3.6 Narcotics Act,1970;Amendment No.(1985) No.3(1987) and No.4(2000)
	3.7 Medical Devices Act,1988
	3.8 Royal Degree on Prevention of Volatile Substance Use,1990; Amendment No.2(2000)
	3.9 Tobacco Product Control Act,1992
	3.10 Non-smokers Health Protection Act,1992
4	Acts related to health professions
	4.1 Medical Registration Act,1990
	4.2 Medical Profession Act,1982
	4.3 Nursing and Midwifery Profession Act,1985;Amendment No.2(1997)
	4.4 Pharmaceutical Profession Act,1994
	4.5 Dental Profession Act,1994

Source: Ministry of Public Health, 2005

3.8. Current challenges

3.8.1. Water supply problems

Despite development of water supply and sanitation which aims to control food and water borne diseases, morbidity rates remain high due to the high bacterial contamination of the water. Also increasing are diseases caused by chemical and toxic substances contaminating the water whether from natural sources, industry, agriculture, or from communities. Examples include lead poisoning from mining, black fever from arsenic poisoning in areas where tin mining is prevalent, and freckled teeth from excessive fluoride levels in groundwater.

3.8.2. Improve quality of drinking water at the local level.

According to decentralization policy, local administrative organizations will have primary responsibility for the quality of drinking water and will need technical assistance and other support from relevant agencies.

3.8.3. Better access to piped water.

Each local administrative organization and relevant national agency needs to develop a plan to increase the accessibility of piped water to meet the drinking and consumption needs of their population. The government puts its great effort in helping them to meet the goal of accessing to pipe water for each village by 2008.

3.8.4. Sanitation problems

The disposal of excreta from household latrines is hampered by a lack of awareness of local administrations, a lack of skill and knowledge of local staff who operate the facilities, and limitations in the budgets for construction of central excreta treatment systems. The problem of domestic hazardous wastes is also increasing due to greater use of high technology equipment and chemical substances in households. Management conflicts in local authority wastewater treatment systems often result in ineffective and non-continuous operation. The major problems are insufficient finance for system operation and maintenance, and the development of an appropriate fee for the use of wastewater treatment facilities that are acceptable by everyone.

3.8.5. Health behavior problems

There is still insufficient knowledge or utilization regarding hygienic health behaviors, particularly in the utilization and care of drinking water sources. Inappropriate attitudes to food sanitation are apparent where the selection of delicious, appetizing, low price food is made without concern for the cleanliness and safety of the food and its preparation, particularly uncooked foods.

There are campaigns and support for social mobilization for health promotion as follows:

3.8.5.1. Campaign on Health Promotion throughout Thailand.

The government was declared 2002-2004 the “Health Promotion throughout Thailand Years”. The Empowerment for Health events were organized twice in 2002 and 2003 to encourage the people to participate in building/promoting their own health or practicing healthy behaviors and to expand this kind of effort so that it becomes a Thai lifestyle at the regional level nationwide. Besides, ThaiHealth and all its partnership members organized a fair entitled the

gathering of happiness-promoting people to encourage Thai people to create healthy status or conditions on a sustainable basis.

3.8.5.2. Campaign on Exercise for Health.

The Ministry of Public Health (MoPH) has been supporting Thai people to exercise by launching several projects such as move for health and 30-person running for health, and by setting up health promotion clubs. Such efforts aim to raise awareness so that the people will exercise for 30 minutes every day and at least 3 days a weak. At present, there are totally 35,532 health promotion (with exercise) clubs and 47.3% of the people aged 6 years and over exercising 30 minutes every day and at least 3 days a week (the target is 50%). With such achievements, Thailand was honored to host the 6th Global Conference on Health Promotion in Bangkok in August 2005.

3.8.5.3. Promotion of Health Food Consumption.

Efforts or projects for the promotion of health food consumption include: hotline 1675 for good eating and good health, nutrition hotline, eating according to age, cleanliness and safety for illness prevention, children love green vegetables, and promotion of vegetarian food consumption.

3.8.5.4. Campaign on Non-Smoking.

The Action on Smoking and Health Foundation (ASH Thailand), an NGO, has been successfully implemented non-smoking campaigns among Thai people. As a result, the smoking rate had dropped from 30.1% in 1976 to 21.6% in 2003. During fiscal years 2001-2003, the projects implemented include non-smoking campaigns among children, youths and women, smoking cessation promotion among smokers, Quit-Line 1600 for smoking cessation counseling, raising social awareness and celebrating the World No Tobacco Day through the mass media, expanding non-smoking areas to cover restaurants, offices, monasteries, sports arenas and events, establishing a network for non-smoking in Southeast Asia, and monitoring and disclosing unacceptable tactics of tobacco companies. Importantly, with support from ASH Thailand, the MoPH has issued rules or regulations for tobacco consumption control, including the MoPH Announcement (No. 10) of 2002 and (No. 13) of 2003 designating 20 categories of places as non-smoking areas, and the MoPH Announcement (No. 8) of 2004 requiring that cigarettes produced in or imported into the country have a pictorial warning depicting the danger of tobacco on each pack and the picture must be of four colours covering an area of not less than 50% the total area of both sides. This is to make the people aware of the danger of toxic substances in cigarette smoke and to prevent youths from starting smoking.

3.8.5.5. Health Promotion for Particular Age Groups.

1) Mothers and Infants Group.

The MoPH has launched a surveillance program for pregnant women across the country. In 2003, 75.2% of pregnant women received four antenatal or pre-natal care services as required and 56.3% of them had screening test for thalassemia. Regarding exclusive breast-feeding promotion, the breast-feeding rate was only 16.3% in 2001 (lower than the 30% target) and only 98.5% of the 804 target hospitals could implement the baby-friendly programme. Importantly, health facilities at all levels have been supported to implement the mother-to-child transmission (MTCT) prevention of HIV for pregnant women attending antenatal care clinics. All HIV-infected pregnant women would receive antiretroviral drug AZT until they had labour pain. Newborns would also receive AZT and powder milk (infant formulas). As a result, the MTCT rate had dropped from 18.6% in 1996 to 9.0% in 2001 and the MoPH was

given a recognition award in 2001. In 2003, the MTCT rate was recorded at 9.3%. Regarding newborn health promotion activities, the MoPH has launched a project on asphyxia reduction and can reduce the rate of newborns with such condition to 35.3 per 1,000 live births (higher than the target of 30 per 1,000 live births). A project on development of child day-care centres was implemented in 4,332 centres, but only 13.9% of which could meet the criteria of good centres.

2) School-age and Youth Group. In addition to implementing projects on health

status monitoring and dental health promotion among primary and secondary schoolchildren, the MoPH, in cooperation with the Ministry of Education, has launched the Health-Promoting Schools Project aimed at making each school become a starting point for physical and mental health promotion for schoolchildren and the community. In 2003, out of 29,377 schools participating in the project, 12,372 schools (42.1%) could meet the criteria for health-promoting school. Besides, the Thai Health Promotion Foundation, in cooperation with the Ministry of Education, has initiated the Full-of-Fun Schools Project aimed at developing a teaching/learning process for health and well-being in a holistic manner. This initiative aims to cover 300 schools by 2005, which will result in the students having been instilled with life-skills and disciplines so as to help create their own physical, mental, social and spiritual well-being.

3) Working-age Group.

The MoPH has implemented health promotion activities to encourage males to play a more active role in reproductive health, rather than having only females playing such a role. Family planning services are provided to all target groups nationwide, in cooperation with the Community and Population Development Association, the Integrated Population and Health Development Association of Thailand, and the Reproductive Health for Quality of Life Development Association of Thailand. Health promotion activities for males and females of menopausal age are carried out at 188 clinics for males (1.9% of the 9,931 target clinics) and at 4,146 clinics for females (41.7% of the target). Another important activity supported by the MoPH is the "Health-Promoting Hospitals Project"**,** aimed at improving hospital service systems according to the health-promoting hospital principles in a more systematic manner. In 2003, 572 (68.8%) out of all 831 MoPH hospitals participated in the project, but only five hospitals (0.6%) met the criteria for the HPH project. This low achievement was due to the fact that most of the hospitals were more interested in improving themselves according to the hospital accreditation (HA) criteria. Besides, several other health promotion projects have been simultaneously launched such as the Healthy Workplaces Project with 2,691 workplaces participating in 2003, out of which 1,585 (58.9%) met the criteria for such effort. This project has hot been successful as expected because only a few small and medium-sized enterprises (SMEs) participated and it lacks the participation of local administrative organizations.

4) Elderly Population Group.

The MoPH has been monitoring and supporting community health promotion programmes for the elderly by organizing a national week for elders to raise social awareness about the value of the elderly, providing physical check-up services, and holding forums demonstrating the capacity of senior citizens clubs. Besides, the Senior Citizens Council of Thailand under the Patronage of HRH the Princess Mother has been serving as a focal point for approximately 7,000 senior citizens associations/clubs throughout the country. Major activities undertaken include raising awareness about self-value of elders groups, supporting the setting up of forums for exchanging ideas among elders, providing knowledge about health, and organizing health-related activities to promote self-healthcare for elders. In FY 2002, the MoPH organized a national seminar for elders clubs and networks. In 2002, a joint statement of senior citizens networks was made, specifying that they will support health promotion among

Thai elders so that they will be able to take care of their own health and to live a longest life possible with quality in society, unite all their forces as alliance of senior citizens networks of Thailand to further enhance the quality of life of the elderly. A pilot project on health-promoting monasteries is being implemented in 24 Buddhist monasteries to encourage religious organizations to take part in the development of health and environment especially for the elderly. Regarding the movement for legislation related to the elderly, the MoPH had been a core agency in drafting an elderly bill since 1995. After the bureaucratic reform law was effective, the work related to the protection and promotion of the rights of the elderly was transferred to the Ministry of Social Development and Human Security, which coordinated the legislation process.

3.9. Indicators on afore-mentioned issues

- Proportion of urban population with sustainable access to an improved water sources (%)
- Proportion of rural population with sustainable access to an improved water sources (%)
- Proportion of urban population with access to improved sanitation (%)
- Proportion of rural population with access to improved sanitation (%)
- Set of indicators that provided according to basic needs of human being (Rural Development Information Center, 2005)

TABLE 14 Indicators on afore-mentioned issues

Indicators	Year			Targeted	
	1990	2000	2005	2008	2010
• Proportion of population with access to an improved water sources (%)	86.2	94	97	99	100
• Proportion of population with access to improved sanitation (%)	86	98			
• Proportion of rural population with access to tap water (%)	n/a	n/a	85.7	99	100

3.10. Conclusions

Although Thailand has high levels of access to safe drinking water as well as sanitation facilities and the MDG target 10 has been achieved. The quality of water and facilities still requires attention. Cooperation between central government and local administrative organizations has to be strengthened and well planned. Managing skill needs to be sharpened and capacity building for local administrative organizations is extremely important. For health matter, preventive and participatory health-care activities should be implemented as follows:

1) To create a proactive health system that aims at promoting healthy conditions, protecting safety of life and health, in terms of food safety and security, environmental and occupational safety, consumer protection and disease prevention.

2) To create a security system for protecting people's health from the negative impacts of economic, social, and developmental activities, and to create an insurance system

for the people to have access to quality health care with universal coverage on an equitable basis, particularly for the poor and underprivileged.

3) To strengthen individuals, families, communities and society to have the potential for self-care and health promotion, using the learning and participatory approach in the setting up and management of health systems.

4) To set up mechanisms and measures for creating, seeking and increasing the potential for screening knowledge and technology for health development, emphasizing research and development in the utilization of international and Thai wisdom in a well-informed manner for self-reliance in health.

3.11. References

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3.12. Recommend Reading/Website

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Challenge: Water and Ecosystems

Overview: Thailand's natural endowment of biodiversity – the variety in genes, species, and ecosystem – is both rich and naturally abundant. The country stretches nearly 2,000 km from north to south and boasts forested mountains, very wet and very dry climates (and great variety in-between), various types of wetlands. A complex coastline with crystal clear waters around teeming coral reefs, and turbid waters lapping productive mudflats.

While the direct values through agriculture, fisheries and forestry are obvious, the indirect values of biodiversity to climate regulation, water quality and quantity, erosion control, sediment retention, soil formation, and nutrient cycling have yet to be fully appreciated or integrated into development planning. Thailand's biodiversity also has values for future generations.

All these fertilities need right amount and quality of water to keep them healthy and sound that created promising environment. Allocation of water from man made reservoirs has taken into consideration an importance of maintaining healthy ecosystem. The maintenance of river integrity is based on maintaining minimum stream discharges to repel salt water intrusion at the lower reaches of rivers, minimum level of pollutants, and maintain minimum dissolved oxygen level to ensure that the quality of the aquatic environment does not fall below acceptable levels.

4. Water for ecosystems

4.1. Biological Assessment of freshwater systems including coastal zones

4.1.1. Aquatic fauna

Thailand is rich in term of aquaculture, the Thai maritime area covers over 378,000 km2, including the territorial waters extending 12 nautical miles from the coast, and the Thai EEZ. Two-thirds of the area (252,000 km2) covers the Gulf of Thailand, and the rest (126,000 km2) in the Andaman Sea. The total coastline length is 2,614 km with 1,660 km on the Gulf of Thailand and 954 km on the Andaman Sea. In the peninsular South, the western coast has been submerged while the east coast has been uplifted. Less regular shorelines, more bays and more islands are found in the west, and there is a considerable range of coastal habitats - head lands, marine terraces, tidal flats, mud flats, sand dunes, runnels, estuaries, deltas, lagoons, marshes, swamps and off shore bars – each of which harbors a different suite of biodiversity. Fishery is a significant source of income for the people living along the coast lines. Inland fishery is also a major economic activity for farmers who capture the aqua richness and vast diversity of this aquaculture.

Table 15 Number of farms and area of freshwater fishes culture (only having product) by type of culture, 1992-2001

Year	Pond culture		Paddy-field culture		Ditch culture		Cage culture	
	Number of farms (Farms)	Area (Rai)	Number of farms (Farms)	Area (Rai)	Number of farms (Farms)	Area (Rai)	Number of farms (Farms)	Area (Rai)
1992	69,444	158,468	7,919	148,589	602	1,054	508	24
1993	88,463	178,011	9,060	153,243	979	1,435	463	87
1994	101,741	191,934	9,416	169,358	1,326	3,711	486	10
1995	121,592	247,292	7,728	112,258	1,901	5,421	322	22
1996	141,991	306,787	8,504	80,693	2,926	6,158	582	145
1997	156,621	315,691	9,203	98,980	2,577	7,774	544	105
1998	191,776	404,850	7,994	104,394	4,033	9,262	532	174
1999	229,093	442,631	9,777	113,595	4,278	12,506	721	243
2000	239,122	428,226	11,396	157,774	4,655	14,668	909	238
2001	252,672	461,973	10,983	152,915	4,090	13,342	846	228

Note: 6.25 rai = 1 ha

Source: Office of Agricultural Economics, 2003

Table 16 Quantity of freshwater fishes by species and type of inland water, 2000-2001

Species	Reservoir		Public swamp		Fish barrage		Total	
	2000	2001	2000	2001	2000	2001	2000	2001
Total	20,674.83	18,058.33	36,398.97	29,663.86	6,857.01	4,668.02	63,930.81	52,417.21
Tilapia(Pla-Nil)	5,598.30	4,853.58	5,644.43	6,363.69	1,433.05	1,104.25	12,675.78	12,321.52
Common carp	604.48	421.09	1,182.60	790.38	439.81	268.84	2,226.89	1,480.31
Local carp	4,040.62	3,847.06	7,215.18	7,912.29	1,751.22	1,185.04	13,007.02	12,944.39
Sepat Siam	89.04	0.55	117.63	16.27	7.49	1.33	214.16	18.15
Chiness carp	268.96	247.00	471.01	481.75	201.77	167.15	941.74	895.90
Cat fish(Pla-Duk)	1,269.48	490.49	4,588.27	1,655.19	370.64	158.74	6,228.39	2,304.42
Snake-head fish	1,752.83	1,238.18	4,051.29	3,103.33	699.85	258.44	6,503.97	4,599.95
Cat fish(pla-Swai)	67.39	5.20	236.41	249.11	27.51	29.40	331.31	283.71
Giant freshwater prawn	11.30	23.65	8.81	25.44	3.74	1.49	23.85	50.58
Tilspid(Malayan)	1.90	51.24	16.08	2.00	1.06	0.00	19.04	53.24
Sand gobies	15.00	1.81	42.38	7.75	7.06	0.13	64.44	9.69
Giant gourami	0.17	0.00	0.96	13.47	0.04	0.00	1.17	13.47
Probabus jullieni	463.11	746.41	459.80	497.70	149.78	114.98	1,072.69	1,359.09
Roher	882.08	473.00	1,114.41	1,206.12	296.56	249.25	2,293.05	1,928.37
Knife fish	84.96	43.22	184.17	6.41	47.62	7.25	316.15	56.88
Black ear	86.71	0.00	-	0.09	-	0.00	86.71	0.09
Swamp eel	7.92	3.31	38.08	8.19	3.82	1.70	49.82	13.25
Moonbeam gourami	68.24	3.86	106.94	33.62	2.09	1.83	177.27	39.31
Miseellaneous fishes	3,030.31	2,596.06	4,684.94	2,942.02	707.07	590.72	8,422.32	6,128.80
Climbing perch	489.52	548.13	1,404.09	597.43	224.40	54.20	2,118.01	1,199.76
Frog	0.67	0.44	11.03	7.17	0.49	0.32	12.19	7.93
Brown block sea catfish	295.50	51.46	327.12	273.03	17.12	1.97	639.74	326.46
Sheat fish	0.66	0.00	218.40	217.95	-	0.00	219.06	217.95
Striped tiger	5.68	6.81	82.12	57.85	4.45	8.48	92.25	73.14
Crap	173.38	69.95	571.51	230.33	83.03	38.08	827.92	365.36
Hard-Lipped barb	41.61	804.01	60.44	343.28	3.27	47.86	105.32	1,195.15
Yellow checkok carp	-	0.00	6.95	3.13	-	0.00	6.95	3.13
Mud carp	632.95	377.21	2,118.54	920.28	153.97	139.02	2,905.44	1,436.51
Spot feather back	89.39	83.56	0.35	203.07	0.09	0.28	89.83	286.91
Serpent head fish	6.99	41.03	9.72	31.50	0.59	0.10	17.30	72.63
Minnow	-	0.00	3.70	0.00	0.31	0.00	4.01	0.00
Whisker sheath fish	0.12	5.37	137.18	332.24	0.29	0.03	137.59	337.64
Freashwater catfish	1.79	1.34	10.72	273.53	0.41	0.53	12.92	275.40
Striped dwarf	142.19	45.36	135.88	161.97	6.15	5.30	284.22	212.63
Miseellaneous shrimp	7.25	24.98	19.19	5.87	4.61	2.57	31.05	33.42
Spiny eel	0.14	0.20	-	0.00	1.87	0.03	2.01	0.23
Small scale mud carp	324.68	534.40	1,002.93	500.83	205.65	226.43	1,533.26	1,261.66
Blane's striped feather-back	96.10	80.82	27.01	162.19	-	0.00	123.11	243.01
Others	23.41	337.55	88.70	27.39	0.15	2.28	112.26	367.22

Note: All quantities in ton

Source: Office of Agricultural Economics, 2003

4.1.2. Rivers and coastal zones

There are about 606, 63, 50 and 12 species of freshwater fish, crabs, shrimps and turtles known from Thailand, although further surveys would doubtless reveal more. The Mekong harbors one of the world's most diverse and rich fish faunas with about 570 species known (see also Table 16). Loss of forest cover in the foothills resulting in loss of organic inputs and overly warm water, damaging fishing methods, agricultural chemicals and over fishing have caused the abundance of many fish to decline over the last few decades, with inevitable

economic, health and social impacts on the riparian villagers, especially among the poorest segments of the communities who rely on these 'free' goods.

Table 17 Fish species richness in selected river systems.

River system	Number of species
Salawin	110
Southeast Thailand	120
Chao Phaya	250
Mekong (Thai portion)	289

Source: Vidthayanon et al, 1997

4.1.3. Wetlands

A total of 42,653 wetlands have been counted (Table 17), the majority of which are riverine habitats and tributaries. Sixty-one major wetlands are considered to be of international importance, and 208 of national importance. The most famous freshwater wetlands are Phru Khuan Khi Sian in Phattalung Province, Bung Khong Lon in Nong Khai Province, and Nong Bong Khai in Chaing Rai Province.

Table 18 Number of different wetlands.

Wetland System	Number
Rivers and tributaties	25,008
Lagoons	14,128
Lakes and flooded plain	1,993
Coastal wetlands	1,256
No classification	268
Total	42,653

Source : ONEP, 1999

4.1.4. Terrestrial plants and animals

There are about 15,000 vascular plants in Thailand but only approximately 6,000 species are recognized by botanists. Many of these are in danger of extinction because of the rapid destruction of their habitats, principally in northern, northeastern and eastern regions of the country. This critical situation has activated the Thai Government to gather botanical information and to conserve Thai plants before they are lost.

Species such as rattans, palms, bamboos, trees of economic importance, medicinal plants, ferns, and especially orchids, are taken from the forests at an alarming rate and to an extent that cannot be sustained. In many regions, such species are clearly suffering from a heavy decline in their genetic diversity.

A large number of Thai plants have never been examined for their potential economic importance and useful products, more over, many species have not yet been described correctly or given their correct name. The value that these plants may have for mankind has been ignored.

The Botanical Garden Organization was established in 1992 to address the major part of these problems. It also aims at gathering a fundamental knowledge, conserving the genetic diversity of Thai plants, and strengthening studies and research on Thai plants.

In 2003, the list of threatened species of Thai plants and animals included 84 plants, 37 mammals, 37 birds, 19 reptiles, 35 fishes, and 1 mollusk. The number of threatened and endangered species has greatly increased during the last decade.

Pileated gibbons are found mainly in SE Thailand and Cambodia, although a small population can be found in southern Lao PDR. In 1987, the total area of Pileated gibbon habitat, closed canopy forest, in Thailand was about 6,258 km^2, which was estimated to be 30-40 percent of the original area available to them.

The decline in wildlife populations has made some people think about captive breeding and reintroduction as possible solutions. The idea of captive breeding of animals and cultivation of plants for commercial purposes has been advocated as a strategy to reduce the hunting/collecting pressure on wild species, and has been stimulated by the success of a few wildlife breeding programs, e.g. crocodiles and orchids (both of which have high direct-use economic value) for commercial purposes. However, there are no clear indication of gains for conservation in these programs. Nevertheless, the idea of breeding programs has been supported by government officials, who see them as a possible source of income for villagers living close to protected areas (PAs). The present policy now is to permit certain species to be bred for commercial purposes but, again, there is little indication that wild populations benefit.

The Western Forest Complex is the last major stronghold for viable populations of globally threatened and endangered fauna and flora in mainland Southeast Asia. With 17 contiguous PAs totalling over 18,000 km^2 and a total forest cover of over 80 percent, the Western Forest Complex is one of the largest protected area systems in the region. The core area, Thung-Yai and Huai Kha Khaeng WSs, has been a UNESCO World Heritage Site since 1991. In 2000 the Western Forest Complex (WEFCOM) Ecosystem Management Project was launched as a collaborative project between the Thai and Danish Governments, local academics, local communities, and NGOs. The aim is to encourage Complex-wide planning and collaboration among stakeholders sharing a common concern over the long-term status of the region. The project has produced first-rate tools such as comprehensive GIS maps with reliable distributions of fauna and flora and human settlements, and has stimulated the formation of the provincial conservation forums for stakeholders to discuss matters related to WEFCOM conservation and management.

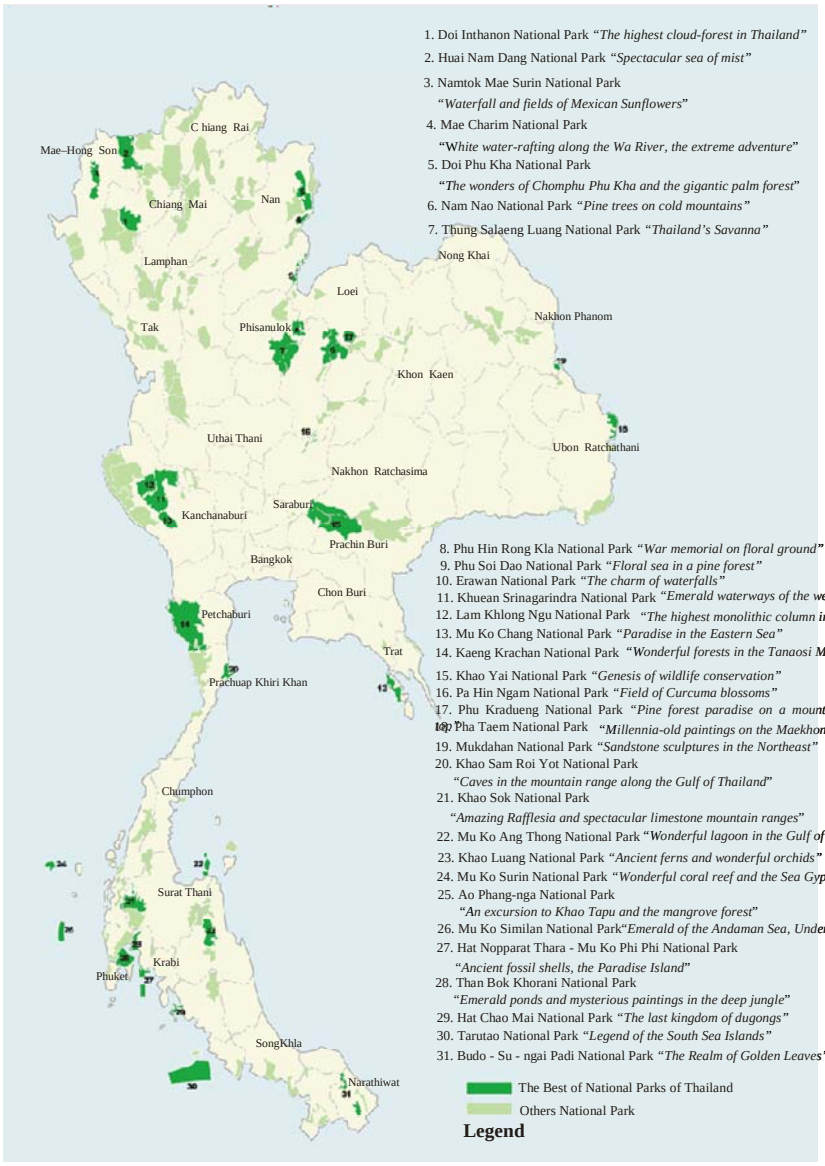


Figure 11 The best National parks of Thailand

4.1.5. Bangkok's Chao Phraya

The 380 km Chao Phraya is the life blood for northern and central Thailand including Bangkok. Despite its socio-economic value and the very large agricultural area which it serves, the Chao Phraya basin has maintained a high diversity of fishes from which local communities can earn an average income of 88-134 baht per day. At least 329 fish species can be found in the Chao Phraya and its tributaries, among them ten threatened species, one of which, the freshwater 'Batfish' (Oreoglanis siamensis) is endemic. When ONEP conducted the National Inventory of Wetlands in Thailand Project in 1995, the Chao Phraya River was listed as one of 48 wetlands of national importance.

Within the Chao Phraya basin are a number of significant wetlands. Bung Boraphet, Nakhon Sawan Province, is a large (212.38 km^2) freshwater lake which is in the flight path of various migrant birds and some 20,000 birds of more than 187 species nest here. About 150 fish species are recorded from the lake. Not surprisingly, Bung Boraphet is a potential candidate to be designated as a Ramsar Site of International Importance. Bung Boraphet also has a high economic value to villagers who live around it. Fishers have an average annual income of 310 USD, and the annual catch of fish reaches 400 - 500 tons.

4.1.6. Coastal and marine ecosystems

Thailand's long coastline, sizeable sea areas and varied habitats are home to a host of species (Table 18) many of which are of considerable economic importance either through direct exploitation or through the tourism that is attracted to coral reefs and beach habitats. However, past exploitation has compromised the capacity of these areas to produce generous sustainable yields of a range of products (Table 19 and 20).

Table 19 Number of Thai species in four groups of marine life

Taxonomic group	Number of species
Sponges	50
Hard Corals	270
Soft Corals	15
Sea Fans	16

Source: Thumrongnavasawat and Tipanan, 1998

Table 20 Area (sq. km.) used for coastal aquaculture

Year	1985	1995	2000
Coastal aquaculture (km^2)	374	716	715

Source: National Statistic Office,

Table 21 Number of households in each year dependent on marine and coastal resources

Major Activities	Number of households		
	1985	1995	2000
Marine fishery	51,702	52,116	56,859
Coastal aquaculture	5,889	28,588	37,045
Total	57,591	80,704	93,904

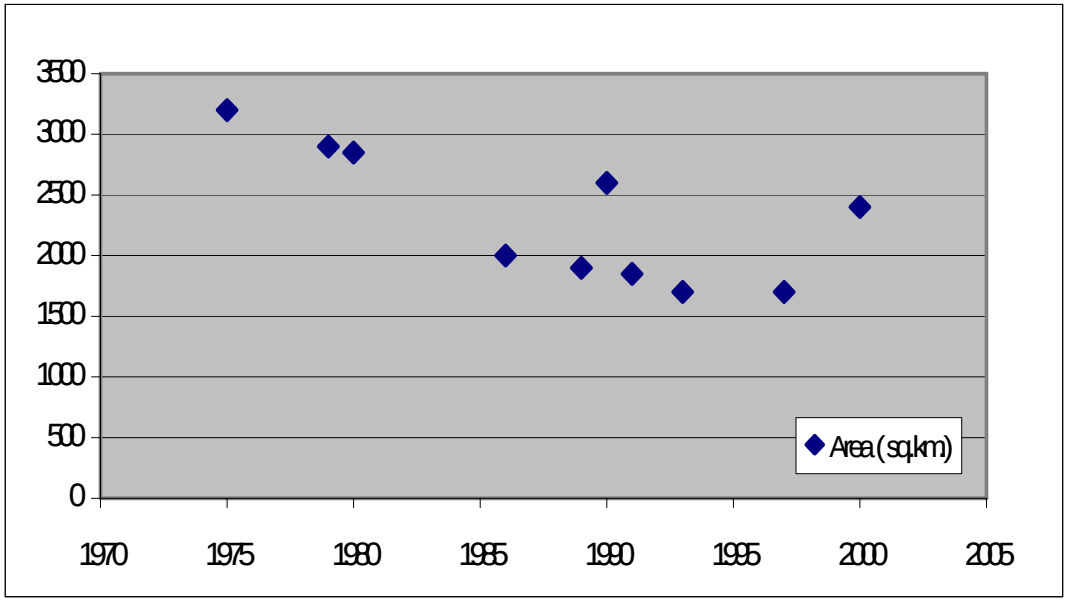
Source: National Statistic Office,

4.2. Programs and strategies

4.2.1. Protection of ecosystems

4.2.1.1. Mangrove forests

Mangrove forests comprise up to 35 species of plants about 25 of them trees - but the species composition depends on the soil type, tide characteristics, distance from the sea, salinity and degree of disturbance. They are thus relatively simple communities and are able to exploit the ever-changing dynamic of the interface between the marine and terrestrial worlds. They have high productivity, as shelters and nurseries for many aquatic animal species, as important food sources for commercially important species, and as physical protection for coastlines against strong winds and waves. Coastal communities can earn income from mangrove forests by gathering charcoal, poles for scaffolding, fuelwood, medicinal plants, tree bark for tannin production, fish, shrimps, crabs, mollusks, and honey. These special forests used to cover about 3,680 km^2 in 1961, but by 2002 there were only 2,400 km^2 (and possibly less) remaining, and much of that was poor quality. The major causes of loss of mangrove forest in Thailand are timber and charcoal industries while some areas were converted for urbanization, agriculture and – between 1985-1990 in particular – aquaculture (Figure 12).



Sources: Royal Forrest Department and National Statistical Office, 1980 and 1990

Figure 12 Decline in the area of mangrove forest

High financial returns have attracted people to convert mangrove forest to intensive shrimp farms. Thailand earns more than $1.2 billion annually from exporting frozen shrimps and so commercial shrimp farming is expanding by about 6,000 ha per year, with serious impacts on coastal communities, mangrove forest and its wildlife. An interesting study in Surat Thani Province, southern Thailand, showed that the economic benefits of conserving mangrove forest are significantly higher than the economic returns of intensive shrimp farming.

After some major reforestation projects the area under 'mangrove forest' is increasing, although the original levels of biodiversity do not seem to be regained, perhaps because of the small range of species planted. In 2003 a broad mangrove project was initiated to

commemorate the 72nd birthday of Queen Sirikit. The project has the goal of managing 115,000 ha of mangrove in 23 provinces, including reforestation and the setting aside of 48,000 ha of good quality mangrove as Protected Areas (PAs). In late 2004, a five-year Action Plan for Mangrove Management in the Gulf of Thailand was established. This has five main elements:

- Conservation and restoration to increase the area under mangrove trees,
- Promotion of sustainable use of mangrove resources,
- Coordinated participation in the development of the mangrove resources
- Databases and research to help conserve, restore, and sustainability use of mangroves
- Evaluation and monitoring of the results of mangrove management.

Responsibility for different sets of actions fall to Department of Marine and Coastal Resources (DMCR), local government organizations, academic institutions, schools and communities which will be judged against a set of performance indicators.

4.2.1.2. Seagrasses, productive underwater meadows

There are about 104 km^2 of seagrass meadows in Thailand comprising some 12 species in seven genera. They are highly productive and serve as a feeding and nursery area for many marine animals, some of which also provide food for humans. Most seagrasses are found in relatively shallow water (1-7 m), although they can grow down to 30 m depth in the offshore islands where water is clearer. Dense seagrass meadows, mangrove forests and coral reefs can provide protection against shore erosion (Table 21).

Table 22 Coastal zone affected by coastal erosion general as a result of the loss of mangrove forests , seagrass meadows or coral reefs.

Severity Level	Coastal length (km)	
	Gulf of Thailand	Andaman Sea
Very severe	180.9	23
Less severe	305.1	90.5

Note: More than 5m loss/year is considered as very severe while 1-5 loss/year is less severe.

Source: Department of Marine and Coastal Resources, 2004

Table 23 Abundance and percentage cover of seagrasses around Thailand's coast

Status of seagrass	Percentage Cover	Area (km^2)	Percent
Very healthy -healthy	>60 -100	62	60
Fair	40 – 60	21	20
Degraded	5 -<40	21	20

Source: Phuket Marine Biological Center (PMBC) (xxxx)

Although most seagrass meadows are in good condition (Table 22), these meadows have suffered from inshore pushnets and trawlers as well as from pollution and eutrophication from tourist resorts. A recent campaign on seagrass conservation included the following:

- Building public awareness and giving education on seagrasss conservation to various stakeholders including local people and fishermen so that they appreciate the importance of seagrass ecosystems as nursery grounds, shelter and feeding habitat for marine life;

- Eliminating all fishing methods which degrade seagrass beds and promoting fish traps and gill nets;

- Zoning seagrass areas to preserve feeding habitats for dugongs and sea turtles and also reduce conflict between small scale fisheries and commercial push nets and trawlers; and

- Improving law enforcement and participatory management between government officers and local volunteer for coastal resource watchers.

4.2.1.3. Coral reefs – 'rainforests of the sea'

Coral reefs are sometimes called the 'rainforests of the seas' because of the profusion of different life forms in staggering abundance. All these species interact with each other to form extremely complex and little-understood communities. Coral reefs are made up of the compacted and cemented skeletons and skeletal sediment of sedentary organisms which are then smothered by other organisms – up to seven phyla of both sessile and mobile invertebrates (such as corals, worms, mollusks, sea squirts, sea stars and bryozoans) - in a single area of reef. The outermost layer of a coral reef is living tissue comprising primarily hard corals and algae with their tissues impregnated with limestone.

As is well known, the exquisite beauty of undisturbed reefs can be marketed and this has made them extremely, and increasingly, valuable to the tourist industry. Indeed, Thailand promotes the excitement, wonder and fulfillment of diving or snorkeling over reefs as one of their major attractions for domestic and foreign tourists. The diving of Thailand is world class, and thousands of people, including many internationally-respected experts, go there each year solely to dive, having no interest in other aspects of Thailand or its culture. But it is not just their beauty, which is notable because they protect coasts from erosion, and many of the larger animals and plants associated with them have major direct and indirect economic value.

There are 154 km^2 of coral reef in Thailand divided into 79 km^2 around 130 islands and a few mainland locations in the west, and 75 km^2 around 250 islands in the Gulf of Thailand.

The status of coral reefs west and east of Thailand in 2002 is shown in Figure 13. From 1992 to 2000, reef conditions deteriorated, especially in the Andaman Sea. Coral reefs in the western part of the Gulf of Thailand have fared better (Figure 14). Both natural and man-made factors damage the reefs.

The natural factors include:

- Catastrophic storms such as the southwest monsoon in the Andaman Sea in 1986, and Typhoons Gay and Linda in the Gulf of Thailand in 1989 and 1997

- Periodic outbreaks of the crown -of –thorns starfish (Acanthaster planci) in the Andaman Sea during 1984-1986

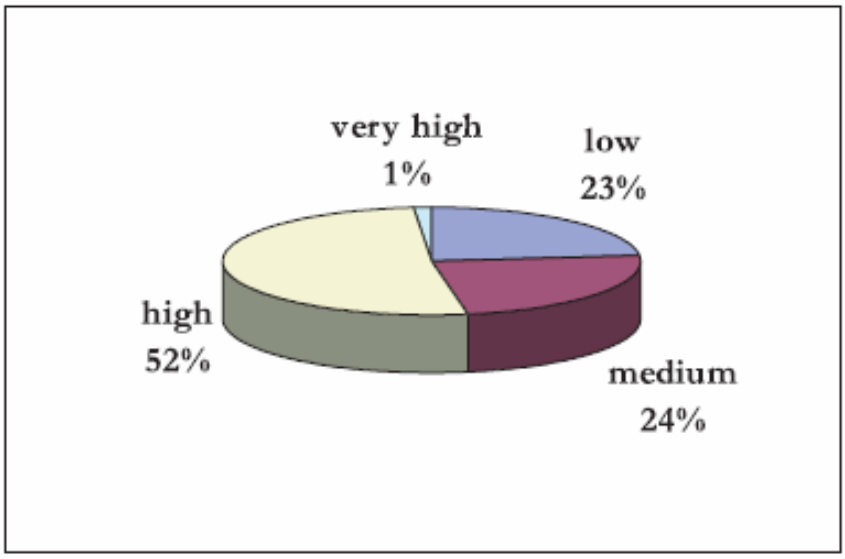
- Increases in sea temperature in 1991, 1995, 1998 and 2003 which caused coral bleaching in the Andaman Sea and the Gulf of Thailand. Coral bleaching in 1991 and 1995 caused 10 percent coral mortality in the Andaman Sea while the reefs in the Gulf of Thailand were severely damaged by coral bleaching in 1998.

The human factors include:

- Sedimentation, such as at Phuket Island in the Andaman Sea in the 1980s, caused by off-shore tin mining.

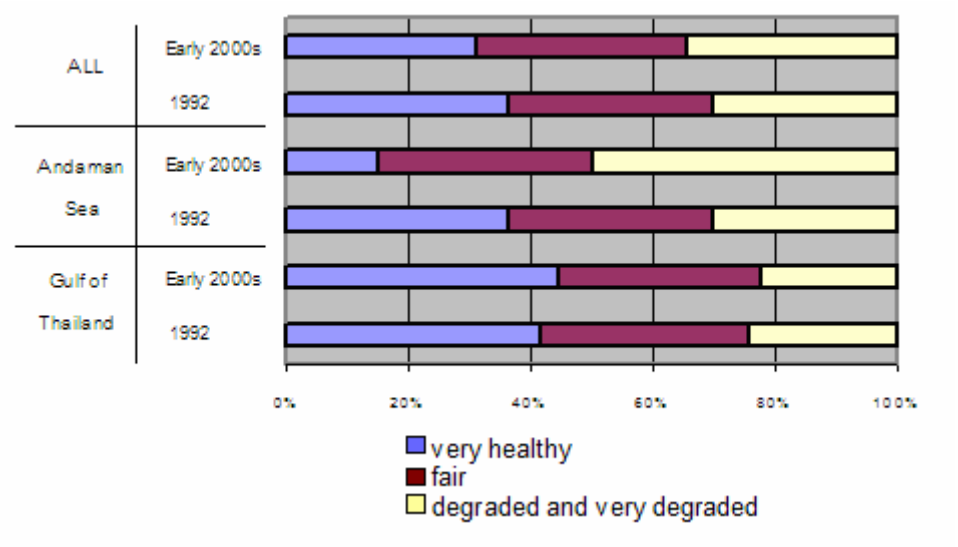
- Damage caused by anchors of tour boats. Mooring buoys have now been installed in most tourist sites. This has effectively reduced the impact from anchoring. Trampling on corals in shallow water by snorkels and boat grounding are still major factor causing reef damage.

- Dynamite blasting for fish was common in the past but it is now illegal and rare. However, fishing for trash-fish (for animal feed), nets covering coral reefs and coral trampling by fisherman searching for shellfish are still common.



Source: Water Resources Institute (WRI), 2002

Figure 13 Thai reefs at risk in 2002 (Total reef area = 1,787 km^2)



Source: Water Resources Institute (WRI), 2002

Figure 14 Change of coral reef area and statues in Thailand

4.3. Application of Environmental Impact Assessment

4.3.1. Needs for EIA Report Preparation

National Environmental Quality Act (NEQA) 1992 set up requirement for different project types and sizes to prepare EIA report. Office of Natural Resources and Environmental Policy and Planning (ONEP) then set up guideline in preparing EIA so that those concerning with its preparation, the consultant firm project proponent, EIA reviewer and permitting agency, can work together in the same direction.

Purpose of the EIA report is

- To classify, predict and estimate impacts to environment from various projects comparing to existing environmental condition without the project. Also to reduce impacts to environment at early planning stage which will, subsequently, contribute to reduction of the cost of rectifying environmental rehabilitation at the later date, resulting in sustainable development.

- To introduce environmental factors into the project planning and decision making.

4.3.2. Basic concepts of EIA report preparation

EIA report is based on studying the impacts to the environment from activities in the project and surrounding areas, effecting living, non living organism and the environment on short and long term basis. In preparing EIA report information from plant, animal, soil, water, air, human health and employment will be considered. The detail in the study varies with kind of project & project location.

EIA report is a technical report, based on the theoretical assessment of future environmental change. The study must point out the impacts of the project to the environment and natural resources. It should recommend suitable measures to prevent or to correct the project impacts to the environment and suitable methods to monitor environmental condition. The report must be clear and is easy to understand. It should mention method and technical reference used in preparing the report.

EIA report must offer alternatives for consideration i.e. project site selection, alternative method for project implementation which produces less pollution, to help in deciding project implementation. A comparative study on project investment and financial return in the report will be used as basic to design pollution control system in advance, to prevent impact to environment, before project implementation.

4.4. National Biodiversity Strategies and Action Plans

Two National Biodiversity Strategies and Action Plans (NBSAP) have been produced by the Biodiversity Section of Office of Natural Resources and Environmental Policy and Planning (ONEP), for the periods 1998-2002 and 2003-2007. The first five-year plan contained 446 proposed projects with a total cost of $140 million to be implemented by 67 agencies using internal funding. Unfortunately, due to the economic crisis in 1997, almost nothing of the first plan was implemented. For the second plan, the estimated budget is 7.54 billion Baht (or $188.5 million) and the status and success of NBSAP is to be monitored by the National Committee is emphasized. Its priorities are:

- Building capacity of institutions and their staff,
- Enhancing the efficiency of protected area management,
- Improving the incentives for conservation at the local level,
- Conserving species, populations and ecosystems,
- Controlling and monitoring processes and activities that threaten existence and richness of biodiversity,
- Promoting management of biodiversity in urban, rural and traditional cultural environments, and
- Promoting cooperation between international and national institutions.

An implementation of the NBSAP during recent period up to 2005 can be found in http://chm-thai.onep.go.th/NationalReport/20PartII/Article10[1].doc and http://chm-thai.onep.go.th/CHM/convention_eng1.htm

4.5. National Wildlife Management Master Plan 2004–2013

Over its first year Ministry of Natural Resources and Environment has prepared a number of plans to address biodiversity conservation, as well as forest management and restoration, protected areas, comprehensive water management, and wildlife. In 2003-2004, the government set up a broad committee to draft the *'National Wildlife Conservation Master Plan'*. Previously wildlife conservation in Thailand had been executed under the 'Wildlife Preservation and Protection Act', no master plan had ever been available to guide national activities, set targets, and evaluate results. The duration of the plan was set for 10 years and the proposed budget was estimated to be $450 million. The plan contains four approaches, 18 strategies, and 40 proposed projects. The 'approaches' are, 1) wildlife study, research, and databases; 2) integrated wildlife conservation and management; 3) conservation of diverse wildlife species and habitats; and 4) sustainable wildlife utilization. At the project level, each activity is specified with respect to objectives, duration, budget, evaluation indicators, and involved agencies. The Master Plan will be presented to the Cabinet for approval in late 2004. Two NBSAPs published by ONEP in 1997 and 2002.

4.6. Managing Protected Area

Protected areas (PAs) are the cornerstones of conservation without which the fullest possible range of biodiversity has little chance of enduring.

Thailand's PA system was created by legislation in 1961, and has developed a high degree of professionalism and growth. The system was modeled according to International Union for Conservation of Nation and National Resources (IUCN) guidelines, and its officials must have university educations and pass competitive civil service exams. Many officials have had graduate training abroad. Guards and rangers also receive special technical training to assist them in their duties, although greater professionalism could be developed in conservation crime investigation and law enforcement.

Thailand has 103 national parks, 55 wildlife sanctuaries and 56 non-hunting areas covering 53,000, 36,000 and 4,450 km^2 respectively (table 23). Between 1997 and 2003, the number of terrestrial national parks increased from 82 to 103 as more regenerating forest and watershed areas were reclassified. In the near future, it is expected that an additional 46 national parks, 4 wildlife sanctuaries, and 5 non-hunting areas will be added to the conservation estate. The total area of national parks is expected to increase significantly more in the future, consistent with the policy of promoting increased tourism in the Kingdom. By 2003, about 100 management plans for PA units had been drafted, including for 60 national parks. Their implementation has been carried out by the Land and Forest Resources Division of Royal Forest Department (RFD) with collaboration from Kasetsart and Mahidol Universities, the Thailand Institute of Scientific and Technological Research (TISTR) and private companies.

Table 24 Protected area by type of area: 1999-2003

Type of area	1999		2000		2001		2002		2003	
	Unit	Area (m^2)	Unit	Area (m^2)	Unit	Area (m^2)	Unit	Area (m^2)	Unit	Area (m^2)
Total	327	86,611.80	341	91,326.70	341	90,506.10	346	92,450.10	343	93,811.00
National park	96	48,927.80	102	52,226.10	102	52,263.50	102	52,263.50	103	52,782.20
Forest park	66	851.1	68	852.1	67	870.5	69	895.4	58	730.3
Wildlife conservation area	48	33,433.50	53	34,848.80	55	34,897.80	56	35,911.20	55	35,749.00
Non-hunting area	49	3,304.60	49	3,304.60	48	2,379.20	49	3,280.20	56	4,452.80
Botanical garden	15	59	15	59	15	59	16	63.7	16	60.1
Arboretum	53	35.8	54	36.1	54	36.1	54	36.1	55	36.6

Source: National Statistical Office, 2004

As of 2004, Thailand's 24 MPs protect coastal and marine areas that encompass 6,231 km^2 and include six percent of the coastline. Most (17) of these are located in the Andaman Sea, the rest are in the Gulf of Thailand. These PAs contain diverse and important biological resources, including habitats such as mangrove forests, coral reefs, seagrass beds, soft sediment communities and beaches. Thailand's marine PAs not only provide homes for many important marine species; they also give subsistence benefits to the local people and contribute to the valuable tourism and fishery industries. Whereas more than 50 percent of all coral reefs in Thailand are included in existing MPs, substantially less of other marine and coastal habitats occur in the MPs. For instance, only about 15 percent of the remaining mangrove forests are included in coastal MPs. Furthermore, even where MPs are in place the biodiversity of many areas is being degraded through overuse by the tourism and fishery

industries. Major threats to marine biodiversity include encroachment for resorts and shrimp farms, illegal fishing within prohibited zones, as well as infrastructure development within parks that is incompatible with conservation practice.

The Petroleum Authority of Thailand (PTT) constructed the first gas pipeline from Myanmar to the Gulf of Thailand and became involved in forest rehabilitation efforts along the route. With the participation and support of the Biodiversity Research and Training Program (BRT), PTT agreed to broaden their sponsorship to include small-scale PA management. The focus is Thong-Pha Phum NP, a strategic area where three major ecoregions converge, and part of the important Western Forest Complex (WEFCOM) that serves as an important corridor between the forests in the north of Thailand with those on the peninsula.

While it is widely believed that the management of protected areas in Thailand (and elsewhere) is improving over time, there have been no objective means of showing trends. In order to deal with this issue the IUCN, the World Bank and World Wildlife Fund (WWF) produced a *tracking tool* (a series of questions with scored answers). This tool has been translated into Thai and, it is hoped, will soon be applied across the country. Its use in Thailand would allow individual PAs to track improvements over time, as well as seeing how Thai PAs in general are faring relative to other countries.

4.6.1. Policy guidelines for governance

Policy and plan for promoting and maintaining national environment quality for the year 1997 – 2016 has been implemented. Core policy elaborated in this plan consists of

1) Policy on natural resources

This policy aims at increasing in use efficiency, coordinated use and conflict resolution, rehabilitating deteriorated resources, increasing of efficiency in managerial skill by way of systematic decentralization and coordinating mutual efforts of public-private partnerships, supporting economic principle in managing for efficiency and increasing equality, improving laws and regulations, supporting research and knowledge base society and also improving environmental data base, and increasing awareness to all.

2) Policy on pollution control

This policy aims at reducing and controlling pollution from community, agriculture, industry, and construction including rehabilitation of environment in high priority area to the economy, promoting systematic waste and hazardous waste management, and establishing the system for preventing and solving related accidence, developing implementing of unified system including applying of polluters pay principle,

3) Policy on rehabilitation of natural and architectural reserve in order to be developed as the national natural and cultural reserves.

4) Policy on community environment

This policy aims at managing of community environment and green belt areas for continuous improvement and maintaining their livelihoods and also responding to technology changes.

5) Policy on education and public relations to increase capability of community at all level to be strengthened and willing to cooperate in the process.

6) Policy on environmental technology to enhance using new technology in managing environmental quality.

4.7. Indicators on afore-mentioned issues

Table 25 Indicators on afore-mentioned issues

Indicators	Year				
	1992	1996	1997	2000	2003
• Proportion of land area covered by forest (%)	26.3	25.5	25.4	33.1	33.1
• Number of terrestial national parks			82		103
• Proportion of rivers that have quality monitoring system (%)					

4.8. Existing gaps

During an implementation of the second five years of the Environmental Quality Management Plan in 2002 – 2006, some gaps can be identified as follows:

1) Due to public sector reform in 2003, adjustment in responsibility and organizations has made changes in implemented agencies and an effect to an implementation of the plan.

2) Strategic plans of related agencies were not in line with the Environmental Quality Management Plan. And there was a lacking of an efficient integrated approach to link between the agencies concerned in environment and water.

3) Dissemination of the Plan is still in a limited target groups.

4) Insufficiency of personnel especially at the local level including lacking of equipment and mechanism for implementation.

5) Many components of the plan for example awareness raising and participation need time for implementing it.

4.9. Conclusions

An abundance of biodiversity in the past has been changed. Degradation in land, forest, head water, in-stream water and the others have affected and caused loss in biodiversity. To tackle with such problems interrelation among sectors has to be established and well planned. An implementation needs supporting instruments like law and enforcement, strong organizations, partnership between public and private, and a country-wide and individual basin awareness campaign.

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4.11. Recommended Reading

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5. http://www.onep.go.th/wetlandsthai

6. http://www.onep.go.th/eia/

7. http://chm-thai.onep.go.th/Publication/ThaiBiodiv/ThailandBiodiversity-eng.pdf

Challenge: Water and Human Settlements

Overview: In Thailand, the rural and urban area is defined based on type of governance. The rural is governed by local organization (i.e. District Authority Organization) while the urban is governed by the municipality. There are several important issues related to urban and rural migration including health problems and water supply. According to the UN database, the access of urban population and rural population to improved water supply and sanitation is increased. However, when comparing the sanitation indicators represented by the number of households with clean water and sanitary latrines, to the morbidity rate of major water-related disease such as acute diarrhea, food poisoning, dysentery and enteric fever, it was found that while the coverage of households with clean water and sanitary latrines has increased, the morbidity rate of acute diarrhea and food poisoning has also increased. Morbidity rate of dysentery and enteric fevers however, have decreased since 1990. For water supply issues, water supply in Bangkok and its vicinity is provided by a state enterprise called Metropolitan Waterworks Authority (MWA). Source of water is mainly from Chao Phraya and Tha Chin rivers. The water quality of both rivers is also discussed. In urban areas outside Bangkok and its vicinity water supply is provided by Provincial Waterworks Authority (PWA). For rural water supply, provision of safe water from village water supply system for all people in every village in Thailand has been carried out. In 2005, there are altogether 74,398 villages in Thailand; 63,796 villages have been provided with village water supply systems. Within three-year from 2006 to 2008, the Department of Water Resources will manage to provide the village water supply system to all remaining villages. Apart from the health problems and water supply, water demand management, decision making mechanism, and investing waste water treatment plants are also described in this chapter.

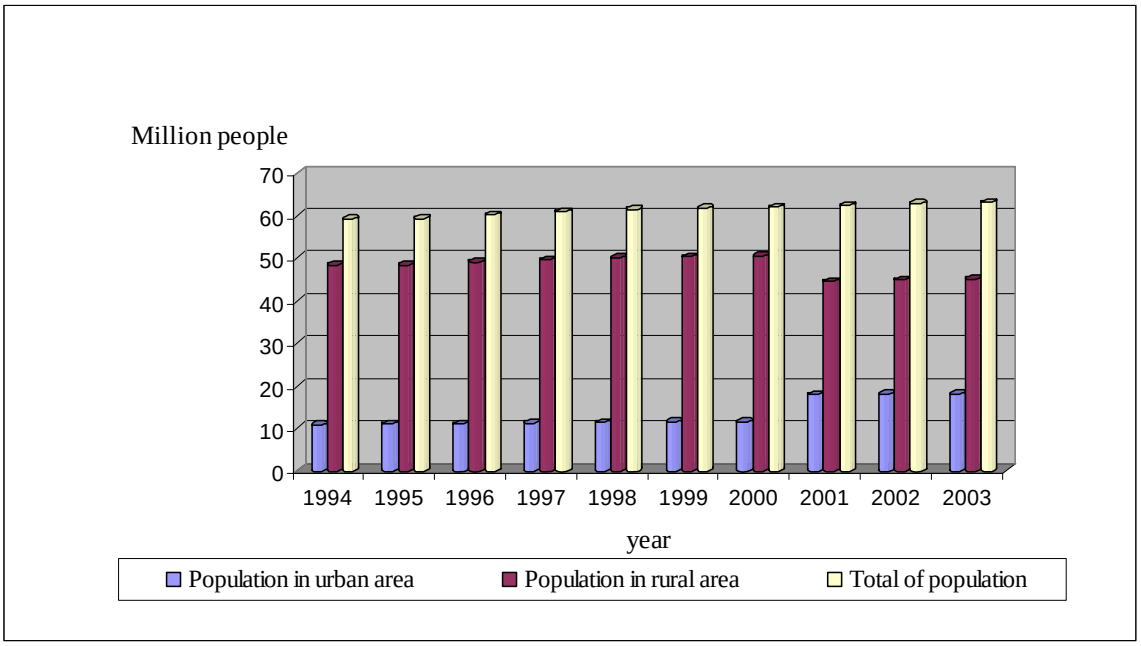
5. Water and Settlements

5.1. Definition of urban and rural settlements

Rural and urban areas are usually defined based on activity in the area, number of population, and population density of the area. Agriculture is assumed to be the principal activity of rural populations while industrial production and services are engaged primarily with urban dwellers. In Thailand, the rural and urban area is defined based on type of governance. The rural is governed by local organization (i.e. District Authority Organization) while the urban is governed by the municipality. The municipality must have at least 10,000 inhabitants and its density is 3,000 inhabitants per 1 square kilometer.

5.2. Urban and rural population

As of Department of Provincial Administration's registration database, number of urban population was increased considerably in 2001 due to an upgrade of the administration bodies at the village levels. The percentage of urban population increased from 18.5% in 2000 to 28.60% in 2003. In 2003 population of the whole country was 63,079,765 inhabitants with a growth rate of 0.7%. A number of urban population was 18,042,103 inhabitants or 28.60%. Comparing to the figure cited in World Population Monitoring 2001 by 2000, the share of the world population living in rural areas had declined to 53 %, while the number of urban-dwellers had risen to 47% (United Nations, 2000). The number of Thailand's urban-dwellers is less than the average of the global trend. However, notice has to be made that the official data excludes urban-dwellers who have not yet registered to the system.



Source : Department of Provincial Administration's registration database 1994 – 2003

Figure 15 Thailand's population

5.3. Access to improved water supply

According to Thailand Millennium Development Goal Report 2004, the proportion of population having access to safe drinking water increased from 80 percent to 93 percent from 1990 to 2000. Improvement was made in both urban and rural areas. The increase in access to safe drinking water was more prominent in rural areas rising 76 percent to 91 percent over the decade. The regional disparities that previously existed have been effectively closed.

It should be noted that only a small proportion of the population (particularly among rural dwellers) have access to piped water, which means they must rely on nature (rain water) and improved water storage. The proportion of households using bottled water also increased significantly from 5 percent to 19 percent between 1990 and 2000 – a result of higher income and prosperity.

Surveys show that piped water in Bangkok meets official quality standards. However, those living in rural areas have slightly lower quality drinking water. For example, in the provinces 68 percent of piped water met physical standards and 87 percent met bacterial standards.

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5.4. Poverty

5.4.1. Public Health Issues

5.4.1.1. Occurrence and frequency of water related diseases

The major health problems that related to water or food and water borne diseases are helminthes, diarrhea, dysentery, enteric fever (typhoid and paratyphoid fever) and food poisoning. The main causes are poor sanitation and non-hygienic behaviors. These diseases cause high morbidity and mortality among the Thai people and still represent the major health problems of the country.

Among these diseases, diarrhea is the leading causes of illness in Thailand with 1,055,393 cases reported in 2002. About 5,578 illnesses are due to typhoid fever and 6,617 cases are due to hepatitis. These diseases can be prevented by providing safe and adequate water supply and sanitation facilities and proper hygiene practices (WHO, 2004).

The Epidemiological Surveillance Report, Epidemiology Division, Office of Permanent Secretary, Ministry of Public Health (1973-2001) found that acute diarrhea and food poisoning are still increasing, whereas between 1983 and 2001 enteric fevers, dysentery and helminthes infection decreased.

The member of households with sanitary latrines had increased from 35.6% in 1975 to 98.1% in 2001. When comparing the sanitation indicators represented by the number of households with clean water and sanitary latrines, to the morbidity rate of acute diarrhea, food poisoning, dysentery and enteric fever, it was found that while the coverage of households with clean water and sanitary latrines has increased, the morbidity rate of acute diarrhea and food poisoning has also increased. Morbidity rate of dysentery and enteric fevers however, have decreased since 1990.

5.4.2. Contamination from wastewater discharges

5.4.2.1. Discharge load by sector

Water pollution from land-based activities is largely associated with urbanization, industrialization, and agricultural activities. Thus the major sources of pollution are domestic sewage, industrial wastes, and agricultural wastes. The main pollutants that pose to water quality problems are organic wastes, bacteria, nutrient, heavy metals, pesticides, and other chemical substances.

5.4.2.2. BOD and COD levels

The major water quality problems were high coliform bacteria (in term of total and fecal coliform bacteria, 34 %), total phosphorus (TP,15%), ammonia-nitrogen (NH-N, 6%), low dissolved oxygen (DO, 12%), and high organic matter (in term of biochemical oxygen demand :BOD, 2%), and nutrients (12%) (Simachaya, 2002). Generally speaking, these problems were perceived to be most serious during summer low flow periods when there is minimal dilution capability available. Once water quality problems have been identified, it is necessary to develop targets for restoration to undertake the planning exercise on a basin-wide basis.

5.5. Population movement and cities impact on ecology

5.5.1. Rural-to-urban migration

The national development with industrialization emphasis plays a major role in causing rural people to migrate to cities to seek jobs in the industrial and service sectors. The proportion of rural-to-urban migrants was 31.13% of all migrants in 2002; and it has been forecast that, in 2020, 38% of the total population will reside in urban areas (Figure 16). Most of the migrants will move to Bangkok, followed by to Bangkok's vicinity, as well as to the eastern seaboard area.

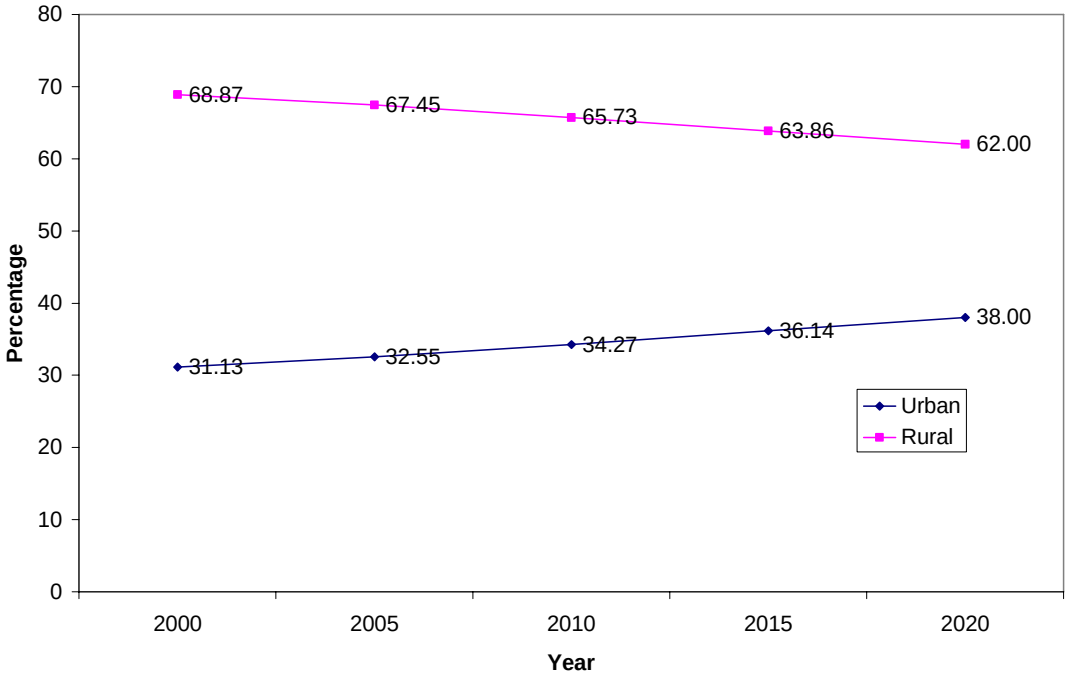

Figure 16 Projection of Urban and Rural Populations, Thailand 2000 – 2020

5.5.2. Urban-to-rural migration

The 1997 economic crisis resulted in the shutdown or downsizing of a lot of business operations. This led to a reverse of labour force mobilization from urban to rural domiciles, particularly to the Northeast and the North. In 1997, the migration of Thai population from urban to rural areas was as high as 37.2% of all migrants, while only 13.4 migrated from rural to urban areas. After the economics expansion in 2002, the proportion of urban-to-rural migration dropped to only 33.0% but the rural-to-urban migration rose to 19.2%, particularly from the Central Plains, the North and the Northeast (Table 25).

Table 26 Percentage of Migrants by Type of Migration and Current Residential Region, 1992 – 2002

Type of migration	Total	Current residential region				
		Bangkok	Central	North	Northeast	South
All migrants	100	100	100	100	100	100
Urban to urban	16.6	30.3	23.1	13.2	10.9	14.7
Rural to urban						
1992	15.5	n.a.	n.a.	n.a.	n.a.	n.a.
1994	15	78.4	9.8	10	6.9	14.4
1997	13.4	74.1	10.5	8.8	5.9	15.9
2002	19.2	67	21.1	14.1	9.6	18.6
Unknown[1] to urban	0.7	2.7	0.5	0.9	0.3	0.6
Rural to rural	28.4	-	29.8	31.4	28.2	40.5
Urban to rural						
1992	32.2	n.a.	n.a.	n.a.	n.a.	n.a.
1994	33.4	-	28.2	38.1	47	20.9
1997	37.2	-	32	39.6	55.5	20.3
2002	33	-	24.9	38	47.2	24.3
Unknown[1] to rural	2.1	-	0.6	2.4	3.8	1.4

Sources: Data for 1992,1994,1997 and 2002 were derived from the Reports on Surveys of Population Migration. 1992, 1994, 1997 and 2002.National Statistical Office.

Note: [1] Including immigrants from foreign countries

5.5.3. Common characteristic of migration

Due to more rural-to-urban migration, the migrants have to change their rural lifestyles and adopt urban lifestyles. This has mostly led to health problems in some workers who cannot properly adjust themselves to the changing conditions; such problems are mental disorders, peptic ulcer, hypertension, and certain diseases or conditions commonly found in urban slums, i.e., child malnutrition, diarrhea and tuberculosis. In addition, most of the migrant workers working in factories are more likely to be exposed to occupational diseases related to industrial chemicals, such as cancer and chemical poisoning. A number of them have to live in an unhygienic environment and some of those who are involved in commercial sex are at increased risk of contracting and spreading HIV/AIDS.

The increasing rural-to-urban migration has created problems of mega-cities requiring a suitable urban development planning approach; in this circumstance health and water services have to be provided to cover all target groups of population.

There is no certain pattern of population movement in Thailand. The significant factor pf movement depends on the direction of migration. Considering the migration from urban to rural areas, the main factor is the infrastructure. The urban area usually expands together with the construction of new infrastructure such as road. Since there is no zoning, the migration usually has an impact on ecology. Considering the migration from rural to urban areas, the main factor is the opportunity to find a job. Agriculture is assumed to be the principal activity

of rural populations while industrial production and services are engaged primarily with urban dwellers. Therefore, more recruitment is needed in the urban area.

5.6. Urban Development and Water Management

5.6.1. Water supply for urban area

Water supply in Bangkok and its vicinity is provided by a state enterprise, which is owned by the government called Metropolitan Waterworks Authority (MWA). Nationwide, potable water supplies are generally provided by two agencies: the MWA and the Provincial Waterworks Authority (PWA). The MWA engages in production and distrivution of potable water in the Bangkok metropolitan region while the PWA engages in production and distribution of water supply in urban area outside Bangkok. The MWA and PWA are responsible for water source development, conveyance, pumping, treatment, storage, and distribution facilities in all urban communities in Bangkok and the provinces all over the country. And PWA works in some communities of rural areas outside municipality areas as well.

Source of water is mainly from Chao Phraya and Tha Chin rivers, which is a part of the two largest dams, Bhumibol and Sirikit dams in the Chao Phraya River basin

5.6.1.1. Water quality of the Chao Phraya river

The Chao Phraya River is considered the lifeblood of Thailand. The 379 kilometer-long river supports 13 million people and is used in a variety of ways, including drinking water, irrigation, and as the primary water source for the Tha Chin River. As a confluent of the Ping, Wang, Yom, and Nan Rivers; the Chao Phraya River water quality is greatly affected by upstream activities. For example, in 1995, 2001, and 2002, upstream flooding resulted in high sedimentation rates and significant changes in water turbidity. In normal to low water levels, domestic, agricultural, and industrial discharges are greater than the river's capacity for self-purification. During 1993 to 2002, domestic, agricultural, and industrial discharges contributed 70 percent, 25 percent, and 5 percent to the waste load, respectively. In the Samut Prakarn Province Industrial Area, industry contributed over 70 percent to the total waste load.

In summary, the majority of waste discharged to the Chao Phraya River is organic waste and fecal coliform bacteria from domestic sources. Water quality is degrading with a slow restoration potential. Dissolved Oxygen (DO) is below the national standard in the lower part of the river. Existing wastewater treatment plants (WWTP) cover only limited areas. For example, in 2002, Bangkok only had a capacity to treat 20 percent of its wastewater. In order to improve the Chao Phraya River's water quality, construction of new wastewater treatment plants is suggested. Moreover, community involvements, through means such as water conservation and waste minimization programs in Pathum Thani and Nonthaburi, are essential (Simachaya, 2003).

5.6.1.2. Water quality of the Tha Chin river

The 320 kilometer-long Tha Chin River is a tributary of the Chao Phraya River and the Mae Klong River. Seventy-six percent of the Tha Chin River Basin is used for agriculture. In general, community, industry, and agriculture contribute 30 percent, 33 percent, and 47 percent to the waste load, respectively. Pig farms are the major source of pollution in Nakhon Pathom Province while industry is a major source of pollution in Samut Sakhon Province. From 2000 to 2002, the Tha Chin River was ranked the most polluted river in the country. Communities and effluent from pig farms in Nakhon Chaisri District, Nakhon Pathom Province were significant contributors to deteriorating water quality in the lower part of the basin. DO was below the national standard of 2.0 mg/l and occasionally below 1 mg/l. Many

canals became sewer lines and experienced rapid growth of water hyacinth. From April to May of 2000, over 16,000 hectares of rice fields were unexpectedly flooded generating over 100 million cubic meters of wastewater. The discharge polluted a reach of the river over 150 kilometers long with an estimated capital loss of millions of bahts. The cost of the ecological damage was not included. The water quality in the Thachin River is declining. Prior to 2000, the problem-solving process in the Tha Chin Basin was proceeding more slowly than in the Chao Phraya Basin. However, the crisis in 2000 presented an opportunity for collaboration among four provinces within the basin: Chainat, Supanburi, Nakhon Pathom, and Samut Sakhon. PCD and relevant agencies envision the Tha Chin River meeting the national water quality standards within the next 10 years. In 2002, the Royal Irrigation Department proposed two water-gates at Banglane District in Nakhon Pathom and Samut Sakhon Provinces for flooding control. However, the locals opposed the project in the public hearing, as it needs more study, especially in regards to the potential environmental impacts, before a tangible solution can be reached. The approach should also consider all stakeholders and other possible alternatives Water quality of the Chao Phraya river water quality of the Chao Phraya river (Simachaya 2003).

Water quality has been improved in the process of Metropolitan Waterworks Authority (MWA's) operation, all the production plants set the quality to meet 1993 WHO Standard for drinking water. According to MWA information all parameters of drinking water produced meets with this standard. (Metropolitan Waterworks Authority, 2004)

5.6.1.3. Leakage in the system

Target was set for MWA that in 2006 leakage from the system will be reduced to 30 per cent. Improvement of the water pipelines was started in 1996. From 1996 – 2004 the length of improved pipelines was 4,760 km. In 2002 – 2005 the project to improve waterworks system was launched in order to develop distribution system including distribution and leakage control by using measures to improve efficiency of distribution system and introduce new technology. As a result in 2004 the leakage was reduced to 30.06 percent.

5.6.1.4. Water supply for urban area outside Bangkok

In urban areas outside Bangkok and its vicinity water supply is provided by Provincial Waterworks Authority (PWA). In 2005 PWA was responsible in providing water supply for 12.1 million people in major cities all over the country. Out of it systems, 72 systems provide guaranteed safe water for drinking, which means they are completely equal in standard with Bangkok's water supply.

5.6.2. Water demand management

Water demand management has not yet been implemented extensively in Thailand. Water utility is the sector that is most involve in this area. Awareness raising campaign has always been made in order to promote water saving among users. However, in Thailand water use in this sub-sector is only 5 percent of the overall volume therefore economical use in this sector has limited affect to water sector as a whole.

5.6.3. Decision making mechanisms

5.6.3.1. Public Participation

Decision making mechanisms in water utility is mostly done by the agencies concerned with very limited public participation. However, considering the broader overview public participation is fully exercised at the river basin level as an involvement of civil societies on the River Basin Committees.

5.6.4. Pricing Policies

At present due to the traditional way of life that water is free, there is no water price for agricultural uses because farmers are poor. For water utility, a price of tap water is calculated based on investment cost not water cost. Payment rates for tap water that users paid to MWA and PWA are varied with type of uses (households, small business, government offices, industry).

5.7. Rural Water Supply

To increase the opportunity for people to access to safe water, provision of safe water from construction of pipe water for every village in Thailand has been carried out. In 2005, there are altogether 74,398 villages in Thailand; 63,796 villages have been provided with village water supply systems; 10,602 villages are still need the village water supply systems. Within three-year from 2006 to 2008, the Department of Water Resources will manage to provide the village water supply system to all remaining villages. And this is done through the local administration bodies, which are responsible for providing water supply in rural area.

5.8. Investing in Wastewater Treatment Plants

There are 87 wastewater treatment plants (WWTP) in 76 provinces of Thailand. All of them are built and funded by government agencies: 22 plants by Ministry of Science and Technology, 50 plants by Civil Department, 7 plants by Bangkok Metropolitan Administration, and 8 plants by other agencies. User pay principle was introduced as an alternative for funding wastewater treatment operation and maintenance and in turn increasing WWTP numbers in which result in clean water availability for poor. The study of charging user fee using polluter pay principle by Pollution Control Department and Wastewater Management Authority based on cost recovery accomplished in 2000. The concept is new to Thai and not yet widely applied. Currently there are four municipalities utilizing this tool and a few more are working toward the idea. Central government supports local government by financing the facility construction. Enforcement is through local government according to the Decentralization Act and the Enhancement and Conservation of the National Environmental Quality Act of 1992. The government is also encouraging private company involvement. Private company may either be an operator or a provider (Simachaya, 2003).

5.9. Other problems in urban and rural settlements

Another water related issue that has an effect toward people living in urban areas is flooding. Major floods in Bangkok have caused damage to the property and loss in economic activities. Flood occurred in Bangkok from 1942–1998 was 11 times in number during rainy seasons. Many factors contributed to such events, Bangkok is located in floodplain area, city expanded without proper city planning, retention areas were changed to building blocks, which are obstructed to drainage and when heavy rain occurred, and sometimes in conjunction with high sea tidal, all these factors contributed to flood. (Bangkok Metropolitan Authority: www.bma.go.th)

Figure 17 Picture shows flood event on the left and Flood Control Center on the right

5.10. Indicators on afore-mentioned issues

Table 27 Indirecators on afore-mentioned issues

Indicators	Year			Targeted	
	1990	2000	2005	2008	2010
• Proportion of urban population with access to an improved water sources (%)	96	97	99	100	
• Proportion of urban population with access to an improved water sources (%)	76.4	91	95	97	100
• Number of community water treatment plants	n/a	68	87		

5.11. Existing Gaps

Lack of sufficient, accurate and up-to-date data, ranging from basic demographics to land conversion and infrastructure deployment patterns are a serious impediment to designing better land management and human settlements policies. While continuous improvement in data quality and availability allows an increasing number of countries to include population estimates and projections in their national environmental plans, data and the resources required for their integration at the micro-scale level are rarely available. Also demographics statistics are called upon to illustrate the challenges lying ahead and the sheer magnitude of the work to be accomplished. (United Nations, World Population Monitoring 2001).

In urban area even piped water quality meet WHO standard and it is known that water from tap is drinkable, people consume bottled, filtered and boiled water which caused a waste of natural resources and energy. The most important finding made on bottled water available for sale in the market reveals that most of them found out to be lower quality than the tap water. The urban dwellers' behavior preferring to drink bottled water has to be changed and awareness raising campaign for people to drink tap water must be accommodated along with water conservation campaign, which has been carried out. In rural area, maintain of water supply system is one challenge that must be take into account. Another challenge is improving of water quality. In some rural area PWA needs to find a far away sources of raw water because of the quality problem and in some cases it has to purchase the land to construct reservoirs. This needs extra investment and it turns to be the cost of tap water production and it needs to be solved to avoid posing a burden of high prices to rural poor.

5.12. Conclusions

To provide sufficient and good quality of water to all villages is the challenges for Thailand especially when quality and management aspects are concerned. In rural areas main problems encountered are quality problems and the major one is high coliform bacteria (in term of total and fecal coliform bacteria, 34%). Other contaminations are chemical and physical. In order to purify, raw water an investment has to be made. The responsible agencies for providing clean water in rural areas are local administration organizations, which almost lack of enough budget and technical know-how. The government targets these organizations to provide pipe water to every village in 2008 with a support in budget and the technical know-how. Whether the target can be met must be monitored.

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Challenge: Water and Food

Overview: Agriculture especially rice growing has long been associated with Thai life and contributed to economic growth and prosperity. Although in 2004 it accounted for only 9.2 percent of GDP, 38.7 percent of population was engaged in this sector. The Central Plain of Thailand is provided with fine agricultural land (2 million ha.), extensive infrastructure (roads, irrigation system). The Central Region accounts for 53 percent of the sugarcane national production and contributes to rice self sufficiency and surplus for export. Diversification of crops, livestock, and aquaculture is vast in Thailand and water uses among these sub-sectors sometimes lead to conflicts both in term of quantity and quality.

In managing water for food there is a need to deal with water use, water control, cropping patterns, and land use as all of these factors are important for a stable production. In irrigated land attempt has been made in equitable allocation of water to farmers. However, in dry season various measures have to be taken into account to avoid conflicts over agricultural uses. They vary from rationalize water to adaptation of cropping techniques to the water regime. To some extent, it will alleviate the problems faced in this sector.

6. Water for food

6.1. Surface area of total cultivated area

6.1.1. Percentage of irrigated land

The percentage of irrigated area in each national economic and social development plan is summarized in Table 27.

Table 28 Progress and trends in 10 years of water resource development

National Economic and Social Development Plan	Irrigation Area (million rai)	% Irrigation area over total Area	Capacity (million m3)	% increase in capacity over previous year
First Plan	9.72	3.031	14.472	n.a.
Second Plan	10.96	3.418	15.079	4.19
Third Plan	14.38	4.484	24.347	61.46
Fourth Plan	15.84	4.939	25.462	4.58
Fifth Plan	18.71	5.834	28.669	12.6
Sixth Plan	20.71	6.458	30.2	5.34
Seventh Plan	21.68	6.76	31.662	4.84
Eighth Plan	22.39	6.982	32.314	2.06
Ninth Plan	28.49	8.884	36.599	13.26
Tenth Plan	30.710*	9.576*	39.253*	7.25*

Source: Office of Budget Programming and Project Planning

Note: Asterisk (*) denotes projected figure.

6.1.1.1. Water used for irrigation

1) Major crops and typical yield of irrigated agriculture

With some 20.4 million hectares (50.4 million acres) of farm land, of which about 10 million hectares (24.7 million acres) are under rice cultivation, Thailand continues to rely heavily on agriculture, although the country has suffered from declining export prices in recent years. Rice is the major crop grown; Thailand is the world's biggest rice exporter. Total rice production amounted to 17.5 million tons in 2001/02. The government has embarked on large-scale irrigation projects and introduced higher-yielding varieties of rice in an effort to increase production. In 2001, agricultural products accounted for 11.7% of exports and Thailand's agricultural trade surplus was nearly $4.5 billion (10th in the world).

Rubber, also a major export, is grown on the peninsula and, to a lesser extent, on the southeast coast. Total production in 1999 was 2,198,000 tons, the highest in the world and accounting for 34% of all production that year. Demand for natural rubber is growing along with the international concern about AIDS. Sugarcane production reached 52.8 million tons, while output of cassava (tapioca), traditionally important in Thailand, totaled 16.5 million tons. Thailand provides about 95% of the world's cassava exports. Much of the harvest is processed into chips and pellets and exported to the EU for fodder. Higher EU tariffs, however, have caused the Thai government to promote dairy, fruit, rubber, and cashew farming instead. Corn production, which has increased significantly in recent decades, reached 4.6 million tons in 1999. One third of annual corn production is consumed annually as fodder, with the remainder being exported to Europe and Japan. Kenaf, tobacco, cotton, and kapok are cultivated mainly for domestic use, but quantities of jute, cocoa, peanuts, soybeans, and medical plants are exported. Canned pineapple and fresh flowers, especially orchids, are important exports. The Thai government's official policy of encouraging mountain villagers to grow coffee, apples, strawberries, kidney beans, and other temperate crops instead of the lucrative opium poppy and marijuana has had some success; another aim of the project is to discourage deforestation through slash-and-burn cultivation. In 1987, King Bhumibol Adulyedej received a Magsaysay Award for International Understanding for his 20 years of effort in this area.

2) Water use efficiency and potential for improvements

Table 29 Increased irrigation area in percentage by NESD Plan

National Economic and Social Development Plan	Irrigation Area (million rai)	% Irrigation Area Increase by NESD Plan
1-3	14.38	
4	15.84	9.217
5	18.71	15.339
6	20.71	9.657
7	21.68	4.474
8	22.39	3.171

Source: Office of Budget Programming and Project Planning, 2004

3) Use of treated wastewater

In addition to cost - free development from government, which has the main responsibility in agriculture, Thailand has considered other types of development such as partial concession using wastewater from the agricultural sector for domestic and industrial purposes. The projects are:

- Dork Krai - Mabtaput - Sattahip pipeline project: implemented by the Eastern Water Resources Development and Management Co., Ltd. Under the concession, 72 million m^3 of water from the Dok Krai reservoir is supplied for domestic and industrial use. In any water shortage, the Royal Irrigation Department may set irrigation water for agricultural purposes as the main priority.

- Water Quality Improvement: In addition to providing new water resources and increasing agricultural management efficiency for projects initiated by His Majesty the King, the Royal Irrigation Department (RID) concentrates on water quality improvement. RID conducts sponsored research and development under the Chai Pattana Foundation. Experiment has been conducted in the area of wastewater and found that the tool can work satisfactory

4) Utilization of groundwater

Groundwater is an important source of water supply in Thailand. Public water supplies for one - fifth of the nation's 220 towns and cities and for half of the 700 Sanitary Districts are derived from groundwater. It is estimated that 75 percent of domestic water is obtained from groundwater sources. Groundwater system in Thailand is mainly recharged by rainfall of about 40,000 million m^3. and seepage from the rivers. It was estimated from previous hydrological balance studies that about 12.5 to 18 percent of rainfall would infiltrate the soils and about 9 percent of rainfall would reach the aquifers. However, this estimate is valid only for the basins under favorable geologic conditions such as those in the Northern Highlands, the Upper Central Plain and along the Gulf Coastal Plain. For the other basins such as those in the Lower Central Plain including Bangkok and in the Khorat Plateau, it was estimated that only 5-6 percent of rainfall reaches the aquifer. More than 200,000 groundwater well projects were undertaken by both government and private with total capacity of about 7.55 million m^3/day. (2,700 million m.3 /year) It is estimated that 75 percent of domestic water is obtained from groundwater sources which can be served approximately 35 million of people in villages and urban areas.

6.1.2. Percentage of rain-fed land

6.1.2.1. Major crops and typical yield in rain-fed land

In 2006 rain-fed agriculture land was about 70 percent of the total agricultural land area. Crops plant in this area are diversified and varied according to types of land which are low land or high land. In low land rice can be produced but with less productivity than the production in irrigated land. In high land the perennial crops are planted such as sugar cane, maize, cassava, and various orchards. Pattern of cropping depends on micro climate or pattern of rainfall of each area. According to a study in 1998/1999, which was done in 6 provinces in the North and Northeast of Thailand, it revealed that 87.9 percent of farmers growing rice and water uses were mainly from natural canals. Most popular dry land crop was soy bean but the most income generating was vegetable.

6.2. Water use of livestock, fisheries and aquaculture

In the 1980s, the fisheries sector was of major importance to the economy as an earner of foreign exchange, marine products accounting for about 10 percent of total exports in 1986. Fish also accounted for about three-fifths of the protein in the national diet and an even higher proportion among the poorer rural population. Until the early 1960s, the country had been a net importer of fish. This situation completely changed with the introduction of trawl fishing, which resulted in a dramatic rise in the marine catch from 146,000 tons in 1960 to 1 million tons in 1968 and 2.1 million tons in 1985. Thailand became the third largest marine fishing nation in Asia after Japan and China. Of Thailand's 40,000 fishing vessels, nearly 20,000

were deep-sea trawlers, many with modern communication and navigation equipment and refrigeration facilities.

By 1980 large-scale fishing operations, based largely in urban areas, were responsible for 88 percent of Thailand's annual catch. The fishing industry was the economic backbone of many Thai coastal cities. The increase in the catch of shrimp was particularly notable, and shrimp exports became a major source of foreign exchange earnings. By about 1972 maximum exploitation of demersal (bottom-dwelling) and pelagic (open-sea) fish appeared to have been reached in the Gulf of Thailand and in the Andaman Sea. In the early 1980s, production remained relatively static, and there was growing concern that these areas were being overfished.

Government control of fishing was limited. The use of certain kinds of fishing gear within three kilometers of the coast was banned, but there appeared to be no restriction on trawl net-mesh size, and undersized commercial food fish were being caught and dumped in with trash fish in the production of fishmeal. Moreover, during the 1970s neighboring Cambodia claimed territorial waters extending to 200 nautical miles from its coast. This reduced the area in the Gulf of Thailand available to Thai fishermen and increased the intensity of fishing off the coast of Thailand. Similar claims by Burma had also restricted Thai fishing in the Andaman Sea.

Inland fisheries, which included both freshwater and brackish water fish, officially reported annual catches of about 160,000 tons in the early 1980s. The actual catch--principally freshwater fish from flooded rice paddies, swamps, irrigation and drainage ditches, canals, reservoirs, rivers, lakes, and ponds--was estimated to be much higher. It was believed, however, to be declining as population growth resulted in overfishing and as increasing water pollution from industrial waste, insecticides, and siltation caused by forest destruction took its toll.

The most promising course for maintenance of fisheries production at the level attained in the 1970s, or for increasing output, was the expansion of aquaculture, including the culture of fish, shrimp, and various mollusks, such as mussels, oysters, and clams. According to the Department of Fisheries, about 4.5 million hectares of inland water areas, mostly rice paddy fields, were suitable for aquaculture. Another 1.3 million hectares, including estuaries, mangrove swamps, and tidal flats, were also usable.

6.3. Goals and Programs

6.3.1. Agricultural policies

6.3.1.1. Reforming irrigation

Thailand is preparing the fundamental structure in order to increase efficiency in the agricultural sector, which is very important for country considering the ratio of agricultural sector over the GDP.

Different conditions in the past together with the economic crisis of the country and the other factors in guidelines, measurement, policy and vision such as constitution 1997, national water policy, vision frame in natural resources management, agricultural productivity, and farmers' participation in the management and cost sharing. Therefore, Thailand must change its concept of water resources development from quantitative to qualitative orientation. Implementations include increased irrigation efficiency, quantity of irrigation water, and promotion in farmers' participation for water management.

Guidelines for Thailand's development can be classified in four main categories: 1) water resource development projects, 2) irrigation system modernization, 3) management improvement, and 4) concession and water quality improvement. Application of these concepts will solve Thailand's socio-economic problems as well as secure sustainable development in the agricultural and irrigation sectors.

6.3.2. Social aspects

6.3.2.1. The role of irrigation in alleviating poverty and improving food security

The agriculture sector needs to link the central task of providing water services to good agricultural practices. It needs to integrate into basin-level water resources management to secure optimal supply, sustainable use and integrated management of water resources and to achieve substantial production increases and diversification of farm income.

Irrigated agriculture systems should aim at improve water use efficiency and productivity and irrigation service through irrigation modernization, including adoption of modernized design concepts, rehabilitation and upgrading of infrastructure, management reform and technical innovations.

Rain-fed agricultural systems should aim at better use of natural rainfall through soil and water conservation, adoption of drought tolerant crops and development of water harvesting systems.

The livestock and agro-processing industries must also reduce their ecosystem impact and become good water citizens.

Integrated pest management could be adopted to reduce the pollution of surface and groundwater bodies by agriculture chemical inputs.

6.4. Indicators on afore-mentioned issues

- Existence of right to use water for subsistence agriculture
- % coverage of irrigation area

6.5. References

1. Kasetsart University, ORSTOM. 1996. Agricultural and Irrigation Patterns in the Central Plain of Thailand: Preliminary Analysis and Prospects for Agricultural Development. Bangkok, Thailand.

2. Panbua, K. 2000. Production and Marketing Condition of Dry Land Crops in Rainfed Agricultural Land, 1998/1999.

3. Office of Budget Programming and Project Planning, 2004. Royal Irrigation Department. Documents for internal uses.

Challenge: Water and Industry

Overview: Industries are vital to human societies and is one of the main users of water. However, industry should assume their responsibility to respect water quality and should take account of the needs of competing sectors

Industrial activity in the Thailand is dominated by manufacturing (including agroindustry, but also some textiles, light assembly, rubber processing etc). Medium and large local and national companies have made major investments in all types of food processing, animal feed production, wood products manufacture, fertilizer and other agrochemical production, and various sorts of agricultural equipment manufacture (BDP, 2002a).

7. Water and industry

Water supply and distribution systems in Thailand are primarily covered by three state owned enterprises. The Metropolitan Waterworks Authority (MWA) deals with the production and distribution of tap water for urban areas, while the Provincial Waterworks Authority (PWA) treats and distributes tap water for regions outside of urban areas. Municipal and private water companies also exist. The Waste Water Management Organization (WWMO) treats wastewater and was created just over two years ago.

7.1. Characterization of industrial activity in Thailand

As Thailand is divided into 5 regions (Central, East, North, Northeast, and South), it is of interest to first examine the distribution of employment and industrial activity at the regional level. The Central region of Thailand (which comprises Bangkok and the heavily industrialized province of Samut Prakarn) accounts for approximately 65% of all factories and 71% of total industrial employment. In fact, the four largest provinces in terms of industrial employment in Thailand are located in the Central Region (Bangkok, Samut Prakarn, Samut Sakhon and PathumThani) and alone represent 55% of the total industrial employment of the country.

Within each region as referred to “Estimating Conventional Industrial Water Pollution in Thailand”, Benoit Laplante and Craig Meisner, Development Research Group of the World Bank, September 2001, a very small number of provinces typically account for a large share of the total number of industrial employment. This is especially the case with the East Region where the provinces of Chonburi, Chachoengsao, Rayong, and Prachinburi accounts for 96% of total industrial employment in the region. In the Northeast Region, the province of Nakhon Ratchasima alone accounts for 41% of total industrial employment in the region, while Bangkok accounts for 36% in the Central region. In the North Region, industrial employment is more or less equally divided between the provinces of Chiang Mai, Lampang, and Lamphun. Finally in the South Region, Songkhla province represents the bulk of industrial employment.

There is no region appears to heavily depend on a single industrial sector with perhaps the exception of the South Region where the Rubber Products (ISIC 3559) and Fish Products (ISIC 3114) industries account together to approximately 37% of the total industrial employment in the region.

This result also extends at the provincial level where none of the most important provinces (Bangkok, Chonburi, Nakhon Ratcharisma, Chiang Mai, and Songkhla) markedly depend on a single industrial sector. The exception may however be the province of Songkhla where approximately 58% of the total industrial employment is found in the Rubber Products and Fish Products industries.

While none of the regions and provinces heavily depends on a very small number of industrial sectors, it is to be noted that some industrial sectors are significantly concentrated in a small number of provinces. These include industrial sectors known to be important sources of pollution. For example, 39% of the total national employment in the Industrial Chemical (International Standard Industrial Classification of All Economic Activities (ISIC) 3511) sector is located in Rayong. Similarly, 43% of total employment in the Dairy products industry (ISIC 3112) is located in Samut Prakarn – so is 35% of the Iron and Steel industry (ISIC 3710); 36% of the Fertilizers and Pesticides industry (ISIC 3512) is located in Phra Nakhon Si Ayudhya; 35% of the Fish Products industry (ISIC 3114) is located in Samut Sakhon and 25% of the Rubber Products industry (ISIC 3559) is located in Songkhla.

In general, industrial estates account only for a small percentage of the total number of manufacturing establishments (2.6% of all establishments are located in industrial estates), and of the total number of industrial workers (9.3%). However, in a small number of provinces, industrial estates do represent a large contribution to industrial activities. In Rayong and Chonburi, approximately 35% of industrial employment is located in industrial estates.

7.2. Water demand of industry

Industrial water withdrawal is still limited compared to the agricultural sector. Water demand conflicts between industry and other sectors have occurred in Thailand. Water quantity aspects become a serious problem for the industrial sector development in the foreseeable future, with double-digit growth rates for industrial development in certain areas.

Water withdrawals are estimated to be 5% for domestic use and 3% for industry (ADB, 2000A) Competition and conflicts over water consumption between agriculture, industry, service sectors, and urban and household consumptions are increasing. Water is becoming increasingly scarce and the government faces supply-and-demand side challenges (ADB, 2000A).

7.2.1. Water Withdrawal for different sectors

Water withdrawal for different sectors, municipal, industrial, irrigation and ecological maintenance, in 2001 can be concluded as following.

Table 30 Water Withdrawal for different sectors

Sector	Water Withdrawal (m^3/year)	Portion of Withdrawal (%)
Municipal Use	2,636.28	4.27
Industrial Use	1,316.33	2.38
Irrigation Use	32,111.65	57.97
Use for Ecological Maintenance	19,598.89	35.38
Total	55,390.15	100

Source: Effective National Water Resources Mangement and 25 Significant National River Basin Management Study, Kasetsart University, July 2004

7.2.2. Industrial Water Demand

The growth of domestic productive industry before 1997 is at a very high rate. Some of water supply is from surface water source close to the industry location and applicable for using such as canals rivers or natural streams. However, most of the industry location is difficult to use water from such sources, underground water is used instead. The industrial use of underground water has a significant effect of land settlement problem. Therefore, water supply should be sufficiently provided for the high growth of industrial production.

The quantity of industrial water utilization required for each type of industrial production is different. According to the study on various industries in 6 industrial estates in 2001 by dividing industries into 19 types, it was found that glass and ceramic industry has the highest water utilization of 12,333.31 m^3/rai/year compared to the water utilization in timber production industry of 482.24 m^3/rai/year in average. In overall industry, the industrial water utilization is 1,892.28 m^3/rai/year or 30 m^3/rai/day (considering industry working day of 300 day/year and 6.25 rai = 1 ha.).

7.2.3. Projection of Future Demand

The future water demand in productive industry was forecasted based on change in the growth of production rate. The forecasted industrial water demand with respect to the growth of production rate is shown as following.

Table 31 Industrial Water Demand in 1994-2018 with respect to Production Capacity

Year	Industrial Estate (m^3/day)	Outside Estate		Total (m^3/day)	Production (m^3/day)
		Food Industry (m^3/day)	Automobile industry (m^3/day)		
2004	468,963	1,525,661	135,618	2,130,242	2,840,322
2005	503,713	1,638,712	145,667	2,288,093	3,050,790
2006	541,038	1,760,141	156,461	2,457,640	3,276,854
2007	581,129	1,890,567	168,055	2,639,751	3,519,668
2008	624,191	2,030,658	180,508	2,835,357	3,780,476
2009	670,444	2,181,130	193,884	3,045,457	4,060,609
2010	720,123	2,342,751	208,250	3,271,125	4,361,500
2011	773,485	2,516,349	223,682	3,513,516	4,684,687
2012	830,800	2,702,811	240,256	3,773,867	5,031,823
2013	892,362	2,903,089	258,059	4,053,511	5,404,681
2014	958,486	3,118,208	277,182	4,353,876	5,805,168
2015	1,029,510	3,349,267	297,721	4,676,498	6,235,331
2016	1,105,797	3,597,448	319,782	5,023,026	6,697,369
2017	1,187,736	3,864,019	343,478	5,395,233	7,193,644
2018	1,275,747	4,150,343	368,929	5,795,019	7,726,693

Source: Faculty of Economy, Thamasart University, 2004

7.3. Industrial water use efficiency

In industrial waste water management, the standard of disposal water quality from industry was specified for some industries with large quantity of water utilization and waste water disposal. 10 types of industry with large quantity of waste water disposal significantly causing 95 % of industrial water pollution by means of BOD are shown as following.

Table 32 Pollution of BOD in different Industrial water using

Industry Type	BOD in %
Pulp and Paper	32
Chemistry	15
Sugar	10
Alcohol	9
Milk Product	8
Metal excluding steel	7
Plastic	6
Fishery Product	5
Food and Fruit Reservation	2
Polyester	1

7.3.1. Industrial water management

Factory which is considered as pollution source by Laws has to install pollution treatment and protection system for water discharging to environment to comply with the standard. In case of factories in industrial estates, pre-treatment system of waste water might be installed before discharging to the central treatment plant of the estates according to required relevant standard of the estates.

Industrial estates will consider constructing the waste water treatment and collecting system with the capacity sufficient for the maximum water utilization according to the size of industry and business area such as 7-10 m^3/rai/day. However, some industrial estates require larger capacity. Besides, factories in some industrial estates have their own water treatment system which can treat water to obtain the standard of the Factory Department and can be directly discharged to environment such as Mab Taput Industrial Estate. The construction of treatment system in most industrial estates usually decomposes into phases since the whole area would not be sold within the first five years. The treatment system is therefore expanded with respect to the expansion of occupied area. Table 26 shows the details of water treatment plants with their capacities in various industrial estates. It is noted that the capacity of the treatment system was calculated for the industrial estates with no information and the total capacity of all industrial estates is 293,300 m^3/day.

Table 33 Water treatment plants in various industrial estates

Estate Name	Province	Use of Area		Treatment Capacity	System
		Industry	Business		
1.Anyathani	Bangkok	73.84	43.37	N/A	-
2.Lad Krabang	Bangkok	1,899		18,600	AS
3.Bang Chan	Bangkok	510	54	N/A	-
4.Sin Sakorn	Bangkok			N/A	
5.Saharat Nakorn	Ayuthaya	868	39	8,000	AS
6.Bang Pa-in	Ayuthaya	1,273	63	12,800	AS
7.Ban Wha	Ayuthaya	1,500	108	16,800	AS
8.Kaeng Koi	Saraburi	449	115	5,000	N/A
9. Nong Kae	Saraburi	1,464	168	15,000	AS
10.Wellgrow	Chacheongsao	2,342	99	1,100	AL, SBR
11.Gateway City	Chacheongsao	3,682	52	17,000	AS
12.Lumpun	Lumpun	6,000			AL
13.Pichit	Pichit	699.58	66.52	5,100	Stabilization pond
14.Khon Kaen	Khon Kaen	20		N/A	
15.Ratchaburi	Ratchaburi	918	157	10,000	
16.Southern	Song Khla	319	45	3,000	AS
17.Asia	Rayong	1,988	8	17,000	
18.Amata City	Rayong	1,996	410	15,000	AS
19.Eastern Seaboard	Rayong	4,826	29	30,000	AS
20.Pha Daeng	Rayong	497.25		N/A	
21.Eastern	Rayong	1,859		12,000	AS
22.Mab Taput	Rayong	5,028.75	627.25	4,000	AS
23.TS 21	Rayong				N/A
24.Pin Tong	Chonburi	136	14	N/A	
25.Amata Nakorn	Chonburi	1,500		15,000	AS
26.Laem Chabang	Chonburi	2,634	146	20,500	AS
27.Bo Win	Chonburi	3,248	72	8,400	AS
28.Samut Sakorn	Samut Sakorn	1,046	28	21,000	AS
29. Bang Pli	Samut Prakarn	796	14	8,000	AS
30.Bang Pu	Samut Prakarn	3,871	236	30,000	AS, AL, RBC

Remarks : AL : Aerated Lagoon, AS : Activated Sludge and SBR : Sequence Batch Reactor

Source : Industrial Estate Authority of Thailand

7.4. Industrial value added from water use

Thailand is one of the world's major primary products and agro-industrial producers and is sometimes referred to as a NAC, a newly agroindustrialised country' (BDP, 2002a).

The industrial sector contributes more than 40% percent of GDP, of which manufacturing is more than 80%. Table 27 illustrates the economic activities as percent of GDP.

Table 34 Economic activity as percent of GDP, 2000

Sector	%
Agriculture	10
Industry	44.3
Service	45.7

Source: ADB, 2001b

On the employment side, three branches account for more than 60% of the total employment in manufacturing. However, the value-added from the same branches is less significant. See Table 28.

Table 35 Value-added and employment in manufacturing, 1994

Branch	**Value-added**	**Employment**
	Share in total (%)	**Share in total (%)**
Food products	9.3	12.5
Textiles	8	16.5
Wearing apparel, except footwear	9.4	28.9

Note: Based on data supplied by national sources with estimates by the Statistics and Information Networks Branch.

Source: www.UNIDO.org, 2004

Most industrial establishments are situated in the greater Bangkok metropolitan region, whereas agriculture is still a major sector of the economy in the Thai areas of the LMB, contributing well over 20% of the regional GDP (BDP, 2002a).

7.5. Impact of industry on degradation of water quality

Considering industrial water quality, pollution problems are identified, especially in major cities such as Bangkok and metropolitan area, Chiang Mai, Phuket, Nakon Ratchasima and Eastern Sea Board provinces. Generally, there is limited treatment of industrial wastewater and insufficient handling and disposal of industrial hazardous waste. So far, industrial water pollution is mainly concentrated around specific industrial establishments and downstream of major urban areas. The growing industrialisation in Thailand provides a warning that more severe water discharge problems will occur and inter-sectoral conflicts of water quality demands will increase.

As indicated in Table 29, industrial wastes are expected to grow accordingly with expansion of the sector. Over the next 10 years the pollution loading is expected to increase by 87%.

Industrial development is also increasing the amounts of hazardous wastes. For example the generation of hazardous wastes in Northeastern Thailand is expected to increase by about 72% over the next five years (but this level represents only 1% of total hazardous waste generated in Thailand), (UNEP/MRC, 1997)

Table 36 BOD loadings in Thailand, 1991, (2001 and 2010 forecasted)

Factory type	1991	2001	2010
Sugar	154	321	566
Pulp and paper	103	233	444
Rubber	96	178	276
Beverages	91	171	274
Tapioca	40	87	157
Slaughter	15	19	22
Canned fish	11	20	32
Tannery	10	40	136
Canned Pineapple	4	6	7
Total	525	1,075	1,914

Note: BOD = Biochemical oxygen demand.

High BOD loadings imply oxygen low discharge water sources.

Source: (UNEP/MRC, 1997)

7.6. Industrial water pollution in Thailand

7.6.1. BOD and TSS emissions: Geographical analysis

7.6.1.1. Regional and provincial estimates

For both of these pollutants as referred to "Estimating Conventional Industrial Water Pollution in Thailand", Benoit Laplante and Craig Meisner, Development Research Group of the World Bank, September 2001, it is observed that the Central Region of Thailand accounts for a large share of both BOD (63%) and TSS (71%) emissions. Within the Central Region, the province of Samut Prakarn is the largest contributor to both BOD (22% of regional emissions) and TSS (36%); Samut Sakhon and Bangkok come second and third. According to these estimates, Samut Prakarn alone thus accounts for more than 12% of the total industrial emissions of BOD in Thailand, and more than 20% of total industrial emissions of TSS in the country. In the East Region, Rayong is the largest producer of both BOD and Chonburi of TSS. In the North, Chiang Mai is the largest producer of both BOD and TSS. In the Northeast Region, Nakhon Ratchasima is by far the largest producer of BOD and TSS. Finally in the South, Songkhla is the largest producer of both BOD and TSS.

7.6.1.2. Water basin estimates

Thailand comprises 37 water basins, with the Central and South Regions accounting each for 11 basins. Authorities in Thailand have recently expressed a willingness to introduce comprehensive pollution control programs based on a water basin demarcation of the territory. To this extent, it is of interest to examine industrial pollution using water basins as a geographical unit.

In the Central Region, the Chao Phraya water basin accounts for the largest share of BOD and TSS emissions, followed by the Tha chin water basins. In the East Region, the East Coast-Gulf is by far the water basin contributing most to industrial pollution with more than 63% of TSS emissions in the Region. In the North Region, the Nan and Ping water basins contribute most to industrial pollution. In the Northeast and South Regions, the Moon and Songkhla water basins respectively account for most of the industrial water pollution.

7.6.2. BOD and TSS emissions: Industrial sector analysis

As referred to "Estimating Conventional Industrial Water Pollution in Thailand", Benoit Laplante and Craig Meisner, Development Research Group of the World Bank, September 2001, at the national level, the Pulp, Paper and Paperboard sector (ISIC3411) is the largest producer of BOD. This sector accounts for 32% of total industrial BOD emissions. The Industrial Chemicals sector account for 15% of total BOD emissions. Other important sectors include Sugar Factories and Refineries, Distilled Spirits and Dairy Products. The first six largest industrial producers of BOD account for approximately 80% of total industrial BOD emissions in the country. With respect to TSS, the Iron and Steel sector (ISIC 3710) account for a very large share of total industrial TSS emissions with a share of 61%. Other industrial sectors represent only a very small percentage of emissions when compared to Iron and Steel, with the Pulp, Paper and Paperboard and Nonferrous Metals sectors coming a distant second with 9% of TSS emissions each. The first six largest sectors account for more than 90% of total industrial TSS emissions.

At the regional level, it is observed that a very limited number of industrial sectors typically account for the bulk of the industrial emissions of BOD and TSS (typically for over 90% of emissions). In the Central Region, the Pulp, Paper and Paperboard industry produces 37% of total BOD emissions and the Iron and Steel industry produces 61% of TSS emissions. This industry also accounts for 72% of TSS emissions in the Eastern Region, and for 70% of the same emissions in the Northeastern Region. It is also an important producer of TSS in the Southern Region, along with the Rubber Products industry. The Industrial Chemicals sector and the Fish Products sector are the largest producers of BOD in the Eastern Region (41%) and Southern Region (43%) respectively. Pulp, Paper, and Paperboard and Sugar Products and Refineries are large producers of BOD in the North and Northeast Regions.

The Iron and Steel industry is the most important producer of TSS in most regions of Thailand, except in the North Region where the Pulp, Paper, and Paperboard industry comes first, and in the South Region where the Rubber Products industry represents shares first place with Iron and Steel. As for BOD, the Pulp, Paper, and Paperboard industry represents the largest producer in the Central region. In all regions of Thailand, important producers of BOD are the Dairy Products industry, the Sugar Factories and Refineries, and the Distilled Spirits industry.

That a very limited number of sectors account for a very large share of conventional industrial water pollution is even more accentuated when the estimates are examined at the provincial level. For example, in Samut Prakarn, the Iron and Steel industry accounts for more than 80% of total industrial emissions of TSS. Other industrial sectors are insignificant when compared to Iron and Steel. In Samut Prakarn, 16 plants alone (7 plants in the Pulp, Paper and Paperboard, and 9 plants in the Dairy Products industry) produce 45% of BOD emissions in the province. In the province of Rayong, the Industrial Chemicals sector explains 75% of total BOD emissions. In the province of Chiang Mai, 3 factories alone account for approximately 45% of total industrial emissions of BOD. A similar result is observed in the province of Nakhon Ratchasima where 4 sugar factories and refineries account for more than 50% of total BOD emissions, and 4 iron and steel plants account for more than 80% of TSS emissions. In Songkhla, 33 plants in the Fish Products industry produce approximately 90% of total provincial emissions of BOD.

For each of the 37 water basins in Thailand, it is possible to examine the nature of the industrial sectors that contribute most to the industrial load of BOD and TSS. Insofar as BOD is concerned, examination of these results reveals that across all river basins, the Pulp, paper and paperboard, Dairy products, Distilled spirits, Sugar factories and refineries, and Fish products account systematically for most of the BOD pollution originating from the industrial sectors. As for TSS, the Iron and steel industry, and the Nonferrous metals industry systematically account of a large share of the industrial load.

Finally, except for the province of Rayong, our estimates reveal that firms located in industrial estates appear to be small polluters relative to firms located outside industrial estates.

7.7. Policy guidelines and incentives

Ongoing demand on both the MWA and the PWA to upgrade and strengthen their systems across the full range of the supply chain is creating a driving force for change within Thailand's water industry. To meet this significant challenge, the industry will need to enhance performance and attract capital inflows.

- MWA: two private sector participation options exist for MWA. The first option is horizontal separation, creating East Bangkok Co. and West Bangkok Co. Under this option, each company will be responsible for the range of activities, from bulk water supply to distribution, billing and metering. The second option involves the corporatisation of MWA to form MWA Co., which in turn will take on a strategic partner that will undertake operation and management of the utility through a management contract.

- PWA: it is proposed that a process of horizontal unbundling be executed, with the possibility of PWA acting as a contract manager in the future, overseeing concession arrangements for the different regions/divisions. The precise nature of this unbundling exercise and PWA's role will be defined following a detailed sector analysis.

- Wastewater treatment facilities and underlying environmental performance standards are largely the responsibility of individual municipalities, however water and wastewater reforms must be linked to ensure environmental quality and effective private sector participation in each sector.

- Regulation: this model of private sector participation will be balanced by an independent regulator established to provide oversight of the water industry. In particular, this regulator will provide certainty to private sector participants with regard to the interpretation of contracts or concession agreements and ensure customer safeguards in the areas of tariffs, quality of service and dispute resolution.

- Timeframe: action will be taken in three core areas and according to the following target timeframe:

- Legal and regulatory reforms to be in place by the end of 1999

- Sector specific actions to be implemented by 2nd half of 1999/1st half of 2000

Enterprise specific actions to be taken by 2nd half of 1999

7.8. Indicators on afore-mentioned issues

- Intensity of application of economic tools in pipe water
- Intensity of application of “polluter pays” principle
- Recognition of environmental cost in the use of groundwater
- Intensity of water reuse

7.9. Reference

1. Benoit Laplante and Craig Meisner, Estimating Conventional Industrial Water Pollution in Thailand, Development Research Group of the World Bank, September 2001

2. Kasetsart University, Effective National Water Resources Management and 25 Significant National River Basin Management Study, Final Report, July 2004

3. Mekong River Commission, Regional Sector Overview, Water Supply: Domestic Water and Sanitation and Industrial Water Use, Basin Development Plan, November 2002

Challenge: Water and Energy

Overview: Thailand possesses a diversity of types and sources of energy, but in modest quantity compared to other countries. Fossil energy plays the major role, especially petroleum products which are used for transportation, electricity generation, as well as used as raw materials in the production process of various industries. Natural gas is however, largely used in electricity generation. Energy consumption rate in Thailand as average of 15 years during 1990-2005 was 1.4 times of economic growth or the energy elasticity of 1.4:1, that is to say if the economy is growing by 5% annually, energy consumption would grow by 7%. Various measures on both demand and supply sides have been implemented to reduce the energy elasticity to 1:1 in 2007.

8. Water and Energy

8.1. Current Energy Production and future Projections

The total of Energy Supply was 92,491 ktoe, rose 7.8-7% from Year 2002, with the net import of 44,342 ktoe or 47.9% of the total Energy Supply while the Domestic Production was 48,149 ktoe or 52.1%

The total primary energy production in 2003 is equivalent to 0.671 million barrel per day with the annual growth of 6.4 %. The most produced energy resource is natural gas with the production of 0.378 million Barrel per day or equal to 56.3 % of the total. Later order of produced energy resources are Lignite of 0.1 million Barrel per day or 16 %, crude oil of 0.096 million Barrel per day or 14.3 %, Condensate of 0.057 million Barrel per day and hydroelectric power of 0.03 million Barrel per day or 4.7 %. The natural gas production indicates its high growth rate in passing years while the growth rates of producing crude oil and condensate are very high, especially the crude oil increasing of three times in 5 year. This shows that the producers increase their capability in the production from the existing sources while continuously explore new sources. Electricity is generated from various energy resources such as natural gas, lignite, coal, etc. However, most of electricity power is generated from natural gas which is also significantly increasing while the generation from other resources is reducing. Hydroelectric power generation highly increases in latest 3-4 years due to the increase of installed capacity from pumped storage system with a large amount of water while power generation from other renewable energy still has small portion in the power system. Besides, the imported electricity from neighboring countries is about 2 %.

8.1.1. Domestic Production

Domestic primary energy production in 2003 was 48,149 ktoe, with an increase of 6.5% over 2002. Commercial energy contributed 69.3% of the total indigenous energy production, and renewable energy contributed 30.7%.

The sources of national electricity production in 2002 were: natural gas (70.3 percent), lignite (17.9 percent), hydro (6 percent), fuel oil (2.4 percent), diesel oil and renewable energy (0.8 percent), and purchase from neighbouring countries (2.6 percent).

About 26.3 percent of thermal capacity and 12.15 percent of hydro capacity are currently privately owned.

About 785 GWh of electricity was imported from Laos and Malaysia in 2002, while about 207 GWh was also exported to these two countries.

8.1.2. Electricity Installed Capacity

The total installed capacity was 24,805 MW, with an increase of 2.7%, of which 14,514 MW or 58.5% were from state/public power utilities and of 10,291 MW or 41.5% were from private power producers. This year, six former generators at Bhumibol Dam were renovated to have a larger generating capacity up to 35.4 MW.

8.1.2.1. Small Power Producers (SPPs) Cogeneration Power Plant

Total installed capacity of Small Power Producers' (SPPs) cogeneration plants was 2,085 MW, or equivalent to 8.4% of the total capacity.

8.1.2.2. Others

Total installed capacity of the other power plants which comprise geothermal, solar cell, and wind turbine plants was 1 MW, all of which was from government.

8.1.3. Electricity Power Generation

The peak generation of national grid in 2003 recorded at 18,788 MW, with an increasing rate of 0.4%, or amounted to 116,983 Gwh, 7.3% increased from the previous year.

Total electricity generated from hydro power plants in 2003 was 7,299 Gwh, an decline of 2.3% over the previous year, and accounted for 6.2% of the national grid generation. All electricity generated by these plants was from government.

Total electricity generated from SPPs' cogeneration plants in 2003 was 13,422 Gwh, an increase of 6.8% over the previous year, and accounted for 11.5% of the national grid generation.

Total electricity generated from other plants (such as geothermal, solar cell, and wind turbine plants) in 2003 was 2 Gwh. All of this amount was generated by government.

Total electricity generated from hydro power in 2003 was 7,299 Gwh, down 2.3% from the previous year, and accounted for 6.2% of the national grid generation.

Total electricity generated from SPPs' cogeneration plants in 2003 was 13,422 Gwh, up 6.8% from the previous year, and accounted for 11.5% of the national grid generation.

Total electricity generated from geothermal, solar cell, and wind turbine in 2003 was 2 Gw

8.2. Current and Future Energy Demand

In 2003, the total energy demand of Thailand amounted to 56,289 ktoe, rising up 6.2% from the previous year in conjunction with the expanding of Thai economy of 6.8%. Modern or Commercial Energy shared 46,538 ktoe or 82.7% of the total energy demand whereas renewable Energy was consumed 9,751 ktoe or 17.3%

It was the fifth consecutive year that the final energy consumption of Thailand had increased at the rate of 6.2% in 2003. Commercial energy consumption, which comprises petroleum products, natural gas, coal & its products, and electricity, increased 5.9%, and renewable energy, including fuel wood, charcoal, paddy husk, and bagasse, increased 7.8%. Details of energy situation are as follows:

Thailand has the total primary energy consumption equivalent to 1.36 million Barrel per day in 2003 with the annual growth rate of 6.2 %. The basic energy need composes of petroleum, most of which is oil, equivalent to 0.6 million Barrel per day or equal to 45.8 % of need, natural gas of 0.5 million Barrel per day or 36.7 %, lignite for electricity generation of 0.1 million Barrel per day or 7.3 %, coal of 0.098 million barrel per day or 7.2 % and hydropower of 0.036 million barrel per day or 2.6 %. It can be seen that petroleum is the most need, however natural gas indicates sequentially high significance with very high growth rate compared to petroleum. Electricity need in the past 16 years shows a high growth rate of 7.08 % since 2000.

The total final energy consumption in 2003 was 56,289 ktoe, an increase of 6.2% over 2002. Commercial energy was shared 8.27% of the total final energy consumption, and the rest 17.3% was renewable energy.

Future energy need is considered to increase from 1.361 million barrel per day of oil equivalent in 2003 to 1.78 million barrel per day in 2008 with the annual growth rate of 5.6 %. Considering by type, petroleum will have a very high growth which is higher than the economic growth and it is forecasted to increase from 0.6 million barrel per day in 2003 to 0.9 million barrel per day in 2008 with the annual growth rate of 7.6 %. The increase growth of petroleum need is expected by the increase of transportation sector with high increase of automobile. Furthermore in short term, the electricity generation using oil will be increased due to the limitation of gas supply system which is during expansion. Domestic and imported hydropower will reduce in short term but will sharply increase in medium term when many large projects under construction start operation.

8.2.1. Electricity

Due to the continual growth of Thai economy to the year 2003, the electricity consumption of Thailand totaled 106,959 GWh, an increase of 6.8% over the year 2002.

Electricity consumption in 2003 grew for the third year in a row at a rate of 6.8% over last year, with totaling of 9,114 ktoe and sharing 19.6% of the final commercial energy consumption. Of this total, 45.9% was used in manufacturing sector. The rest was used in commercial, residential and other sectors, shared 31.9%, 22.0% and 0.2% respectively.

It is estimated that electricity demand will increase by an average of about 6.3 percent/year during the next decade.

Peak demand on the main grid during 2002 was about 16681 MW.

Private sector participation has been launched in the form of privatization of the power plants of EGAT (Electricity Generating Authority of Thailand), EGAT's subsidiaries, an independent power producer program, a small power producer program and purchase of power from foreign countries. All of these programs have long-term power purchase agreements with EGAT for a period of 20 to 25 years.

8.2.2. Energy Demand by Economic Sector

8.2.2.1. Agricultural Sector

In 2003, the agricultural sector consumed a total energy of 3,308 ktoe and accounted for 5.9% of the total final energy consumption, an increase of 9.1% over last year. The major energy consumed in this sector were petroleum products, shared 99.4% of its total energy consumption and the remaining was electricity.

8.2.2.2. Mining Sector

Approximately 0.2% of the final energy consumption, energy consumption in mining sector in 2003 was 115 ktoe, a rise of 8.5% over last year. Almost energy consumed in this sector was electricity; shared 80.0% of its total energy consumption and the remaining 20.0% were petroleum products.

8.2.2.3. Manufacturing Sector

Energy consumption in manufacturing sector in 2003 was 19,988 ktoe and accounted for 35.5% of the final energy consumption, up 7.0% over last year. The major energy consumed was coal, shared 24.9% of the energy consumption in this sector, followed by renewable energy, petroleum products, electricity, and natural gas which shared 23.1%, 21.6%, 20.5%, and 9.9% respectively.

8.2.2.4. Construction Sector

In 2003, the construction sector consumed a total energy of 152 ktoe and accounted for 0.3% of the final energy consumption, increasing with a rate of 2.0% from the previous year. All energy consumed in this sector was petroleum products.

8.2.2.5. Residential Sector

In 2003, the residential sector consumed energy 8,173 ktoe and accounted for 14.5% of the final energy consumption, up 3.3% over last year. Energy consumed in this sector comprised renewable energy 62.7%, electricity 24.5%, and petroleum products 12.8%

8.2.2.6. Commercial Sector (including services, governmental institutes, and non profit organization)

In 2003, the commercial sector consumed energy 3,626 ktoe and accounted for 6.4% of the final energy consumption, up 4.6% over last year. Energy consumed in this sector comprised electricity 80.2% and petroleum products 19.8%.

8.2.2.7. Transportation Sector

Energy consumption in transportation sector in 2003 was 20,927 ktoe and accounted for 37.2% of the final energy consumption, up 6.6% over last year. Most of the energy consumed in this sector was petroleum products, comprising diesel 52.0%, gasoline 26.8%, jet fuel 14.7%, fuel oil 5.2%, and LPG 1.2%. Moreover, a small volume of natural gas for vehicles (0.1%) was consumed by some air conditioned buses in Bangkok Metropolitan Region and electricity was used by sky trains.

8.2.3. Electricity Consumption by Sectors

The electricity consumption of end-users in national grid in 2003 was 106,959 Gwh, 6.8% increased over 2002. Details of electric consumption by sectorsare as follows:

8.2.3.1. Industrial Sector

Among economic sectors, industry was the largest electric consumer in 2003. Electric consumption in industrial sector was 49,062 Gwh, increased 7.3% over the previous year, and accounted for 45.9% of the total electric consumption for the whole country.

8.2.3.2. Commercial Sector (including government sector and non-profit organizations)

In 2003, the commercial sector consumed electricity 33,699 Gwh, increased 6.4% from the previous year, and accounted for 31.5% of the total electric consumption.

8.2.3.3. Residential Sector

In 2003, the agricultural sector consumed electricity 223 Gwh, increased 13.8% from the previous year, and accounted for 0.2% of the total electric consumption.

8.2.3.4. Others

Electric consumption in others (temporary consumers) in 2003 amounted to 442 Gwh, increased 7.0% from the previous year, and accounted for 0.4% of the total electric consumption.

8.2.3.5. Transportation Sector

In 2003, a small volume of electricity 34 Gwh was consumed by sky train in Bangkok Metropolitian Region.

8.2.4. Electricity Consumption by Area

8.2.4.1. Bangkok Metropolitan Region (BMR)

Electricity consumption in BMR was 37,434 Gwh, or 35.0% of the total consumption for the whole country, increase of 4.6% from the previous year in which business and industrial sector consumes electricity 12,746 and 14,381 GWh respectively or increases 4.6 and 4.2 % respectively while residential sector consumes electricity 7,984 GWh or increases 6.1 %.

8.2.4.2. Outside Bangkok Metropolitan Region

Outside BMR consumed 69,525 Gwh, or 65.0% of the total electric consumption, an increase of 8.0% over previous year in which business and industrial sector consumes electricity 12,605 and 33,872 GWh respectively or increases 9.5 % while residential sector consumes electricity 15,331 GWh or increases 5.6 %.

8.2.5. Distribution of Households with Access to Electricity

Table 37 Number of Villages and Households Electrified by Regions in 2003

Regions	No. of Villages			No. of Households		
	Total	Electrified	Electrified in Percent of Total	Total	Electrified	Electrified in Percent of Total
Whole Kingdom	73,725	72,627	98.5	17,853,423	14,984,098	83.9
MEA Area	976	976	100	2,801,177	2,359,221	84.2
PEA Area	72,749	71,651	98.5	15,052,246	12,624,877	83.9
Northern	16,123	16,046	99.5	3,571,560	2,914,675	81.6
Northeastern	32,375	31,511	97.33	5,084,107	4,433,861	87.2
Central	15,075	15,589	99.26	4,110,239	3,357,449	81.7
Southern	8,546	8,505	99.52	2,286,340	1,918,892	83.9

8.3. Hydropower

The gross theoretical hydro potential of Thailand is about 17746 GWh/year, the technically feasible potential is about 16292 GWh/year and the economically feasible potential is more than 15186 GWh/year. So far, about 31.2 percent of the technically feasible potential has been developed.

The total installed capacity of all hydro plants is about 2922 MW. In 2002, hydro plants generated 6480 GWh, producing 8.6 percent of electricity (6 percent excluding pumped storage).

The 4500 MW Salween hydro project, comprising a 168 m-high RCC dam with a reservoir capacity of $21x10^9$ m^3, is planned to be developed in the long-term future.

There are also plans to harness the hydroelectric potential of 4000 small irrigation dams throughout the country.

Total installed capacity of hydro power plants was 2,973 MW, or 12.0% of the total capacity, all of which was from government

8.3.1. Number and Capacity of Dams

Table 38 Existing National Grid Hydro Power Plants in 2003

Names of Power Plants (Location)	Ultimate Capacity (MW)	No. of Units and Capacity (No.*MW)	Total Installed Capacity (MW)	Average			Generation (GWh)
				Water Level (mMSL)	Annual Inflow (MCM)	Annual Outflow (MCM)	
EGAT Plc.							
Bhumibol (Tak)	779.2	6x82.2 1x115 1x171	493.2 115 171	250.6	3,566.50	7,877.69	2,160
Nam Pung (Sakhon Nakhon)	6	2x3	6	280.5	122.1	82.9	16
Ubolrattana (Khon Kaen)	25.2	3x8.4	25.2	178.8	2,398.20	2,497.30	88
Sirindhorn (Ubol Ratchathani)	36	3x12	36	139.3	1,148.60	802.7	59
Chulabhorn (Chaiyaphum)	40	2x20	40	751.5	98.5	111.5	101
Sirikit (Uttaradit)	500	4x125	500	152.4	5,482.00	6,791.40	1,308
KangbbKrachan (Petchaburi)	17.5	1x17.5	17.5	94.7	1,056.40	663.4	67
Srinagarind (Kanchanaburi)	720	3x120 2x180	360 360	175.3	4,626.30	6,370.50	1,725
Bang Lang (Yala)	72	3x24	72	105	1,295.10	912.9	135
HuaibbKum (chaiyaphum)	1.3	1x1.06	1.06	305.5	44.5	60	3
Ban Santi (Yala)	1.3	1x1.275	1.275	330.6	13	13	6
Tha Thung Na (Kanchanaburi)	38	2x19	38	58.2	5,387.30	5,386.10	226

Table 37 Existing National Grid Hydro Power Plants in 2003 (Con't)

Names of Power Plants (Location)	Ultimate Capacity (MW)	No. of Units and Capacity (No.*MW)	Total Installed Capacity (MW)	Average			Generation (GWh)
				Water Level (mMSL)	Annual Inflow (MCM)	Annual Outflow (MCM)	
EGAT Plc.							
Ban Khun Klang (Chiang Rai)	0.2	2x0.09 1x0.02	0.2	N.A.	N.A.	N.A.	1
Chong Klam (Prachinburi)	0.02	1x0.024	0.024	N.A.	N.A.	N.A.	0
Vajiralongkorn (Kanchanaburi)	300	3x100	300	148.2	4,897.00	5,248.50	836
Mae Ngat (Chiang Mai)	9	2x4.5	9	338.6	283.9	177	20
Rajjaprabha (Surat Thani)	240	3x80	240	78.3	2,095.10	1,821.50	285
Huai Kui Mang (Kanchanaburi)	0.1	1x0.1	0.1	N.A.	N.A.	N.A.	-
Rajjaprabha (Surat Thani)	240	3x80	240	78.3	2,095.10	1,821.50	285
Huai Kui Mang (Kanchanaburi)	0.1	1x0.1	0.1	N.A.	N.A.	N.A.	-
Pak mun (Ubol Ratchathani)	136	4x34	136	N.A.	N.A.	N.A.	119

Table 37 Existing National Grid Hydro Power Plants in 2003 (Con't)

Names of Power Plants (Location)	Ultimate Capacity (MW)	No. of Units and Capacity (No.*MW)	Total Installed Capacity (MW)	Average			Generation (GWh)
				Water Level (m MSL)	Annual Inflow (MCM)	Annual Outflow (MCM)	
DEDE							
Mae Hong Son (Mae Hong Son)	1	1x0.85	0.85		run of river		3
Mae Kum Luang (Chiang Mai)	3.2	2x1.6	3.2		run of river		9
Huai Mae Phong (Phayao)	0.86	1x0.86	0.86	906.1	N.A.	N.A.	4
Mae Sarieng (Mae Hong Son)	1.25	2x0.625	1.25		run of river		2
Aikapoa (Narathiwat)	0.2	2x0.1	0.2		run of river		0
Kiridharn (Chanthaburi)	12	2x6.0	12	202.1	N.A.	N.A.	33
DEDE							
Bokaew (Chiang Mai)	0.2	2x0.1	0.2		run of river		0
Mae Mao (Chiang Mai)	4.6	2x2.3	4.6	688.9	N.A.	N.A.	8
Mae Sap (Chiang Mai)	1.36	2x0.68	1.36	527.1	N.A.	N.A.	1
Mae Sa-nga (Mae Hong Son)	5.04	2x2.52	5.04	488	N.A.	N.A.	18
Mae Had (Chiang Mai)	1	2x0.409	0.818		run of river		2
Mae Tuen (Chiang Mai)	0.25	2x0.125	0.25		run of river		0
Klong Lam Plok (Pattalung)	2	2x0.591	1.182		run of river		2
Nam Kha Mun (Phitsanulok)	2	2x0.515	1.03		run of river		3
Nam Kha Mun (Phitsanulok)	2	2x0.515	1.03		run of river		3
Huai Mae Sot (Chiang Mai)	1	2x0.33	0.66		run of river		2
Klong Du Son (Satun)	0.68	2x0.34	0.68		run of river		2
Huai Pathao (Chaiyaphum)	4.5	2x2.25	4.5	469.2	N.A.	N.A.	21
Kiew Lom (Lampang)	0.4	2x0.175	0.35		run of river		1
Huai Lam Sin (Pattalung)	1	2x0.479	0.958		run of river		-
Lam Phra Phloeng (Nakhon Ratchasima)	0.85	1x0.850	0.85		run of river		2

Table 37 Existing National Grid Hydro Power Plants in 2003 (Con't)

Names of Power Plants (Location)	Ultimate Capacity (MW)	No. of Units and Capacity (No.*MW)	Total Installed Capacity(MW)	Average			Generation (GWh)
				Water Level (m MSL)	Annual Inflow (MCM)	Annual Outflow (MCM)	
Huai Pathao (Chaiyaphum)	4.5	2x2.25	4.5	469.2	N.A.	N.A.	21
Kiew Lom (Lampang)	0.4	2x0.175	0.35	run of river			1
Huai Lam Sin (Pattalung)	1	2x0.479	0.958	run of river			-
Lam Phra Phloeng (Nakhon Ratchasima)	0.85	1x0.850	0.85	run of river			2
Huai Nam Khun (Chiang Rai) PEA	1.8	2x0.9000	1.8	run of river			1
Mae Thoei (Chiang Mai)	2.2	1x2.250	2.25	run of river			9
Mae Ya (Chiang Rai)	1	1x1.10	1	run offriver			5
Kun Pae (Chiang Rai)	0.1	1x0.10	0.1	run of river			0
Mae Tain (Chiang Rai)	2	2x0.965	1.93	run of river			5
Mae Jai (Chiang Rai)	1	1x0.875	0.875	run of river			2
Mae Pai (Mae Hong Son)	2.5	2x1.25	2.5	run of river			9
Total			**2,972.98**				**7,299**

8.3.2. Proportion of Hydropower in Overall Energy Production

Total electricity generated from hydro power plants in 2003 was 7,299 Gwh, a decline of 2.3% over the previous year, and accounted for 6.2% of the national grid generation. All electricity generated by these plants was from government.

8.3.3. Current and Potential Water Resources for Energy Production

The annual average precipitation is 1560 mm, and the total mean annual precipitation volume is 800 km^3, of which 199 km^3 is runoff.

There are 20 large dams (>15 m) in operation, comprising 17 embankments, one concrete structure and two composite dams. The total water storage of all the county's reservoirs is 62.15 km^3.

Per capita domestic water consumption is 200 to 400 liters/day in urban areas and 150 to 200 liters/day in rural areas.

The Kud Ta Phet reservoir project, which is under construction in Lop Buri province, will supply $600x10^3$ m^3 of water per year for domestic consumption as well as irrigation water for an area of 7760 ha in the wet season and 1680 ha in the dry season. It is scheduled for completion in 2005.

The 95 m-high Khlong Tha Dan RCC dam, being built for irrigation on the Nakon Nayok river, will be the world's largest volume RCC dam, at $5x10^6$ m^3.The US$ 143 million scheme is scheduled for completion by the end of November 2005.

Construction of the 24 m-high Prasae zoned earthfill dam, and 6 m-high saddle dam in Rayong province is still continuing. It will provide irrigation water for the Wang Chan and Klaeng districts.

There are a number of agencies responsible for water resources and services, such as the Metropolitan Waterworks Authority (MWA), the provincial Waterworks Authority (PWA), the Royal Irrigation Department, the Department of Public Works, and so on.

The MWA is responsible for water supply services in Bangkok Metropolitan and the PWA in the rest of the urban areas in Thailand, respectively. Some parts of these services have been privatized by the Government in recent years. For instance, the PWA has already privatized several of its water supply schemes in the form of BOT, BOOT and lease contracts, and hopes to continue increasing private sector participation in this way.

8.4. Alternative Forms of Energy

8.4.1. Renewable Energy

The total production of renewable energy in 2003 was 14804 ktoe, an increase of 7.2% from 2002. Of this total, 68.3% was shared by fuel wood, followed by bagasse and paddy husk, shared 22.2% and 9.5% respectively.

The main renewable energy imported in 2003 was charcoal and the remaining was a small amount of fuel wood. Total renewable energy imported was 17 ktoe, an up 2 folds from the previous year. Total imported value was 55 million Bath, up 6.18%.

Total renewable energy consumption in 2003 was 9,751 ktoe, an increase of 7.8% from last year, and accounted for 17.3% of the final energy consumption.

Renewable energy was mainly consumed in residential sector shared 52.6% and the rest 47.4% was consumed in manufacturing sector.

Renewable fuel consumption for electric generation in 2003 was 3,067 thousand tons with an average rate of 8 thousand tons per day, increased 36.4% over the previous year, and accounted for 2.8% of the total fuel consumption of national grid generation. All renewable fuel (paddy husk, bagasse, fuel wood, garbage, and agricultural waste) was consumed by private power producers.

8.4.2. Hydro, Geothermal, Solar Cell, and Wind power

Hydro power has been developed for power generation since 1964. In 2003, electricity generated from hydro power totaled 1,617 ktoe, a decrease of 2.4% over the previous year, and accounted for 4.9% of the total domestically commercial energy production.

Moreover, other primary energy sources have been used for power generation such as geothermal, solar cell, and wind. In 2003, electricity generated from these energy sources totaled 2 ktoe.

8.4.3. Small hydro

There is a small hydro potential of 473.8 GWh/year.

There are four small hydro plants in operation with an installed capacity of 26 MW and an annual generation of 94 GWh/year. None is under construction, but a further three are planned (30 MW, 175 GWh/year).

Further small hydro development will include the following three projects: Pasak Jolasid (6.2 MW), Chao Phraya(14 MW) and Khlong Tha Dan (10 MW).

8.5. Goals and Strategies for Future Energy Demand

In the past 15 years the ratio between energy consumption and Gross Domestic Product, called Energy Intensity, in Thailand indicates an increase trend while developed countries show their decrease trend. Considering the Energy Elasticity as a ratio between energy consumption growth rate and GDP growth rate, it was found that Thailand has the energy elasticity of 1.4 : 1 while developed countries have the value ranged from 0.8 : 1 to 1 : 1. The reduction of energy consumption with care and effectiveness can mitigate the country load in energy provision, save cash outflow due to energy import, and reduce risk of energy shortage and pricing stability. Therefore, the goal of effective energy consumption proposes to reduce the country energy elasticity from 1.4 : 1 at present to 1 : 1 in 2007 that can save energy expense of the country for 3.1 billion Baht during 2007 to 2017.

In order to reduce the growth rate of energy consumption as the proposed goal, the action plan is emphasized in transportation and industry sectors which have the portion of energy consumption of 37 and 36 % respectively.

In regard to the role of Independent Power Producers (IPPS) in 2003, the Electricity Generating Authority of Thailand (EGAT) has purchased electricity from IPPs, namely the GLOW IPP Co.,Ltd. (713 MW) in January 31, 2003 for a 25 year-contract and the Eastern Power and Electric Co.,Ltd. (350 MW) for a 20 year-contract.

Regarding the international cooperation on power development in 2003, EGAT signed the power purchase agreements with the project investors of Lao PDR from the Nam Theun 2 of the metering point 920 MW (at minimum water level) on November 8, 2003 for a 25 year-contract.

8.6. Policy and Legislation

Further hydropower development in Thailand could involve multipurpose water resources projects, mainly for the purposes of irrigation or flood control, with hydropower being generated as a by-product. There are also opportunities to install hydro plants at existing dams or water resources projects for other purposes.

8.7. Indicators on Afore-mentioned Issues

- Use of economic value in water allocation for hydroelectricity generation
- Existence of environmental impact assessment (EIA) for hydroelectricity infrastructure

8.8. Reference

1. National Economic and Social Development Board, Strategic Study of Infrastructure Development to Enhance National Competitive Capacity Building in Energy Sector, Thammasart University, August 2004

2. Thailand Energy Situation 2003, Department of Alternative Energy Development and Efficiency

3. Electric Power in Thailand 2003, Department of Alternative Energy Development and Efficiency

4. Briefing of Energy Policy and Planning Office 2006, Ministry of Energy

D-MANAGEMENT CHALLENGES

Challenge: Managing Risks

Overview: In recent years Thailand has been encountered with many floods and other water related disasters. Measures have been taken to alleviate its results, however loss of lives and properties still happen each year. Flood and drought is considered as our first priority of challenges that need to find an appropriate solution and it is a goal to be achieved.

9. Climate Change and Variability

9.1. Frequency and Amplitude of Water Related Disasters

1) Flood

In Thailand, flooding results from tropical disturbances, typhoons, or a combination of the two. The heavy rainfall swells the rivers which bursts their banks or creates severe flooding conditions along the tributaries from backwater effects. Flooding in river basins in Thailand is often severe. Urban area along the mainstream is regularly flooded. The peak flood period lasts from early June in the North to early December in the South.

The hydro-meteorological causes of floods are prolonged heavy rains on saturated soils. This leads to an increase in surface runoff that can only slowly be discharged through the river systems. Flooding can occur due to river overflow or surface runoff. Heavy local rains throughout the region and typhoon-induced surges of water in the river system contribute to the overflow of riverbanks. In addition, a range of natural and man-made factors presently affect flooding.

Climate change, particularly global warming effects, is believed to be a contributing factor to increased frequency and intensity of severe flooding. Increased rainfall amount and sea-level rises will result in greater risk of flooding in low-lying coastal and estuary areas. Warming of the water temperature in the sea would result in an increase in the number and intensity of typhoons causing sea surges that would also contribute to inundation of low-lying areas.

Table 39 Number of villages suffering flood in 2003

Type of Flood	Inundated Flood	Flash Flood	Total
Number of Villages	6,878	2,447	9,325
Percentage of Total Villages	10.58	3.77	14.35

Note: Number of Villages suffering Flood from the total number of located villages of 64,982 villages

Source: Effective National Water Resources Management And 25 Significant National River Basin Management Study, Kasetsart University, July 2004

Among the above mentioned figures, there are the area of repeated flood which is defined as the area always suffering flood where generally locates along major streams, especially in the Chao Phraya, Mun and Chi river basins. As a result of flood, many areas such as Mae Ramad, Ko and Shun river basins in Petchaboon province also suffer land slide caused by flash flood in 2001. Flooding occurs every year in most of river basins in Thailand and trends to cause more severe damage affecting people live and country economics. In the past 10 years, flooding caused damage of over 5,000 million Baht for 6 years, especially in 1995, 1996 and 2002 when damage is over 10,000 million Baht. Considering flood damage by river basin, it was found that the river basins with severe damage are Pa Sak, Yom, lower Chao Phraya, Mekong, Chi and Mun river basins.

2) Droughts

Droughts during dry season in Thailand occur frequently every year. This is due to continuous increase of water demand caused by population and economic growth of the country while the natural and man-made storage have insufficient capacity for the whole year. Most of the areas suffering droughts are the areas which water consumption and uses rely on rainfall and natural stream.

Drought in Thailand can be classified into 2 levels, the first level is the area where consumptive water is still available but agricultural water is shortage and the second level is the area where both consumptive and agricultural water is shortage.

Table 40 Number of villages suffering drought in 2003

Level of Drought	Level 1	Level 2	Total
Number of Villages	19,236	16,568	35,804
Percentage of Total Villages	29.6	25.5	55.1

Note: Number of Villages suffering Droughts from the total number of located villages of 64,982 villages

Source: Effective National Water Resources Management And 25 Significant National River Basin Management Study, Kasetsart University, July 2004

It is noted that almost half of the villages suffering drought level 2 is in the northeast region. In the past 15 years, it was found that droughts cause damage in agricultural sectors approximately 200 million Baht per year, especially over 1,500 million Baht in 1999.

3) Tsunami

On 26th December 2004 the Indian coastline experienced the most devastating tsunami in recorded history. The tsunami was triggered by an earthquake of magnitude 9.0 on the Richter scale at 150 Km. from west coast of Sumatra in the Indonesian. This natural disaster effected to Indonesia, India, Sri-Lanka, Malaysia, Thailand, and Muldive Islands. The critical scene was on Bandar Aceh, northern of the coast of Sumatra, where more than 150,000 died. 230,000 people were killed directly by earthquake and tsunami, more than ten thousand of missing and injured. The damage was toward to houses, hotels, buildings and properties.

Thailand casualty estimates 5,500 dead, 3,000 missing, 8,400 injured (as of Jan. 25 Bangkok Time) and uncounted bruise of houses / buildings / hotels / properties. The tidal waves effected to 6 provinces at the west coast / Andaman coast, Ranong, Phang-nga, Krabi, Phuket, Trang, Satun. It also caused damages to water sources such as shallow wells, and rural waterworks but it had not negative effect toward sea water quality except in some areas that affected in form of siltation.

9.1.1. Economic and Social Consequences of Major Water Related Disasters

1) Flood

Table 41 Damage of Flood from 1993 to 2003

Year	Number of Event	Number of Injury	Number of Dead	Cost (million Baht)
1993	66	-	16	5,240.58
1994	11	254	47	2,181.61
1995	74	12	46	5,058.88
1996	73	11	442	11,858.58
1997	74	21	158	11,370.49
1998	64	427	98	3,842.22
1999	36	3	8	2.00
2000	-	-	53	1,381.64
2001	8	-	-	6,224.27
2002	14	68	244	3,666.29
2003	200	NA	216	13,385.32
Total	620	796	1,328	64,211.88

Source: Effective National Water Resources Management And 25 Significant National River Basin Management Study, Kasetsart University, July 2004

2) Droughts

Table 42 Damage of droughts from 1989 to 2003

Year	People (million)	Agricultural Area (million Rai)	Cost (million Baht)
1989	1.76	1.29	121.97
1990	2.11	1.97	92.17
1991	4.93	1.04	262.17
1992	8.10	5.33	176.18
1993	9.11	2.04	198.76
1994	8.76	17.92	98.76
1995	12.48	3.00	177.62
1996	10.97	0.10	289.16
1997	14.68	1.43	249.16
1998	6.51	1.79	67.17
1999	6.13	3.14	1,520.50
2000	10.56	0.004	641.71
2001	18.93	1.71	71.96
2002	12.66	5.03	330.77
2003	5.94	0.48	174.33
Total	133.62	46.30	4,474.39

Source: Effective National Water Resources Management And 25 Significant National River Basin Management Study, Kasetsart University, July 2004

9.2. Structural Measures against Disasters

The structural measures against water disasters compose of

- Large to medium scale water resources development distributed to cover all potential river basins
- Small scale water resources development with water distribution system including improvement of existing reservoirs
- Construction of diversion weirs with water distribution systems including improvement of existing weirs and their systems
- Construction of pumping stations with water distribution systems
- Dredging of natural stream with construction of regulating structures
- Dredging and recovering natural ponds and reservoirs
- Construction of dikes along river banks and protection dikes around urban areas with drainage system
- By-pass diversion of flood way from urban areas
- Avoidance and control of land use in flood way areas
- Use of underground water where it is appropriate and lack of surface water or as reserved water in the areas of insufficient surface water

In the Chao Phraya river basin which is the most significant river basin in Thailand, the structural measures against disasters to mitigate flooding and drought were proposed as follows:

1) Large water resources development projects including Kaeng Sua Ten, Kew Kor Mah and Mae Khen reservoirs.
2) Water storage increasing projects such as Moei-Salawin-Bhumibol reservoir diversion and Kok-Ing-Nan diversion.
3) Eastern flood way diversion project from Bang Sai to the Gulf of Thailand

According to the water resources management and development project in the Chao Phraya river basin, an available water in the basin can be increased at least 11,000 MCM. Besides, it can mitigate drought problem as well as flooding in lower basin including Pathumthani, Nonthaburi, Bangkok and Samut Prakarn provinces where passing upstream flood of 1,900 m^3/s was reduced while waste water of 9 MCM per day from major cities can be diluted and, moreover, there is also sufficient amount of water to mitigate water pollution problem in Chao Phraya and Tha Chin rivers.

9.3. Non-structural Measures against Disasters

The non-structural measures against water disasters compose of

- Increase of water utilization and distribution efficiency
- Promoting stakeholder participation in water allocation
- Enhance the thinking of water value for using water in conservative way

- Development in technology of water supply, monitoring water distribution system for mitigation of flooding and drought
- Conservation and recover of natural water sources
- Improvement of reservoir operation
- Land-use zoning in flood way areas
- Development of flood forecast and warning system

9.3.1. Land-use Planning

In a water related land-use planning, various factors of water utilization, existing water sources of both surface and underground water, water resources development projects and water resources management approaches are required in carrying out the land-use planning with respect to constraints and opportunities such that agriculture based on existing water storage can not be distributed to cover the entire demand areas with equal rate. Therefore, the demand areas have to be decomposed into specific groups based on available water geographical potential in developing water storage and irrigation systems in such a way to define the most appropriate zoning to achieve the maximum productivity based on cropping pattern in each area.

The land-use planning measure against flood disaster in urban areas is considered as following.

- Specify urban areas where require flood protection
- Decompose into sub-areas to implement flood protection systems based on their severity, problems and significance

However, in implementing flood protection and drainage systems in urban areas, the following criteria shall be considered.

- The sub-area decomposition shall be based on specified land-use, urban zoning and degree of damage
- External flood protection shall be considered by specifying levels of protection with respect to topography of the area
- Planning of principle drainage system shall conform to topographic condition and natural drainage
- Study on the impact of flood protection and drainage system should be taken into account with mitigation approaches

In case of risk from tsunami, there is very little that can be done to prevent the occurrence of natural hazards. But while these natural disasters cannot be prevented, their results, such as loss of life and property, can be reduced by proper planning. Government agencies should formulate land-use regulations for a given coastal area with the tsunami risk potential in mind, particularly if such an area is known to have sustained damage in the past. Tsunami hazard perception by the people of a coastal area is necessary in mitigating loss of life and damage to property. Hazard perception by the public is based on a technical understanding of the phenomenon, at least at the basic level, and a behavioral response stemming from that understanding and confidence of the public for the authorities responsible for warning. Over

warning, based on inadequate data on which to base the prediction, often leads to false alarms and lack of compliance with warning and evacuation attempts. Such false alarms result in a loss of faith in the capability of a warning system and result in reluctance to take action in subsequent tsunami events. Fortunately, forecasting of tsunami in recent years has been quite good and the image of the Tsunami Warning System and its credibility has been improved considerably. Forecasting, however, is not an exact science as the phenomenon itself is very complex and data on which the forecast is based may often be inadequate for certain areas of the Pacific.

9.3.2. Responding to Disasters

In urban areas such as city and provincial areas nearby rivers, it should be studied of flooding area conditions, specification of urban areas with flood problem according to damage categories so that the following responding approaches can be activated.

1) Evacuation of people from the areas with severe problem

2) In the urban areas with low to moderate problem, the following approaches can be performed.

    - Approaches before flooding i.e. flood forecasting, flood warning for the area and time of flood, flood protection for significant areas, etc.

    - Approaches during flooding i.e. evacuation plan, flood retention method, emergency mitigation, etc.

Approaches after flooding i.e. clearing and cleaning of flooded areas are also be arranged.

In case of tsunami for Thailand, the massive waves struck coasts in 2 hours after the news of earthquake in the India Ocean was announced. By this truth, the Seismic station is necessary for predict the tsunami. The seismography station will collect data from the seismic wave and turning to the result for warning or immigrating populations for the warning area. Today Thai Meteorological Department has 12 seismography stations in all regions for reporting the center, size and depth of earthquake. One of them, Chiang Mai seismography station, used the IRIS system which has the digital 3 components seismograph. For the rest are analog system stations which are very accurate but have to take a lot of time for comparing with others stations and analyzing by manual with professional / experts. To improve the tsunami warning system, Thai government must install the digital seismograph at least 2 station at southern (Phuket or Songkhra) and western (Kranchanaburi or Prachuapkhirikhan). The earthquake event on 26th December Meteorological Department could analyzed in 15 minutes by using data from only Chiang Mai station. Another way for the tsunami warning is analyzing information from the Tide gauge which will show the variation or difference of sea-level. In Thailand, Thai royal navy has the Water Level Station Monitoring at Koh Tapaonoy, Phuket. However this station is close to the coast (only 17 minutes before impact) then it should be install the other the Tide gauges in the appropriate place and report the level in real time monitoring through the satellite. In conclude, the tsunami warning system should ;

1. Install the Digital seismograph

2. Install the Tide gauge and develop the old one into the real time monitoring

3. Set up the level of warning , timing in each stages of warning and clearly define the procedure to relevant officers and staffs.

4. Develop the communication for exchange information with the international warning organization.

5. Install the invent “DART” or the Deep Ocean Assessment and Reporting of Tsunamis which consist of an anchored seafloor bottom pressure recorder (BPR) and a companion moored surface buoy for real-time communications.

In system processing, an acoustic link transmits data from the BPR on the seafloor to the surface buoy. The data are then relayed via a GOES satellite link to ground stations (Milburn, et al., 1996), which demodulate the signals for immediate dissemination to NOAA's Tsunami Warning Centers, NDBC, and PMEL. The moored system is shown in the accompanying figure.

9.3.3 Early Warning System for Flood and Mudslide Areas

In 2004, 398 villages were identified as high risk villages of flood and mudslide. Data of rainfall, runoff and water level has been collected particularly for these areas and an early warning system was set up for each village. The system provides a simple rainfall measurement stations which automatically record and transmit information of the quantity of rain. When the recorded levels of rainfall in a given time reaches a critical level (has been determined to present a danger) the system will transmit signals to the responsible people in potentially affected locality automatically. In each of the localities there is a person who has been trained to act in these circumstances to spread the news quickly to other villagers and inform them of the steps that they should take for their safety. And at the national level it will link data to Water Crisis Prevention Center.

9.3.4. Water Crisis Prevention Center

This Center was set up in 2003 to be a body that collect and disseminate data. It consists of a primary data collection and management system for every main river basin in Thailand. The purpose of this Center is to collect and compile all available data to assist a decision making in preventing and solving water problems. These data were used to develop a Geographical Information System (GIS) database for all main river basins throughout the country. It also creates a Management Information System (MIS) to help following up water crisis situations. The Center coordinates with central and provincial government offices in flood prone areas to provide necessary acts. Its also provides weekly water report for transmission to concerned persons via the internet.

9.3.5. Supervisory Control and Data Acquisition (SCADA)

In some river basin in Thailand where flood and water pollution has frequently happened take for example flooding in the Bang Pakong and Prachinburi River Basin caused by heavy rainfall, deforestation of the upper watershed, insufficient reservoir for retarding water, inefficient drainage in natural water way causing by heavy siltation and construction that obstruct water flow and changing in land use patterns. Therefore, SCADA is employed for early forecasting and warning system for both flood and pollution in this river basin. It is used as an automatic real time forecasting and warning system, which is integrated to the former telemetering of the river basin. In introducing such system, a mathematical model is developed to become an efficient decision support system. The information is aimed to disseminate to public as well.

9.4. Indicators on Afore-mentioned Issues

- Existing of emergency procedures for flood and drought situations
- % of flood-and drought-prone areas where warning exist
- Existence of classification of risk areas

9.5. Reference

1. Kasetsart University, Effective National Water Resources Management and 25 Significant National River Basin Management Study, Final Report, July 2004

2. Thai Hydrologist Association, Earthquake and Tsunami, Conference on Tsunami, Royal Irrigation Department, February 2005

3. Supapis Polngam, Remote sensing technology for Tsunami Disasters along the Andaman Sea, Thailand, Geo-Informatics and Space Technology Development Agency (Public Organization) : GISTDA, September 2005

4. Department of Water resources. Ministry of Natural Resources and Environment. Annual Report of 2003, 2004, and 2005

5. Department of water Resources. Ministry of natural Resources and Environment. Role in Thailand Water Management. 2006

9.6. Recommended Reading/Website

1. http://www.disaster.go.th/html/english

Challenge: Sharing Water between Uses and Users

Overview: Freshwater is becoming an increasingly scarce and vulnerable resource in Thailand as population and economic growth are demanding a growing share of the country's water supplies. This development is particularly evident in many river basins that are overwhelmed with such demand. The highly productive basin economy depends on water supply for a variety of uses, including drinking water, water for industrial processes, for hydropower production, for irrigation, for nurturing an environment, and for combating intrusion of salinity in the dry season. From 1994 – 2003 Thailand's population increased from 59.10 million to 63.08 million (Department of Provincial Administration 2003) even an increasing rate was not alarming but enormous economic activities made water becoming more stress. In the Central plain of the Chao Phraya Basin, demanding from farmers to cultivate more rice have made farmers increasing rice cultivation in dry season by using irrigated water. The land area now served by irrigation systems in this Basin far exceeds the water available for dry season irrigation. The inflow into the Bhumibol and Sirikit reservoirs, the main water supply for the lower Chao Phraya irrigation system, has decreased since their construction due to an increase in upstream population, changes in land use, and economic growth in the upper basin.

10. Allocation of Water Resources

10.1. Competition for Water within countries

10.1.1. Agriculture water use

Major use of water is agriculture. Water supply for crops can be obtained from direct rainfall, surface water irrigation or groundwater irrigation. Though Thailand has a 6 – 9 month period of rainy season with an average rainfall from 1,000 mm to 4,500 mm from one region to another, the country's agriculture crops still suffer from drought periods and sequences of dry spell as well as flood disaster. These varying hydrologic conditions create uncertainties in wet season rice production especially in non-irrigated areas. The irrigation system stabilizes the rice cultivated area and the rice production. The storage dams would secure a stable supply of water and reduce damages due to floods and droughts. In 1998, 34.8 percent of total land area was farm holding land (National Statistical Office, 2002) and about 50 percent of this farm holding land area or 10.4 million ha has been used for paddy farming (Office of Agricultural Economics, 2001).

The average water requirement for high yielding varieties of rice during 160 days from land preparation to the end of reproductive period was found to be 9,400 m^3/ha in wet seasons and 12,500 m^3/ha in dry seasons. In 1998, 54.5 percent of total land area was farm holding land and about 50 percent of this farm holding land area or 13.98 million ha has been used for paddy farming (Office of Agricultural Economics, 2001)

10.1.2. Groundwater use for irrigation

The only large-scale groundwater irrigation project in Thailand is at Sukhothai province in the North of the Country. Rice is the main crop during wet seasons. Field crops such as soya beans, cotton are the main crop during dry seasons. Groundwater is used to supplement surface water during wet seasons. In dry seasons, irrigation mainly utilizes groundwater. The amount of groundwater use for irrigation in Sukhothai was between 21.8 – 46.7 million m^3/yr. (Royal Irrigation Department, 2006)

10.1.3. Domestic water use

In 2000, access to safe drinking water for urban and rural population was 97% and 91% respectively. For Bangkok and its vicinity, capacity of water supply production in 2000 was 4.62 million m^3/d to serve a total population of 8 million. In rural areas apart from pipe water supply system, other forms of domestic water are shallow wells, deep wells, village ponds and bottle water.

10.1.4. Industrial water use

Industrial development is one of the most important means for economic development of Thailand. Water is an essential part in the industrial processes especially in industrial estates in the eastern part of the country. Industrial use of water ranges from washing raw materials and equipment to cooling and boilers. Industry is a relatively small user of water compared to agriculture, which use about 30 times the amount of water per unit of GDP than industry does. However, industry if by its own waste mismanagement will reduce the available water not only to itself, but also to other sectors.

Raw water for industry in the Eastern Thailand is delivered in pipelines from the reservoirs and Eastern Water Resources Development and Management PLC manages the system.

10.1.5. River integrity

The maintenance of river integrity is based on maintaining minimum stream discharges to repel salt water intrusion at the lower reaches of rivers, minimize levels of pollutants, and maintain minimum dissolved oxygen levels to ensure that the quality of the aquatic environment does not fall below acceptable levels. A minimum flow of 16 m^3/s is currently considered sufficient in the lower reaches of the Chao Phraya River to repel saline intrusion. Pollution control is more problematic. Most of the wastewater discharges of domestic and industrial origin have increasingly been controlled and mitigated through the enforcement of separate effluent standards by various regulating governmental agencies. In addition, the regulation of stream flow in the Chao Phraya River by releases from upstream reservoirs operated by Electricity Generating Authority of Thailand or EGAT Public Company Limited (EGAT PLC) and Royal Irrigation Department can to some extent improve the poor downstream water quality during the dry season. Allocation of basin water supplies must take into account these needs.

10.1.6. Management mechanisms for allocation among sectors

Within Thailand specially the Chao Phraya Basin, there is a long history of informal water allocation. In some northern areas, informal systems have been in place and successfully implemented for over 200 years. The informal water allocation systems in the northern parts of the basin differ from those in the middle and lower areas. The difference is primarily due to topography. In the north, the river valleys are small and better defined socially. In the middle and lower sections, there was usually enough water for a rice crop in the wet season, which was sufficient to sustain a farm family, and for home consumption through the year.

Since 1994, a multi-agency working group comprises Royal Irrigation Department (RID), Agricultural Extension Department, Department of Water Resources, Meteorological Department, EGAT PCL, Department of Water Transportation, and Department of Local Administration has prepared the water allocation plan for the basin. The plan takes into account the available water in the reservoirs and water demands downstream. Demands are classified into six sectors: domestic, including pipe water supply and industry; irrigation of rice; irrigation other than rice; prevention of saline intrusion including eco-balance; waterway

navigation; and additional rice crops (*na prung*). The working group balances the demand against the amount of water available in the reservoirs; priorities are set among the five sectors and among competing areas. The water is allocated using the following priority system:

- First priority is for domestic use, water which for all practical purposes includes water for drinking, cooking and bathing, for both rural and urban environments.
- Second priority is for subsistence agriculture in rural area, which for all practical purposes includes water to grow sufficient rice and non-rice crops for home consumption.
- Third priority is for navigation and environmental requirements.
- Fourth priority is for commercial uses, which covers hydropower, commercial agriculture and for-profit businesses.

The actual water allocation practice in the lower basin is as follows: water releases from both reservoirs are controlled by the EGAT PLC. The Royal Irrigation Department routinely checks the downstream water level at the Chai Nat Diversion Dam. If the water level is less than it should be, given the quantity released by EGAT, then it is known that too much water has been used between the reservoirs and the Chai Nat Diversion Dam. The working group then designs a rotation system to conserve water. Organizational and individual users in each province along the basin are assigned a number of days on which they will be allowed to take water. Enforcement is the responsibility of provincial authorities, coordinated by the Ministry of Interior. Compliance with the water allocation plan is mixed. It is good among the agencies represented on the working group; compliance by farmers, however, is not good. Farmers that do not comply earn more income than complying farmers because they plant a second rice crop in defiance of the plan. There is no enforcement because it is not against any law not to follow the water allocation plan. Accordingly, efficiency and equity are low.

10.1.7. Roles of water users and stakeholders

Water user group establishment has been promoted in irrigation projects. However, strengthening its capacity and supporting its activities need to be taken into consideration seriously. The RID tries to promote participatory irrigation management in water allocation and maintenance of the irrigation projects aiming at equitable water allocation and economical water use at farm level including sustainable irrigation infrastructure. In this regard, water user groups have been reactivated and strengthened in order to serve as an effective mechanism in the process. It is not yet empirical that how effective these water user groups are but the role of RID in promoting and strengthening the groups should help them more institutionalized and efficient.

Another institution, the River Basin Committee has its mandate in prioritizing water allocation and specifying water requirements as well as equitable and efficient water allocation measures, is the mechanism that the stakeholders' representative can play their roles in a decision making process. In one of the project of the Department of Water Resources to introduce many aspects of an integrated water resources management including water allocation to the river basin's stakeholder like the Bang Pakong Dialogue Initiative, the roles of the stakeholders who represent in the Bang Pakong River Basin Committee (BP-RBC) have been sharpened. To take part in water allocation at the basin level, a decision support system and its modeling in water allocation has been introduced to the BP-RBC. At the same time water use survey at the smallest level or individual households has been

practiced through the BP-RBC and its network. This will eventually lead to an equitable and efficient water allocation that stakeholders play an important role in pursuing it.

In irrigated land the problem of competing in water uses has not been easily solved. Many factors are involved and they should be considered in a unified manner. To introduce fair and equitable water allocation, water right is an important factor that will allow more manageable water distribution. However in doing so, it should constitute many social aspects and the law accommodated it should be in place. At this stage what can be done is to raise awareness among stakeholders concerned to consider its advantages and disadvantages and to propose this matter to public when appropriate.

10.2. Competition of water among riparian countries

10.2.1. Transboundary rivers, lakes and groundwater aquifers

The Mekong River is the important river for Southeast Asia. It runs 4,800 kilometers from its headwaters on the Tibetan Plateau through Yunnan Province of China, Myanmar, Thailand, Cambodia, Lao PDR and Vietnam. For sustainable development, utilization, conservation and management of the Mekong River Basin water and related resources, the Governments of the Kingdom of Cambodia, the Lao People's Democratic Republic, the Kingdom of Thailand, and the Socialist Republic of Viet Nam decide to have an cooperation agreement. Based on the agreement, the Mekong River Commission (MRC) was established. The following detail of the MRC is excerpted from Mekong River Commission for Sustainable Development (Mekong River Commission, 2005).

The Mekong River Commission (MRC) was established on 5 April 1995 by the Agreement on The Cooperation for The Sustainable Development of The Mekong River Basin. The MRC member countries are Cambodia, Lao PDR, Thailand and Viet Nam. MRC maintains regular dialogue with the two upper states of the Mekong River Basin, China and Myanmar.

The MRC member countries agree to co-operate in all fields of sustainable development, utilisation, management and conservation of the water and related resources of the Mekong River Basin, such as navigation, flood control, fisheries, agriculture, hydropower and environmental protection.

The MRC consists of three permanent bodies: The Council, the Joint Committee (JC) and the Secretariat.

The National Mekong Committees (NMCs) act as focal points for the Commission in each of the member countries and are served by the respective National Mekong Committee Secretariats.

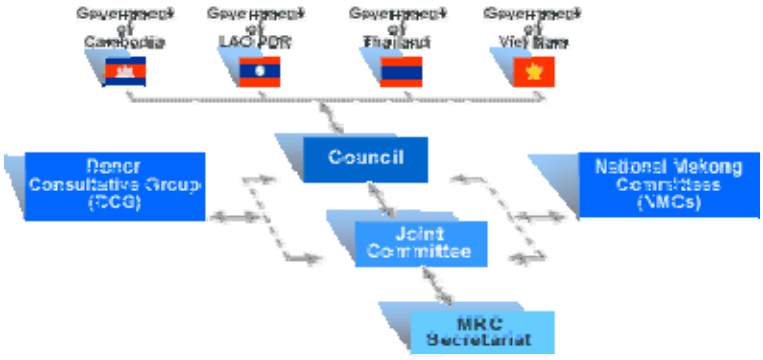

Figure 18 The Mekong River Commission

The Council, which meets once a year, consists of one member from each country at ministerial or cabinet level. The Council makes policy decisions and provides other necessary guidance concerning the promotion, support, co-operation and co-ordination of joint activities and programs in order to implement the 1995 Agreement.

The Joint Committee consists of one member from each country at no less than Head of Department level. The Joint Committee is responsible for the implementation of the policies and decisions of the Council and supervises the activities of the Mekong River Commission Secretariat.

The MRC Secretariat is the operational arm of the MRC. It provides technical and administrative services to the Council and the Joint Committee. Under the supervision of the Joint Committee, the Chief Executive Officer is responsible for the day-to-day operations of more than 100 professional and general support staff. The main counterparts for MRC activities in the four member countries are the National Mekong Committees (NMCs).

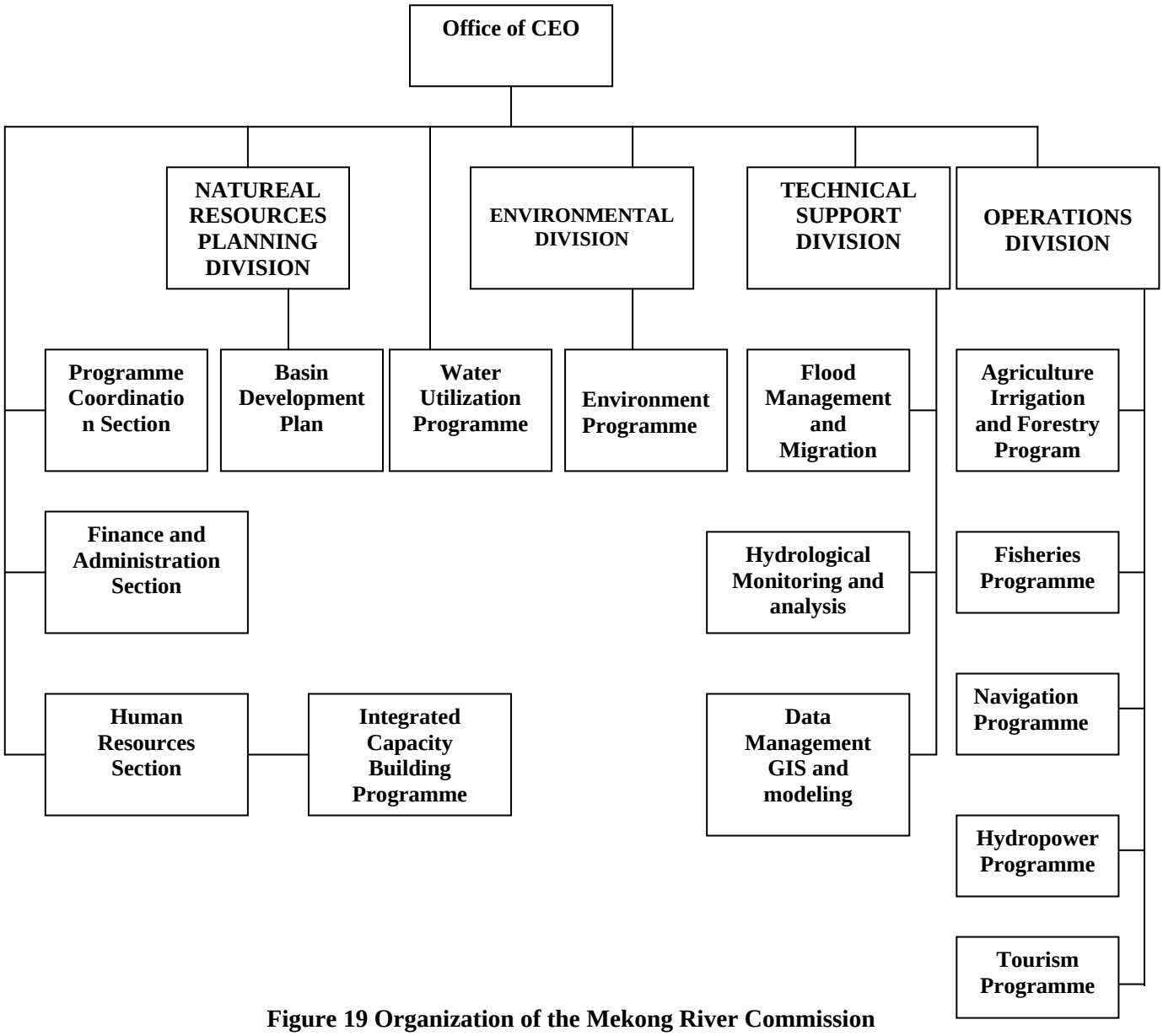

Figure 19 Organization of the Mekong River Commission

10.3. Allocation mechanisms

10.3.1. National legislation

Surface Water: The utilization of surface run-off water is regulated by Section 1339 of the Civil and Commercial Code. This section recognizes the natural principle that water always flows to a lower place and that a landowner must accept the natural flow of water across the land. The provision also entitles a landowner to retain surface run-off to meet the needs of farm production and livelihood needs, and the surplus water must be allowed to flow naturally. The Code also recognizes the right of the landholder to retain water in a well or pond and to prohibit access of other persons to this water source.

Irrigation Water: The management and use of water in irrigation canals is tightly controlled by the Royal Irrigation Act, 1942, which is intended to govern the construction, operation and maintenance of irrigation projects undertaken by RID. The government, through RID, has a wide range of powers to regulate water utilization and development, including the power to prohibit any person from withdrawing or using water in irrigation canals if such withdrawal or use would cause damage to other persons. Other sections indicate that RID has the right to move water across or to store water on private land without hindrance from the landowner, and that the landowner must take all necessary steps to prevent unnecessary leakage from his land. Section 8 of the Act allows the imposition of irrigation fees through the issuance of a ministerial regulation. Under the Act, the rate of irrigation fee collected from the owners or possessors of irrigated land or agricultural users outside the irrigated land shall not exceed 5 baht per *rai* per year. The rate of the irrigation fee for industrial, municipal and other uses shall not exceed 50 satang per cubic metre. However, the Act is clearly out of date and outmoded with regard to the appropriate level of fees to be imposed.

Several Acts deal with the protection of waterways. These Acts generally prohibit the dumping of rubbish and other materials, toxic water and toxic chemicals into waterways and establish fines and imprisonment for offenders. Most of these Acts are now very old and the fines and punishment and the scope and nature of pollution covered are no longer in keeping with modern conditions and circumstances.

Groundwater: Presently, the only direct law related to the regulation of groundwater is the Groundwater Act 1977 (amended in 1992). The Groundwater Act was put in place with the intention to regulate groundwater utilization after the Government realized the adverse effects from uncontrolled utilization of groundwater. The Ministry of Industry regulates groundwater through the issue of permits for well drilling. The Groundwater Control Division under the Ministry of Industry is responsible for reviewing well drilling requests and for the issue of well permits within the BMA and its surrounding provinces, namely Pathum Thani, Nonthaburi, Samut Prakan, Samut Sakhon, and Nakorn Pathom. The Groundwater Control Division also takes the responsibility for collecting the groundwater fee payment from private sector users, in accordance with the reading from well meters attached to the permitted wells.

However, the Groundwater Act contains important weaknesses: (a) the definition of what constitutes groundwater is imprecise; (b) shallow tube wells do not have to be registered; and (c) it requires no accountability from government bodies, departments or state organizations that utilize groundwater resources. Therefore, thousands of unlicensed shallow tube wells draw groundwater from shallow aquifers, and government bodies, departments and organizations have an unlicensed right to extract groundwater from deep aquifers.

Once over-exploitation of groundwater was recognized as the major cause of land subsidence and deterioration of groundwater quality in the area of Bangkok, the Cabinet established a measure to prevent and mitigate groundwater and land subsidence for the area in 1983. The main content of this measure is to set critical groundwater zones, of which three are identified

according to the degree of land subsidence. Land subsidence also has a direct effect on increased flooding in local areas, such as in Samut Sakhon, Samut Prakan, Pathum Thani, and Nonthaburi provinces. The government has now introduced a regulation banning groundwater abstraction in the Bangkok area where the user has access to surface water supplies.

10.3.2. National/International agreements

Mekong River Commission (MRC) comprises 4 member countries namely Cambodia, Lao PDR, Thailand and Vietnam and the 1995 Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin is its framework for cooperation. Its recent strategy has been changed from a "project" to a "programme" focus. The new approach considers MRC activities as part of comprehensive programmes supporting basinwide strategies of the riparian countries.

The MRC has three types of programmes: core, support and sector programmes. These represent three current and future needs for the riparian countries. The core programmes are those central to the purpose of the Commission, and are intended to be the ones remaining in the long term. They are addressing central issues in the 1995 Agreement in line with the Strategic Plan directly addressing Goals 1 to 3, water utilization; basin development plan; and environment programme. The activities under these programmes are, in the long term, to be funded by the contributions of the member countries, thus ensuring sustainability.

The support programme is directly addressing Goal 4 of the Strategic Plan, capacity building. This programme is important in the short and medium term to address capacity building needs of the MRC and the riparian Governments. As capacity increases, the support programme will diminish in size.

The sector programmes, fisheries; agriculture, irrigation and fishery; water resources management; and navigation are addressing important sectoral issues in the basin within the mandate of the 1995 Agreement and in line with the Strategic Plan. The programmes have a regional focus intended to address development needs in the sectors from a basinwide perspective, complementing and supporting national and bilateral development initiatives. See more details at www.mrcmekong.org

Thailand as MRC member joins all the programmes and has worked closely with the other 3 countries and MRC Secretariat.

10.4. Indicators on afore-mentioned issues

- Existing of apex body responsible in water management
- % of area that technical aspect is applied in water allocation
- % of projects that water user groups play continuous roles
- % of water user groups that formulate rule and regulation in water allocation
- % of RBCs that formulate rule and regulation in water allocation
- % of RBCs that implement water allocation

Table 43 Indicators on afore-mentioned issues

Indicators	Year			Targeted	
	1998	2003	2005		
• Existing of apex body responsible in water management	Yes	Yes	Yes		
• Proportion of irrigated land that allocation mechanism existed (% of total irrigated land)	47	49	50		
• Number of River Basin Committee established	-	29	29		

10.5. Existing gaps

Water allocation involves different stakeholders that must work harmoniously and different types of skill are needed in such work. Technical know-how and model for allocation should be applied at the river basin level scale for technical use in the decision making process. This should be operated by government officials in associated with other stakeholders in the RBC. While at the smaller scale involving of water user groups and individual households should be handled through responsible agencies. In Thailand law on water allocation has not yet stipulated, therefore formulating rules and regulations in this respect needs effort and cooperation of various stakeholders.

10.6. Conclusions

Introducing of water allocation system in Thailand needs to be done as piloting project in some of selected river basin because it must comprise detail description and action that involve multi-stakeholders. It must apply to a real situation and the river basin is an appropriate boundary for an integration process. After piloting and testing, the procedure should then expand to the other river basins.

10.7. Reference

1. Department of Provincial Administration, Ministry of Interior, Thailand registration Data 2003.

1. Royal Irrigation Department, Ministry of Agriculture and Cooperatives. 2005. Participatory Irrigation Management, the Operation and Maintenance (in Thai).
2. Royal Irrigation Department, Ministry of Agriculture and Cooperatives' 2006 data on abtraction of groundwater in Sukhothai from 1984 – 2005.
3. Office of Agricultural Economics, 2001 Data on Land Utilization and Holding

10.8. Recommended Reading/Website

1. http://www.adb.org/water/actions/THA/disputes-beneath-surface.asp#understanding

2. http://web.nso.go.th/eng/index.htm

3. http://www.oae.go.th/English/statE.htm

Challenge: Valuing Water

Overview: Water can be considered a natural asset, the value of which resides in its ability to create flows of goods and services over time. Values derived from water can usually be divided into two types (Fig. 3.1): use values (also known as extrinsic values and direct use values) and non-use values (sometimes called intrinsic values, passive use values, or existence values). Another common term is 'option value', which describes the fact that some individuals who do not wish to use the water resource now are willing to pay or forgo current benefits to preserve the resource for future generations or for some future use. This therefore clearly represents a non-use value for the current generation; but depending on its potential use by future generations, an option value could be either a use value or a non-use value.

Use benefits relate to the use to which water and water resource systems are put. The use values arise from the direct use of water by consuming it or its services. As use has a number of dimensions (quantity, quality, timing and location), many issues arise as soon as water uses are further specified. It is important to be aware of these specifications when, for example, comparing marginal values between sectors to assess the economic efficiency of allocations among them. For fair comparisons, adjustments are required to express values in commensurate terms of place, time and form (treated or raw water, instream or offstream, etc.). Therefore, water uses can be further specified under several different categories. In what follows three options are considered: by subtractability, by location, and by economic role.

In economic terms, according to its role in the production chain, water use can be classified or defined as either an *intermediate* or a *final* good. An example of the former is water used in the production of other goods or services, such as the irrigation of crops or the driving of turbines to make electricity. Alternatively, water can also be used directly (i.e. as a final good) by the final consumer in the household or for recreational activities like swimming. The concepts of economic value in these categories differ somewhat: the consumer's uses of water provide personal happiness or direct utility, while the producer's uses of water have value derived from the ultimate value of the resultant goods or services.

Non-use values are values placed on the mere *existence* of a resource and its physical, biological, social or cultural characteristics. Non-use values are benefits received from knowing that a good exists, even though the individual may not ever directly experience it. These values thus are not associated with any specific use. Many social and cultural values of water had been issued.

11.Valuing Water

11.1. Integrated Water Resources Management

11.1.1. Economic, Social and Cultural Value of Water

11.1.1.1. Parade of the Buddha Image "Luang Por Sothorn"

Phra Buddha Sothorn or Luang Pho Sothorn is the name of the ancient sacred Image of the Lord Buddha which is not only widely well known to all, but also highly respected and adored by both Thai people and foreigners. It is erected before the Major Image in the chapel of one royal monastery, Wat Sothorn, in The Province of Chachoengsao about 61 Kilometers east of Bangkok by railway and 101 kilometers by the State highway that is accessible by both land and water.

Wat Sothorn, the specified holy place for Luang Pho Sothorn, is geographically situated on the right bank of the Bang Pakong River about 2 kilometers towards southern west of the provincial Hall. Luang Pho Sothon cebrating festival is held three times a year.

However, after the Bang Pakong Diversion Dam began operations in March 2000 the parade of the Buddha Image "Luang Por Sothorn", previously celebrated each rainy season on Bang Pakong river, was forced to break from the traditional route. Construction of Bang Pakong dam blocked the navigation and the parade could no longer travel from Muang District upstream to Bang Kla District, having to stop at Jukka-cher sub-district.

Currently the authorities are reconstructing the river closure dam to include a navigation lock, in part to reinstate these ceremonies in response to public outcry.

11.1.1.2. The Royal Ploughing Ceremony

This ceremony, which is held in May, makes the end of dry season and the beginning of the new rice planting season. One of its essential parts is the ploughing of the field which is carried out in the traditional manner with a pair of oxen specially selected to draw the plough. A senior noble man, or a high ranking government official is appointed the Ploughing Lord, while four female officials act as his assistants to carry the seeds in baskets suspended from yokes carried across their shoulders.

At the commencement of the ceremony, the Ploughing Lord selects one of three identical-looking pieces of cloth which are actually of varying lengths. His choice serves as a prediction of the amount of rainfall. At the completion of the ploughing, the animals drawing the plough are led to troughs containing food and refreshments such as paddy, corn, legumes, sesame, liquor, water and grass. The animals's first choices again serve as means of predicting the harvest for the forthcoming season.

As the majorities of Thais live in the countryside and make rice-farming their main occupation, the Royal Ploughing Ceremony serves as an auspicious start to the new planting season, as well as giving them a vision of what the season will bring mainly affected by the amount of available water.

11.1.1.3. Loy Krathong-The Festival of Lights

Loy Krathong, or the Festival of Lights, is celebrated on the full moon night of the twelfth lunar month (in November), when the rainy season has ended and the rivers and streams are filled with water. It is an occasion of great festivity of all, nobility and ordinary folk alike, and involves neither Brahmin nor Buddhist rites. Various legend prevails as to the origins of the festival. At present, understanding is that the festival is celebrated as an act of worship to Chao Mae Kongka-the Goddess of the Waters.

Water plays an important part in the life of all Thais, particularly the farmers who need it to irrigate their fields, as well as for a variety of other purposes. They sometimes pollute the waters unintentionally, or perhaps use it mindlessly without thinking of its origins or potential scarcity. The festival is, therefore, celebrated as a way of thanking the Goddess of the Waters for providing the water much needed throughout the year, and as a way of asking forgiveness if they have polluted it or used it carelessly.

The floating of lanterns, which began more than 700 years ago, continued throughout the different stages of Thais history, in varying degrees of popularity and a variety of forms. The festival was accompanied by music and entertainment, recitations and repartee, feasting and fireworks. The banks of the river were lined with people and mobile kitchens were set up to serve a variety of delicacies. An air of enjoyment and gaiety prevailed.

Today the Loy Krathong Festival is celebrated annually with great joy and excitement all over the country. Competitions are held to judge the most imaginative and beautiful floats, and beauty pageants are organized to select the Loy Krathong Queen, or Nang Noppamas. Traditional entertainment accompanies the festival, and in some places there are spectacular fireworks displays.

People from all levels of society and of all age groups either make their own floats from banana leafs, or purchase a ready made one at the local market place, to set afloat in the nearby waterways.

Prior to setting their krathong afloat, the people will place in it a lighted candle, incense sticks, flowers, a coin and some food offerings. They make a silent prayer of thanks for the water received, a request for forgiveness for wrongs done, and a wish for the fulfillment of a secret dream. It is also believed that the Kratongs carry away sins and bad luck, and November is the time to start the coming New Year with happiness as any suffering is floated away.

11.1.1.4. Songkran

In the month of April on the fifth lunar month which is traditionally the Thai New Year is a time for the most popular festival, Songkran Festival. Songkran is a Thai word which means "move" or "change place" as it is the day when the sun changes position in the zodiac. It is also known as the "Water Festival" as people believe that water will wash away bad luck.

The Songkran tradition is recognized as a valuable custom for the Thai community, society and religions. For the public, Songran Festival is a time for rejoicing and merit making. Water becomes a crucial part of this event. People may go to the temple to make merit, sprinkle fragrant water over Buddha images and ask for blessings from the monks.

The value to the family, it is a time for family members to gather in order to express their respects to elderly members of their family and those of superior ranks by pouring fragrant water onto their hands and in return they receive their blessings. For youngsters, It’s really an amusing time when they go out and throw water to each other for being cooler at the hottest time of the year.

The festival also shows the society’s value for the environment through cooperation to clean houses, temples, public places and official buildings.

11.1.2. Poverty, Equity, the Millennium Development Goals

Secure water supply is an important aspect of poverty reduction strategies. Access to water and sanitation are basic human needs and their importance in terms of health and quality of life cannot be overstated.

The UN Millennium Development Goals include the goal (by the year 2015) the goal of reducing by half the proportion of people without sustainable access to safe drinking water. This goal is reflected both in national priorities for development and in the programs of international agencies.

Recently developed national policies on water supply have a number of common themes:

- an integrated approach to water supply and sanitation within a framework of integrated water resource management, to control water quality as well as quantity;

- decentralized planning, implementation and community-based management of water and sanitation services, including greater participation of women;

- expanded water supply through approaches that are demand-driven and responsive to users' willingness to pay;

- greater participation of the private sector, combined with targeted subsidies to ensure basic levels of service;

- continued data collection and monitoring to contribute to further policy development; and,

- increased services to the poor and to remote, ethnic minority areas.

These strategies are being implemented with the aid of a wide range of international and bilateral donors as well as NGOs. The Asian Development Bank also supports a range of activities relating to both urban and rural water supply. The Water and Sanitation Program, an international partnership of aid agencies administered by the World Bank, oversees a number of programs in the region and acts as a coordination point for bilateral assistance in water and sanitation.

11.1.2.1. Role of Water in Poverty Eradication

Domestic use typically represents only a small fraction (about 5%) of total water use in terms of volume (Seager, 2002), but access to clean water and adequate sanitation are essential for health.

Total domestic water use is determined by both population and lifestyle; including access to water and level of development. Use is generally higher in urban areas than in rural areas and consumption increases significantly with availability of piped water.

11.1.2.2. Financing of Water Related MDGs

1) Annual Investments in Water Resources Sector

Annual expenditure on domestic water supply and sanitation varies considerably among countries, but generally relies heavily on international aid and loans. Infrastructure development is heavily supported by bilateral donors and NGOs provide much of the water supply development in rural areas and villages.

In Thailand, apart from natural water stream grid, many man-made water grids were developed to distribute water from natural water storage or man-made reservoir to agricultural area, so called irrigation system. During 2000 to 2004, Royal Irrigation Department (RID) invested in the development of water supply sources and irrigation systems approximately 24,000 million Baht annually in average. Most of irrigation system is an open channel which water can be pumped for using in agricultural production. Up to present, RID has developed the irrigation systems occupying agricultural area of 26.88 million rai or equal to 15.96 % of total agricultural area of 168.44 million rai.

Water supply networks in urban area was constructed of tunnel and pipe with diameters ranged from 0.5 to 3.4 meters to distribute clean water from water supply plants to pumping stations in service areas.

Industrial water supply pipe networks were also constructed to discharge raw water from various sources to factories in industrial areas. The industrial water supply is normally a pipe

system which can solve the problem of water loss due to evaporation and can divert water from excess use water sources to the demand area effectively.

2) Operation and Maintenance Cost of Water Schemes

3) Annual Turnover in Income

4) Public-Private Partnership

The responsibility of water resources planning and management is distributed to policy governing agencies such as Water Resources Department, development and operation agencies in supply side such as RID, and water user agencies such as Metropolitan Water supply Authority and Provincial Water supply Authority as well as public and private companies who develop water supply system for industrial sector.

5) Privatization of Water Sector

Thailand is moving to decentralized models of water delivery, with increasing involvement of the private sector and emphasis on demand-driven user-pay models of supply. The impact of this on equity of supply should be monitored carefully.

11.1.2.3. Water Pricing Tariffs for rural and urban areas as well as for industry and irrigation

Considering irrigation water utilization in Thailand, it can be said that the concept of users be payers should be active since 1942 when irrigation fee collected from users of not more than 5 Baht per rai per year was allowed for agricultural water users and not more than 0.50 Baht per cubic meter for users in other sectors. Up to present, it was 60 years ago from such activation of the irrigation fee, especially for agricultural sector; however it has not been active yet. Only water utilization fee of 0.50 Baht per cubic meter for other sectors is active.

However, there is irrigation fee in some groups of water users. It is well known that water deficit occurs frequently in dry season and becomes continuously more severe. From the past, the water deficit problem was considered as a supply problem which was tried to solve by constructing dams or reservoirs for reserved water storage. This is considered as supply side water management. Attempts of partially demand side management in engineering aspect such as optimal design of water conveyance system with respect to water demand as well as the present water distribution method could not sufficiently solve the water deficit problem in sustainable way. Therefore, it is necessary to develop methodology to control future water utilization conservatively and effectively that is a water demand management in economic aspect which has never implemented in actual.

Irrigation fee at appropriate rate should be an economic methodology to assist more conservative and effective water utilization. In order to develop an approach in specifying an appropriate rate of the irrigation fee, the value of irrigation should be evaluated based on economic cost. In addition, willingness to pay of users as well as applicability of collect the fee in the future should be evaluated in view of users.

11.2. Indicators on afore-mentioned issues

1) Intensity of application of economic tools in agriculture

2) Existence of traditional ways of expressing worship to water

3) Intensity of application of “polluter pays” principle

11.3. Reference

1. Office of the National Economics and Social Development Board and United Nations Country Team in Thailand. 2004. Thailand Millennium Development Goals Report.

2. The National Identity Board, Office of the Prime Ministry. 1990. The Royal Ceremonies Past and Present.

11.4. Recommended Reading/Website

1. United Nations Development Program, Thailand Office (http://undp.or.th/mdgr.htm)

Challenge: Ensuring the Knowledge Base

Overview: In Thailand, the capacity building of environmental knowledge has been supported by the government through education and access to information. The environmental knowledge is in curriculum of all level of education. Moreover, there are laws that guarantee public access to all types of information including environmental information held by the government.

12. Capacity building

12.1. Education

In Thailand, there are government supports for integrating environmental knowledge into public education. The environmental knowledge is in curriculum of all level of education since primary school through doctorate level in University. According to an assessment of the Access Initial National Team Reports of World Resources Institute, there is a strong level of indication in government efforts to build capacity (World Resources Institute, 2002)

12.2. Access to Information

According to Access initiative National Team Report of World Resources Institute, 2002, the legal instruments that form that basin for access information are categorized into three types: (1) constitutional guarantees to information; (2) freedom of information laws that provide access to information held by government agencies; and (3) laws or legal provisions specifically governing access to environmental information. All these three elements are presented in Thailand national law. The following examples of the special provisions are excerpted from closing the Gap (World Resources Institute, 2002). Thailand's Enhancement and Conservation of National Environmental Quality Act of 1992 states that any person is entitled to an information of environmental quality promotion and conservation from government agencies. The constitution of the Kingdom of Thailand, adopted in 1997, provides guidance on classes of environment information in the public domain. Section 59 of the Thai constitution reads that public information should cover all information related to any activity that may affect environment quality, health, and other interests of the local communities. The Thai Official Information Act of 1997, which allows public access to all types of information held by the government, also applies to environmental information.

12.3. Indicators on afore-mentioned issues

- Efforts to build capacity of staff of selected institutions to support access to information and participation by public
- Availability and comprehensiveness of information from selected agencies
- Government investment in environmental education
- Constitutional guarantees to access to information
- Freedom of Information Acts or equivalent legislation
- Access to environmental information provisions

12.4. Recommended Reading/Website

1. World Resources Institute (2002) Closing the gap: Information, participation, and justice in decision-making for the environment. World Resources Institute, Washington, DC