Assessment and Promotion of Human Resources for River Water Quality Management

Edited by

Koichi Fujie

and

Japan Society on Water Environment

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Assessment and Promotion of Human Resources for River Water Quality Management

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The Japan Society on Water Environment (JSWE) is a non-profit and non-governmental academic society established in 1966 to promote the interchange of information among its membership and the development of research on the science and technology of creating a good water environment. The Society also serves as the Japanese branch of the International Association on Water Quality (IAWQ). JSWE publishes a monthly journal, Journal of Japan Society on Water Environment, and holds an annual conference on Water Environment in addition to a number of specialized seminars. JSWE is operating the regional editorial committee of Water Research, the monthly journal of IAWQ, for Japan and the Western Pacific countries.

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PREFACE

The recent rise of the newly industrialized countries in Southeast Asia is posing an increasing threat to the environment. Not only is the urban population growing at an unprecedented rate, flooding the rivers with sewage, but hastily built industrial plants are discharging toxic substances into rivers. The environmental hazard is extended as the foul waters from the rivers pollute the coastal waters. In addition, the areas deforested to accommodate industrial and population growth are suffering erosion and contributing to the siltation of the rivers. Uncontrolled effluents from highly urbanized areas greatly contribute to the overall pollution.

Governments are now alarmed by the high rate of incidents caused by toxic substances of industrial origin. The third ASEAN Ministerial Meeting on the Environment held in Jakarta in October 1987 decided to focus on management of industrial effluents, water quality studies and the rehabilitation of polluted urban rivers as their coordinated activity in the region.

Efforts to control effluents are however constrained by the fact that there are not enough people trained for this purpose. Furthermore, there is no uniform methodology regionally applicable. The purpose of this project, "Assessment and Promotion of Human Resources for River Water Quality Management", is to support such training and the establishment of a methodology in Southeast Asia, where the newly industrialized countries are most concentrated, through the provision of a manual and a workshop on human resources development for water quality management.

A steering group for the project was set up by Malaysia, The Philippines and Thailand, which are the countries of focus, together with countries more experienced in river water pollution control, Japan, Korea and Singapore, to strengthen human resources for river water quality management in the Asia and Pacific region and to improve the water quality of rivers in the region.

Two steering group meetings in Tokyo and Singapore and a workshop in Kuala Lumpur were held. This book was prepared through intensive discussions during the meetings and workshop which centered on current problems and experiences in river water quality management in each country, and diagnostic study of the status and development of human resources for river water quality management.

In the meantime, the great success of the cooperation between the countries participating in this project has not only led to the publication of this book, but also given the signal to initiate a long-term cooperation among Asian countries for the development of human resources for river water quality management.

The United Nations Environment Programme and Japan Society on Water Environment hope that this book will find a wide circle of readers among managerial personnel both in local and central governments, policy-makers, engineers, scientists, and related NGOs.

November 1995

Koichi Fujie and
Editorial Committee in JSWE

OUTLINE OF PROJECT

The Japan Society on Water Environment (JSWE) initiated the project entitled "Assessment and Promotion of Human Resources for River Water Quality Management" in cooperation with the United Nations Environment Programme (UNEP) with the long-term objective of improving water quality in rivers in the Asia and Pacific region, and the short-term objective of strengthening human resources for river water quality management in that area. The outputs of the project were: 1) a diagnostic study on human resources for river water quality management in the Southeast Asian countries, and 2) a manual on human resources development for river water quality management in the Southeast Asian countries produced in cooperation with Japan, Republic of Korea (hereafter Korea), Singapore and Indonesia.

Two steering group meetings and a workshop were incorporated in the project. The total size of project budget was US$339,000, and was funded by US$217,000 from the Environment Fund of UNEP, US$117,000 from JSWE and US$5,000 from the University of Malaya, respectively. The project started in 1991 and was completed in 1995.

To implement the project a steering committee was set up involving the representatives of Malaysia, Thailand and The Philippines, which were the countries of focus, together with countries with more extensive experience in water pollution control in Asia, such as Japan, Korea and Singapore. Indonesia was involved as an observer because of its experience in the implementation of the river water clean-up program PROKASIH. The steering committee members were selected from the candidates nominated by the governments of the countries concerned. In addition to the above a program officer from UNEP headquarters in Nairobi, the deputy regional representative of the UNEP Regional Office for Asia and the Pacific (ROAP) and representatives of JSWE were involved in the steering committee. Four consultants were recruited from Malaysia, Thailand and The Philippines in cooperation with each government and ROAP.

The final output of the project is a manual to give an overview of water pollution and its control, and promote activities for development of human resources for river water pollution control and the strategies in connection with human resources development in the area concerned. The roles of the steering committee were: 1) to review the experiences of Japan, Korea and Singapore in river water quality control, 2) to determine the outline of a manual on human resources development for river water quality management, 3) to review the diagnostic study of the situation in Malaysia, The Philippines and Thailand, and 4) to comment on the draft manual and incorporate suggestions made by workshop participants on the topics as well as their case studies.

The project history is reviewed in the following.

Participants of Project

Steering Committee Members

Mr Abdul Rahim Shahid	Ministry of Science, Technology and Environment, Malaysia
Mr Rodorigo U Fuentes	Department of Environment and Natural Resources,

	The Philippines
Ms Nisakorn Kositratana	Office of the National Environment Board, Thailand
Mr Tan Teng Huat	Ministry of the Environment, Singapore
Mr Yeon-Taek Rim	National Institute of Environmental Research, Korea
Mr Makoto Okazaki	Environment Agency, Japan
Mr Tetsuo Hayakawa	Environment Agency, Japan
Dr Yasumoto Magara	National Institute of Public Health, Japan
Dr Mitsumasa Okada	Hiroshima University, Japan
Mr Gerhart Schneider	UNEP/Freshwater Unit
Mr Yoshiyasu Hirayama	UNEP/Regional Office for Asia and the Pacific (ROAP)

Consultants

Dr Low Kwai Sim	University of Malaya, Malaysia
Dr Reynaldo Lesaca	Environmental Engineering Consultant, The Philippines
Dr Thongchai Panswad	Chulalongkorn University, Thailand
Dr Chongchin Polprasert	Suranaree University of Technology, Thailand

Observers

Mr Nabiel Makarim	Environmental Impact Management Agency, Indonesia
Mr Gempur Adnan	Environmental Impact Management Agency, Indonesia
Ms Cindy G Jardine	PROKASIH (Indonesia) Adviser, Canada

Committee Members for Project Implementation in JSWE

Dr Koichi Fujie	Toyohashi University of Technology, Japan
Dr Hideo Harasawa	National Institute of Environmental Studies, Japan
Mr Tsutomu Sakagawa	Environment Agency, Japan
Mr Atsuhiko Kimura	Environment Agency, Japan
Mr Kiyoshi Iguchi	Kanagawa Environment Research Institute, Japan
Mr Nobuyuki Kashihira	National Environmental Training Institute, Japan
Dr Aloysius U Baes	University of Philippines at Los Banos, The Philippines

Adviser

Dr Mikiyasu Nakayama	Utsunomiya University, Japan

Progress

The project started in May 1991. Dr Ryuichi Sudo, President of the Japan Society on Water Environment (formerly Japan Society on Water Pollution Research), signed the United Nations Environment Programme Project Document (Doc: 4257e) on 19 April 1991 and A T Brough, Assistant Executive Director, Office of the Environment Fund and Administration in UNEP, on 6 May 1991. JSWE started to organize the steering committee and to recruit the consultants to carry out the diagnostic studies based upon the surveys in the countries concerned. The project schedule was as follows:

Date	Activity
Jun 1992	Selections of consultants and steering committee members
Sep 1992 - Dec 1992	Country surveys
Jan 1993	Submission of country survey reports to UNEP via JSWE

Sep 1992	Steering committee meeting
Dec 1992 - Jan 1993	Preparation of draft manual
Feb 1993	Submission of draft manual to UNEP via JSWE
Feb 1993	Review of draft manual by UNEP
Apr 1993	Workshop at Kuala Lumpur, Malaysia
Nov 1993	Submission of Draft Manual to JSWE
Dec 1993 - Feb 1994	Editing of Draft Manual by JSWE and Prof. Low Kwai Sim
Mar 1994	Second steering committee meeting in Singapore
Apr 1994 - Jul 1995	Finalization of manual by JSWE and technical editors
Aug 1994	Submission of final draft manual to UNEP
Aug 1995	Second review of manual by UNEP
Sep 1995 - Nov 1995	Publication and distribution of manual
Dec 1995	Evaluation and closure of project by UNEP

Meeting and Workshop

The project document specified that the project should be implemented based upon the deliberations of steering committee meetings and include a workshop on water pollution control and human resources development issues. The two steering committee meetings and the workshop are outlined below.

First Steering Committee Meeting

Date: 7 - 8 September 1992
Venue: Environment Agency of Japan, Tokyo
Official Participants:

Singapore:	Mr Tan Teng Huat
Japan:	Mr Tetsuo Hayakawa, Dr Yasumoto Magara, Dr Mitsumasa Okada
Malaysia:	Mr Abdul Rahim bin Mohd Shahid, Dr Low Kwai Sim
Thailand:	Ms Nisakorn Kositratana, Dr Thongchai Panswad
The Philippines:	Mr Rodorigo U Fuentes, Dr Reynaldo Lesaca
Indonesia:	Ms Hermien Roosita
Canada:	Ms Cindy G Jardine
UNEP:	Mr Yoshiyasu Hirayama (ROAP)
JSWE:	Dr Koichi Fujie, Dr Hideo Harasawa, Mr Tsutomu Sakagawa, Mr Kiyoshi Iguchi, Mr Yukinobu Kashihira

Subjects:

1) Review of the experience of Japan, Korea and Singapore in river water quality control.
2) Preparation for the country survey and the diagnostic study.
3) Determination of the outline of a manual on human resources development for river water quality management.

Second Steering Committee Meeting

Date: 22 - 24 March 1994
Venue: Melia Hotel at Scotts, Singapore
Official Participants:

Singapore:	Mr Tan Teng Huat, Mr Eng Tiang Sing
Korea:	Mr Hyung-Jae Yang
Japan:	Mr Atsuhiko Kimura, Dr Yasumoto Magara, Dr Mitsumasa Okada
Malaysia:	Mr M Izuddin Abd Ghani, Dr Low Kwai Sim

Thailand:	Mr Wijarn Simachaya, Dr Thongchai Panswad, Dr Chongchin Polprasert
The Philippines:	Ms Rachel A Vasquez, Dr Reynaldo Lesaca,
UNEP:	Mr Gerhart Schneider (Nairobi)
JSWE:	Dr Koichi Fujie, Dr Hideo Harasawa, Mr Kiyoshi Iguchi, Dr Aloysius U Baes, Ms Fumi Tamura

Subjects:

1) Comment on the draft manual and incorporation of suggestions made by the workshop participants on the topics as well as their case studies.
2) Preparation of the manual for publication by amendment and supplement to the draft manual.

Workshop

Date: 12 - 16 April, 1993

Venue: Crown Princess Hotel at Kuala Lumpur, Malaysia

Official Participants:

Singapore:	Mr Tan Teng Huat, Mr P Jothieswaran, Mrs. Ang-Tan Seow Kiak
Malaysia:	Mr Izuddin Abd Ghani, Dr Low Kwai Sim, Dr Siti Norazah Zulkifli, Mr Anuar Abdul Razak
Korea:	Mr Yeon Taek Rim, Mr Hyung-Jae Yang, Mr Sung-Je Cho
Japan:	Mr Tetsuo Hayakawa, Dr Mitsumasa Okada, Dr Yasumoto Magara,
Thailand:	Ms Nisakorn Kositrat, Mr Wijarn Simachaya, Ms Duangnate Kerwrum, Dr Thongchai Panswad, Dr Chongchin Polprasert
The Philippines:	Mr Esterlito Pinlac, Mr Carlos A Panaligan, Dr Reynaldo Lesaca
Indonesia:	Mr Naviel Makarim, Mr Gempur Adnan
UNEP:	Mr Gerhalt Schneider (Nairobi), Mr Yoshiyasu Hirayama (ROAP)
JICA:	Mr Satoru Kohiyama, Mr Hisakazu Hirai, Mr Toshio Moroga
JSWE:	Dr Koichi Fujie, Dr Hideo Harasawa, Mr Tsutomu Sakagawa, Mr Kiyoshi Iguchi

Observers:

University of Malaya, Malaysia

Prof. P K Voon, Prof. Madya Hamirdin Ithnin, Prof. Madya Datin Zaharah Mahmud, Dr Khairulmani Osman Salleh, Mr V Sooryanarayana, Mr Tan Wan Hin, Mr Azaruddin Othman, Mr Mohd. Rafi Yacob, Mrs. Safiah Muhd Yusoff

Ministry of Agriculture, Malaysia

Ir Chong Sun Fatt

Environmental Health Center in Kuala Lumpur, WHO

Mr Tom Dafoe

Subjects:

1) Presentation of the diagnostic study on the situation in Malaysia, Philippines and Thailand.
2) Presentation of draft manual for strengthening human resources in Malaysia, the Philippines and Thailand.
3) Presentation of case studies by the experts working for water pollution control and human resources development in Asian countries.
4) Lecture on water pollution control and human resources development to the participants from the region.
5) Group discussion on the major items as follows:

Group I

i) river water pollution, present state and history
ii) pollution sources, quality and quantity
iii) wastewater treatment technologies
iv) identification of quality of human resources for river water quality monitoring

Group II

i) governmental organization, both central and local, in charge of river water quality monitoring

ii) policies of government for river water quality monitoring

iii) applicable laws, legislation, regulations including standards, both ambient and effluent

iv) enforcement system and mechanisms

Group III

i) identification of shortage of human resources

ii) assessment of educational and training systems

- as national activities:

  improving the educational systems, training courses, etc.

- priorities: technical and projects

  treatment facilities, laboratories, training centers, etc.

iii) role of the government, international and bilateral cooperation agencies, NGOs such as academic societies/associations like IAWQ and its national committees.

Preparation of This Manuscript

This book has been prepared by the editorial committee consisting of Dr Koichi Fujie (chairman), Dr Yasumoto Magara, Dr Mitsumasa Okada, Mr Atsuhiko Kimura, Mr Kiyoshi Iguchi, Dr Hideo Harasawa and Dr Aloysius U Baes based upon discussions at two steering committee meetings and the workshop and the diagnostic studies in the countries of focus by the project's consultants, Dr Low Kwai Sim, Dr Thongchai Panswad, Dr Chongchin Polprasert and Dr Reynaldo Lesaca. The manuscript was technically reviewed by Mr Paul Nagle (technical sub-editor of International Association on Water Quality, IAWQ) and by Ms Hilary Nightingale.

Acknowledgement

JSWE is grateful to the governments of Malaysia, Thailand, The Philippines, Japan, Korea, Singapore and Indonesia for their comprehensive support to implement this project. The instructive advises by Mr Yoshiyasu Hirayama, the former deputy representative of ROAP and by Dr Mikiyasu Nakayama, Utsunomiya University, Japan are acknowledged. JSWE expresses its special thanks to Mr Anthony Milburn, executive director of IAWQ and to IAWQ for their technical contributions to publish this book and to all those who concerned to implement this project.

CHAPTER I

INTRODUCTION

East Asian countries have been experiencing an economic boom over the past several years. Industrial development and trade are on the rise, fuelled by healthy and vigorous foreign investment. Unfortunately, it is the very same development that hastens the degradation of the quality of life and the environment in these countries.

Increased pollution coming from heavily populated areas and industries is threatening or completely destroying vital rivers and waterways, among other environments and resources. Existing physical and societal structures seem unable to cope with the growing environmental problems. It is in the light of this situation that this project becomes both urgent and important.

"Human Resource Development For River Water Quality Management In East Asian Countries" is a collaborative project of the Japan Society on Water Environment (JSWE), the United Nations Environment Programme (UNEP), and researchers from East Asian countries. This manual was prepared for the following purposes:

1) to provide an assessment of and a framework for the proper conduct of river water quality management in East Asian countries;
2) to provide an assessment of and suggest adequate procedures for human resource development efforts for river water quality management; and
3) to propose and examine various activities and programs for forging regional cooperation in the area of human resource development for water quality management.

The East Asian region consists of the ASEAN countries - Indonesia, Malaysia, The Philippines, Singapore, Thailand and Brunei Darusalem; the Newly Industrialized Countries (NICs) - South Korea and Taiwan; and China, and Japan (see Fig. 1.1). The ASEAN countries, more specifically the ASEAN 5 (ASEAN without Brunei), together with the NICs of East Asia, have consistently recorded the highest economic growth rates in the world for the past decade (and even longer for a few countries). During the second half of the 1980s East Asian economies were surging ahead with annual growth rates of between 7 and 10% while advanced western economies were languishing with annual growth rates of not more than 4% (see Table 1.1). In fact, this extremely rapid expansion was reflected in almost every macroeconomic parameter from domestic investment and inward foreign investment to imports and exports. This trend continued during the early 1990s up to the present for all East Asian countries except The Philippines, which was experiencing a slowdown due to locally negative factors.

Yet not everything is rosy, especially in the ASEAN countries. The rapidly growing economies in these countries have not yet translated into economic benefits for the improvement of the quality of life for the whole population or for the preservation of the natural environment. Particularly worrying is the apparent accompanying trend of pervading poverty in the midst of an overall modernization and development, an apparent neglect in the development of human qualities and an increasing destruction of the natural environment, which are in turn continuously magnified by a rapidly increasing population in almost all ASEAN countries.

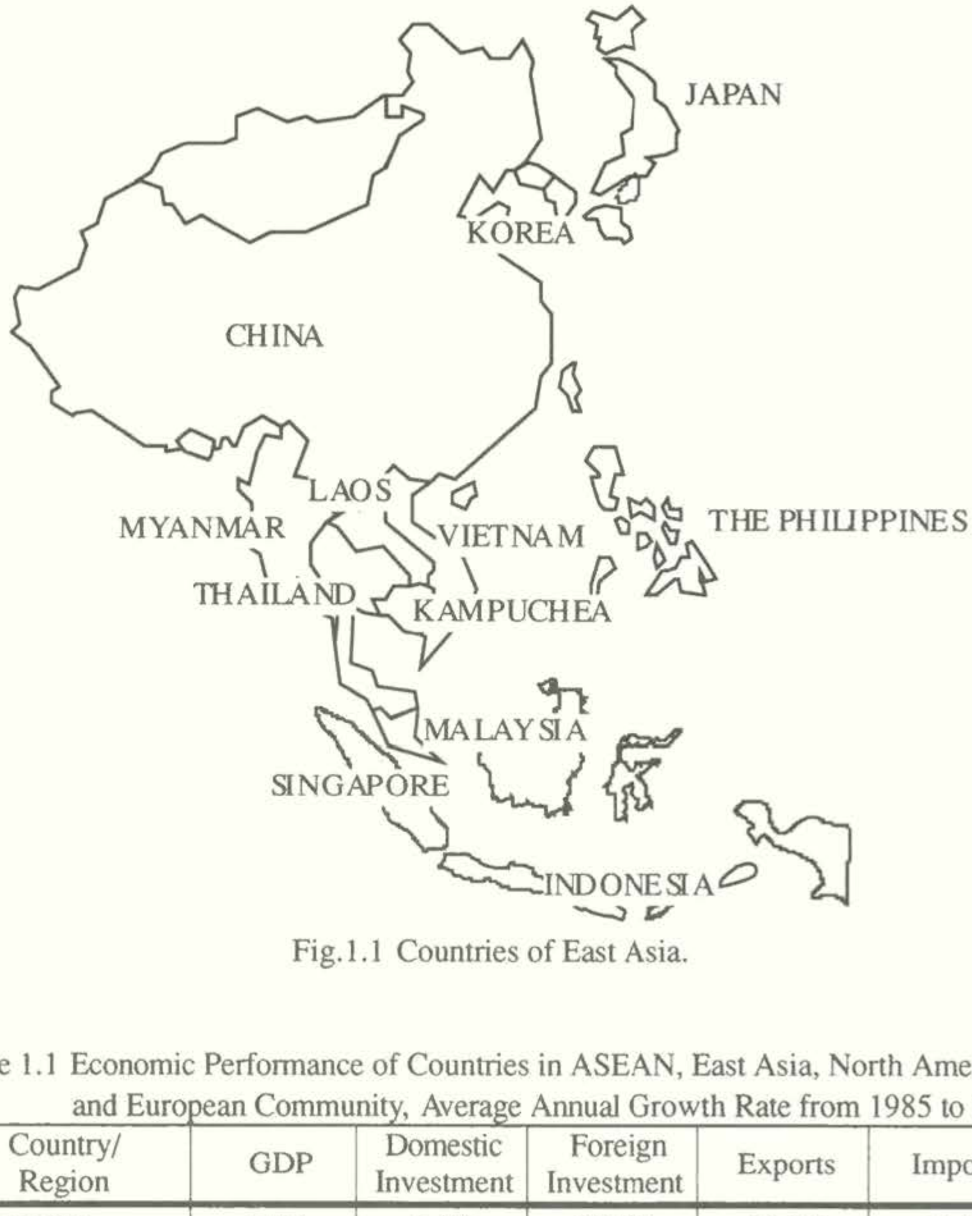


Fig.1.1 Countries of East Asia.

Table 1.1 Economic Performance of Countries in ASEAN, East Asia, North America, and European Community, Average Annual Growth Rate from 1985 to 1990.

Country/ Region	GDP	Domestic Investment	Foreign Investment	Exports	Imports
Singapore	7.99	5.35	30.88	11.25	11.30
The Philippines	4.59	9.33	105.81	10.50	15.83
Thailand	9.89	19.18	64.89	19.30	21.65
Malaysia	6.73	8.73	28.41	14.45	19.49
Indonesia	6.30	12.04	21.06	2.92	12.21
Korea	10.23	16.00	20.63	12.41	13.40
Taiwan	8.71	12.57	26.74	12.81	17.90
Hongkong	5.83	11.73	-24.41	17.88	4.41
Japan	4.58	7.01	18.12	6.30	8.56
NA 3*	2.65	0.54	16.61	5.62	3.97
EC 12**	3.16	5.07	39.11	1.01	1.21

* US, Canada, and Mexico

** European Community

Source: IMF, International Financial Statistics, 1991-92

The "human development index" (HDI) rankings of the ASEAN 5 countries are still just a little above average in comparison with 125 other countries of the world, with the exception of Singapore which had recorded a higher index (see Table 1.2). This ranking was made by the United Nations Development Program (UNDP) as a measure of comparative living standards in different countries of the world. The aspects included in estimating the HDI are life expectancy at birth, adult literacy rate, and GNP per head. As shown by the partial listing given in Table 1.2, GNPs per head of most ASEAN countries are only about 15 to 20 percent of those in industrialized or developed economies. In reality, values of GNP per head are even lower than the UNDP estimates for these countries because of larger disparities in the distribution of wealth and incomes and the continuing tendency for the poor to get poorer and the rich to get richer. The estimates of life expectancy at birth may not improve or may even go lower through the years as causes of diseases, such as poor water quality and the like, have not yet been overcome in these countries.

Table 1.2 Comparative Living Standards of Some Countries.

Country	Life Expectancy at Birth (years)	Adult Literacy Rate (%)	GNP per Capita ($)	HDI Rank
Niger	45	14	452	1
Bangladesh	52	33	883	23
India	59	43	1053	37
Indonesia	57	74	1660	54
The Philippines	64	86	1878	65
China	70	69	2124	66
Thailand	66	91	2576	78
Malaysia	70	74	3849	85
Singapore	73	86	12790	96
Hongkong	76	88	13906	108
USA	76	96	17615	112
Britain	76	99	12270	121
France	76	99	13961	123
Canada	77	99	14375	126
Japan	78	99	15135	130

Source: UNDP, Based on mid-to-late 1980s statistics as cited in Kennedy, P. Preparing for the Twenty-first Century, Vintage Books, 1993. pp.351-352.

The most important concern for us is the negative environmental consequences that are brought about by the rapid urbanization and industrialization in these countries. Air and water pollution from both human settlements and industries are severely affecting human health and natural resources vital to sustainable growth. Pollution affects many people in East Asian countries because industry and population are both heavily concentrated in the big cities. Rivers and other bodies of water located close to big cities, for example, are continuously eroded of their capability to sustain fish and other aquatic life and are polluted to a point where their use as domestic sources of water, or for recreational and other purposes, is rendered impossible.

Separate studies conducted by the World Bank (WB) and the Asian Development Bank (ADB) in 1993 concluded that pollution in industrializing Asia is growing much faster than the region's economies (Associated Press filed report, *Philippine Daily Inquirer*, 8 December 1993, p.19). The press report added that Carter Brandon, an environmental economist who co-authored the ADB report, had stated that while East Asian economies are doubling every ten years or so, pollution is increasing by factors of between five and ten. He said that while Thailand's economy doubled from 1975 to 1988, industrial emissions of sulfur dioxide, nitrogen oxide, and total suspended particulates worsened by eight to twelve times as industrial pollution increased fivefold and the number of vehicles on the road increased eightfold. He added that the Philippine economy grew at a smaller rate during the same period but industrial pollution worsened eightfold.

On the other hand, one need not be a technical expert to realize that, for all intents and purposes, the black waters of most of the rivers flowing through big ASEAN cities are practically dead biologically. It is also easy to realize that one is risking one's health by wading or swimming in their murky waters. The most unfortunate realization is when one can no longer use these waters for drinking and other domestic purposes while there is a scarcity of good quality water from other sources. We simply have to see these rivers to realize the gravity of the problems that have already been created and are continuously being aggravated.

People from all sectors are slowly realizing these environmental problems and have called for solutions. The governments of the ASEAN countries have voiced alarm over the rising pollution levels caused by discharge of toxic and hazardous wastes into water bodies and the increasing incidences of harmful impacts on the general public. At the Ministerial Meeting in Jakarta in 1987, the ASEAN governments decided to focus on the management of industrial effluents and water quality. They also called for the rehabilitation of degraded rivers and waterways. Since then government environmental agencies in these countries have been launching programs and activities in pursuit of these goals, focusing on river water quality management. Singapore has started the rehabilitation of its Kallang River while The Philippines have called for studies to rehabilitate the Pasig-Marikina River system and the Pampanga River system. In Malaysia, studies have been initiated to classify rivers based on pollution levels, the results of which will be used in the rehabilitation of highly polluted segments. Studies of river systems have also been done in Thailand and stringent regulatory measures have been proposed for pollution abatement. Unfortunately, solutions are difficult and, in general, river conditions have hardly improved since then.

There are many factors that influence river water quality management, more so for an already polluted river. There are the policy, administrative and other governmental factors, including all the relevant laws and regulatory measures, which provide the institutional approach for the prevention and abatement of pollution. There are the technical factors which provide the basis for the identification of problems and possible solutions. There are also social and economic factors which should be considered. All the factors and aspects are complicated on their own, but become more so because they are interrelated. A basic difficulty is encountered in conducting a proper river water quality management program if one misunderstands or fails to consider the relationships of these different factors.

We have chosen to focus on the technical matters, specifically on the technical basis of river water quality problems and on the proper technical solutions. It is hoped that a technical understanding will facilitate the understanding and the positive movement of economic, governmental, and social factors. More specifically, we have chosen to focus on the human resource development aspects of river water quality management. Government representatives and experts from ASEAN countries have often mentioned that a lack of trained personnel, among other difficulties, is hampering their efforts in pollution control. But apart from this being mentioned as a practical technical difficulty, we see the greater difficulty of not being able to bridge the different political, economic, and social aspects of management into some harmonious positive relationship because of an unaware and apathetic populace.

By human resource development, we do not only mean to include the education and training of technical experts and technical implementers of a river water quality management program. Also included here are education and awareness-building programs for policy makers, especially those in local government, people from industries and the general public through non-governmental organizations (NGOs). It is hoped that educated and trained technical personnel will improve planning and implemention of a good river water quality management program. Furthermore, it is hoped that an aware and alert populace and core of decision makers will make a good management program possible.

Readers, specifically students, experts and policy makers, may find this manual informative for its reference material on water quality and the status of pollution in major rivers and river systems in East Asian countries. Existing conditions of rivers and river systems in these countries are given in chapter 2. We have given much attention to gathering available information on the conditions of these rivers and river systems. However, there is a paucity of information on the water quality of most of these rivers and river systems. In most cases we were limited to simply describing their general conditions, except for some which we have described in more detail.

This manual is also useful in comprehending the complexities of river water quality management in several East Asian countries. In chapters 4 and 5, we have dealt mainly with assessments of water quality management practices in these countries. Chapter 5 focuses on the specific topic of human resources requirements for proper river water quality management in each of the countries participating in this study. A detailed discussion of the criteria for estimating the required technical personnel for river water quality management is also given in chapter 5. Assessments of experiences in these countries were carried out using positive experiences from both Japan and South Korea as references and the guidelines set by the UNEP/GEMS water operational guide.

In chapter 6, we have attempted to define the priority areas for manpower training for river water quality management, specifically in the areas of pollution control and monitoring. Strategies for human resources development in these countries are discussed and suggestions for cooperative efforts are made.

CHAPTER 2

WATER QUALITY OF RIVERS IN EAST ASIAN COUNTRIES

Rivers are important for the sustainable economic development of East Asian countries. River water is used for domestic purposes, industrial production, generation of hydropower, fisheries and aquaculture, agriculture including water for livestock requirements, navigation and transport, and recreation.

Unfortunately, most rivers in East Asian countries also act as receptors, sinks or carriers for many pollutants from industrial effluents, sewage, and other discharges. The increasing deforestation in most East Asian countries has also caused an increasing amount of eroded soils and humic substances to flow into their rivers. Soil erosion has exacerbated the poor water quality of rivers by increasing the turbidity, suspended solids, and even dissolved inorganic and organic materials. All of these have greatly affected the many uses of these rivers.

The state of water pollution in many East Asian rivers is directly correlated with increasing industrialization and urbanization. Water pollution originates mainly from the return flow of its beneficial uses in households, agriculture and industries. In rivers of East Asian countries included in this project, return flows carrying pollutants include effluent discharges from industries, sewage from domestic sources, irrigation waters and storm waters. Each return flow carries specific, often predictable, pollutant loads which may have an impact on human health and on the aquatic life in these rivers.

In this chapter, the present water quality of several major rivers in the countries involved in this project will be described. It will be noted that the descriptions we have made of rivers vary in detail for the different countries. This variation, in a sense, reflects the level of river water quality monitoring in these countries. We have, at the very least, attempted to present a general picture of the types of pollutants discharged into these different rivers, and the sources of pollution, including estimates of pollution load from each source category.

2.1 Malaysia

There are 87 major rivers in Malaysia. The longest rivers in Peninsular Malaysia are the Sungai Pahang (475 km), the Sungai Perak (400 km) and the Sungai Kelantan. The rivers of Sarawak and Sabah are longer than those of Peninsular Malaysia. The longest of them is the Rajang of Sarawak (563 km). Most of the urban areas are located on the floodplains of the river systems (see Fig.2.1a, b, and c).

A major river water quality assessment program has been carried out in Malaysia in recent years. The

87 major rivers were sampled at a total of 555 sampling stations. River water quality was assessed in terms of its physical, biological and chemical characteristics.

A comparison of the 1990 and 1991 data for water quality shows that, in general, rivers in Malaysia are slightly deteriorating. This appraisal is based on a comparison of 5 water quality parameters:BOD, COD, ammoniacal-N, suspended solids, and pH. Using standards given for class III in the Interim National Water Quality Standards of Malaysia as reference (see Table 2.1.1), 6 of the 87 rivers were found to be seriously polluted, 44 rivers were slightly polluted, and the remaining 37 rivers were still classified as clean.

The deterioration of river water quality was attributed to the continuing discharge of untreated or partially treated human and animal (mainly swine) wastes into these rivers. These remain as the main sources of organic pollutants in Malaysian rivers. Based on a comparison of the values obtained for suspended solids over a 5 year period, 69 out of the 87 rivers monitored were said to be affected by soil erosion and river siltation. The 69 affected rivers are located mostly in Peninsular Malaysia.

Heavy-metal pollution of rivers close to industrial centers in Western Malaysia was also found. For example, the higher values of mercury found in river waters were obtained in the Prai, Kerian, and Jejawi rivers which are all in the area of Penang where most industries are located.

Malaysian rivers are in general more polluted with phosphate than nitrate. The rivers that recorded phosphate levels higher than the 0.1 mg/L standard value for Class III waters were the Sepang River in Melaka; Setiu, Ibai, Dungun, and Paka rivers in Terengganu; and Air Baloi, Pontian, Kecil, Endau, and Skudai in Johor. All these rivers are located in population centers. Phosphate levels of rivers in Sarawak and Sabah were all within the standard limit for Class III waters. For Sarawak and Sabah rivers, all values for nitrate were also within the standard limit of 0.028 mg/L for Class III waters.

A summary of the general sources of pollution of Malaysian rivers is given in Table 2.1.2. This table summarizes pollution coming from both point and non-point sources in the country. Non-point sources are mainly leachates and subsurface flows from agricultural and urban areas, while point sources are from industries and other human activities such as agriculture, animal husbandry, sewage etc.

A major point source of pollution is industry. In 1991, 2292 industrial sites were identified as significant sources of pollution in Malaysia. The major potentially polluting industries are 928 food and beverage factories, 324 rubber producing factories and 270 chemical factories. A majority of these factories are located in Selangor (414), Johor (384), Palau Pinang (328) and Perak (253).

Among other polluting industries are electroplating, textile and printing ink manufacturing, all of which lack treatment facilities. The effluent with the highest pollutant load ever recorded came from a dry-cell battery factory and had received no treatment.

Human and animal wastes are the main sources of organic pollutants. Manufacturing and agro-based industries are next in terms of organic pollutant contribution. The implementation of government regulatory measures on industrial effluents has somehow controlled pollution coming from agro-based and manufacturing industries. Thus in 1991 these two sectors combined contributed only 8% (37 tons/day) of BOD while 13% (65 tons/day) and 79% (385 tons/day) came from animal wastes and sewage, respectively.

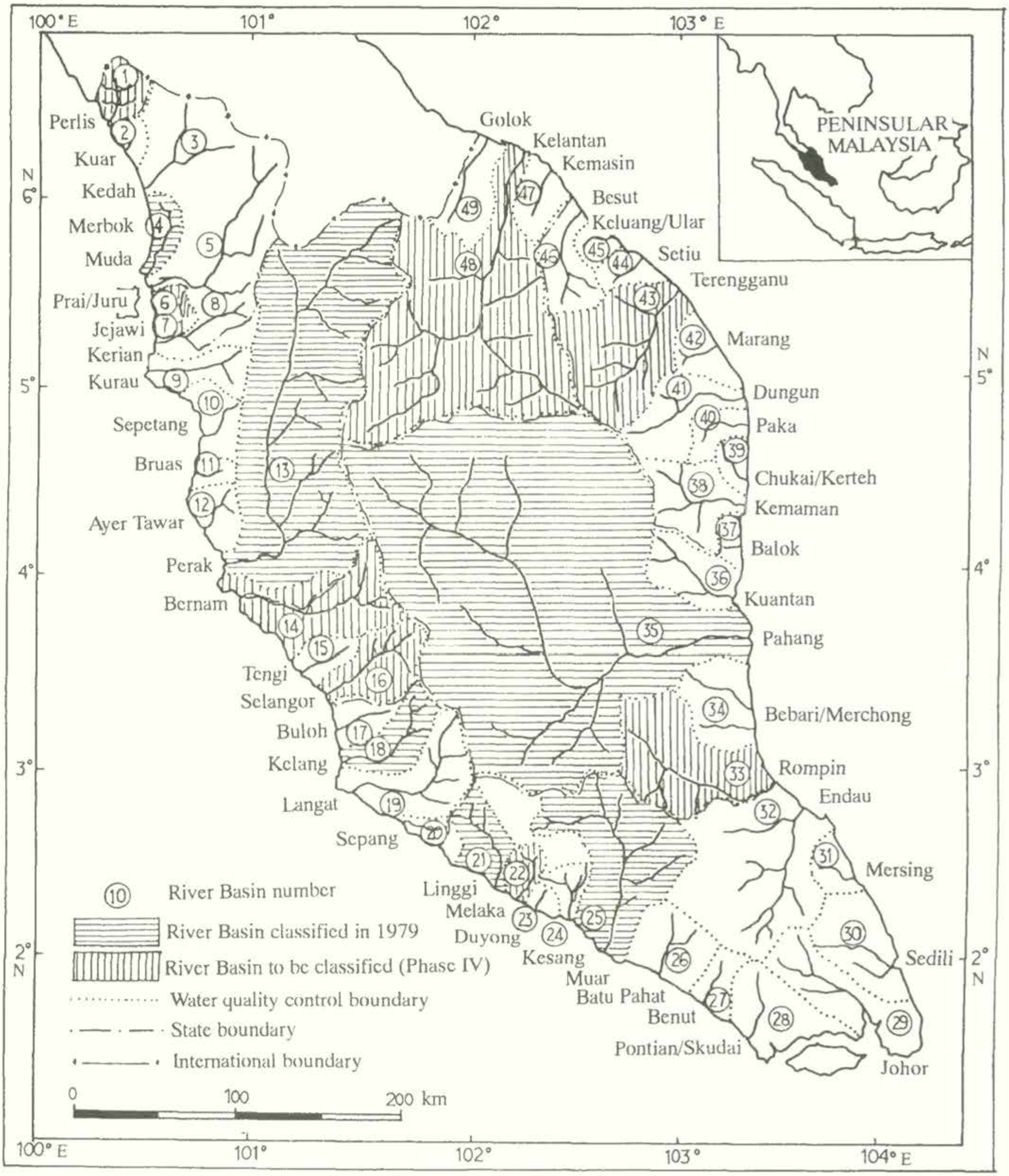


Fig.2.1a Malaysia: Locations of River Basins in Peninsular Malaysia.

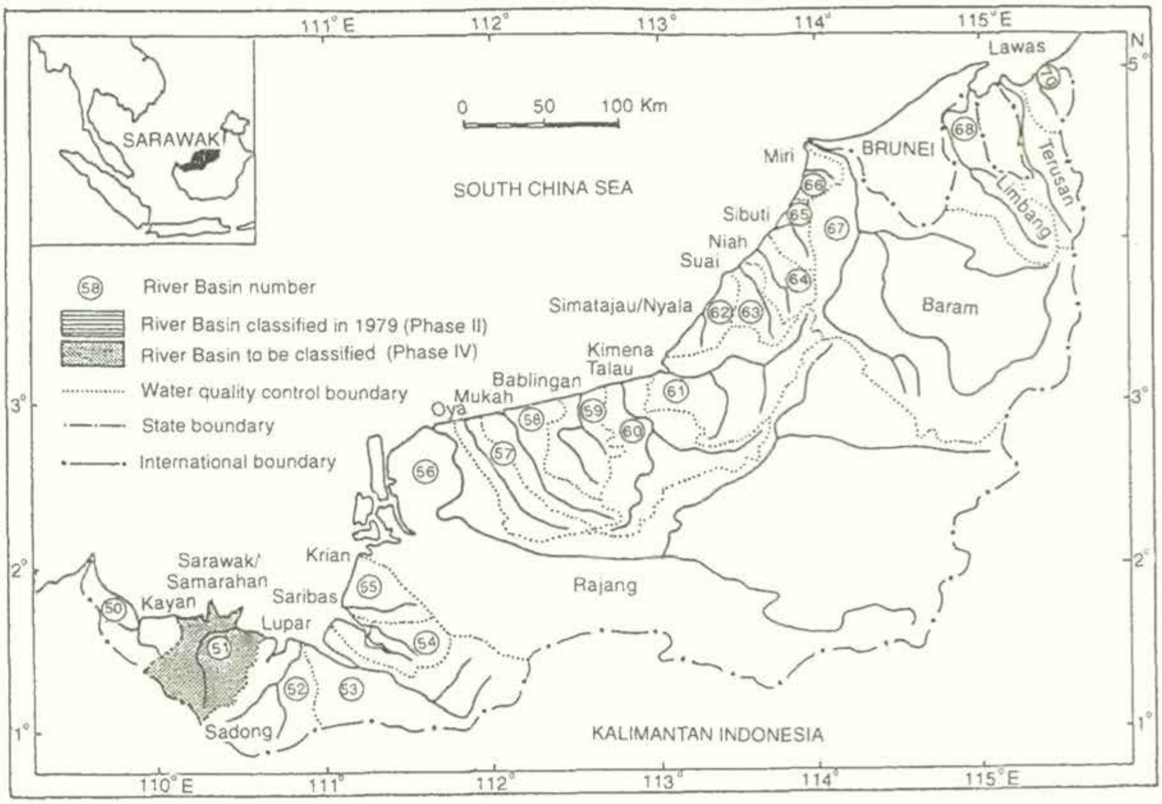


Fig.2.1b Malaysia: Locations of River Basins in Sarawak.

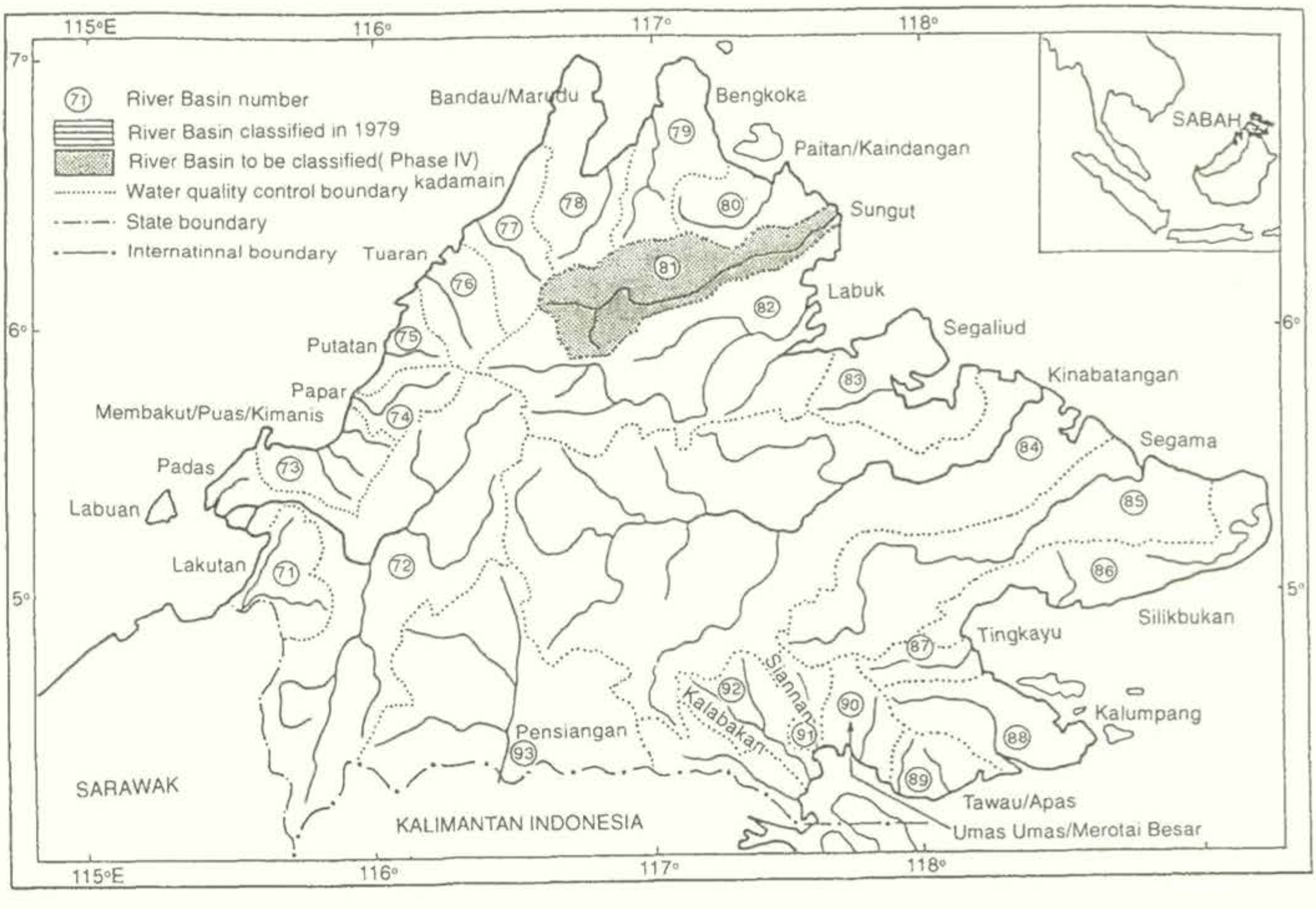


Fig.2.1c Malaysia: Locations of River Basins in Sabah.

Table 2.1.1 Proposed Interim National Water Quality Standards for Malaysia.

Parameters	Classes					
	I	IIA	IIB	III#	IV	V
NH_3-N, mg/L	0.1	0.3	0.3	0.9	2.7	2.7
BOD, mg/L	1	3	3	6	12	12
COD, mg/L	10	25	25	50	100	100
DO, mg/L	7	5.7	5.7	3.5	3	1
pH	6.5 - 8.5	6.5 - 9.0	6.5 - 9.0	5.9	5.9	-
Color, TUC	15	150	150	-	-	-
Elect. Conductivity, µmhos/cm**	1000	1000	-	-	6000	-
Floatables	NV	NV	NV	-	-	-
Odor	NOO	NOO	NOO	-	-	-
Salinity, %**	0.5	1	-	-	2	-
Taste	NOT	NOT	NOT	-	-	-
Total Dissolved Solids, mg/L	500	1000	-	-	4000	-
Total Suspended Solids, mg/L	25	50	50	150	300	300
Temperature, °C	-	Normal	-	Normal	-	-
Turbidity, NTU	5	50	50	-	-	-
Coliform Bacteria						
- Fecal Coliform, counts/100mL	10	100	400	5000 (20000)@	5000 (20000)@	-
- Total Coliform, counts/100mL	100	5000	5000	5000	5000	5000
Al, mg/L	-	-	-	0.056	0.5	-
As, mg/L	N	0.05	NR	0.045 (0.44)	0.1	+
Ba, mg/L	N	1	NR	-	-	+
Cd, mg/L	N	0.005	NR	0.001 (0.011**)	0.01	+
Cr (IV), mg/L	N	0.05	NR	0.054 (1.45)	0.1	+
Cr (III), mg/L	N	-	NR	- (2.53)	-	+
Cu, mg/L	N	1	NR	0.01 (0.012*)	0.2	+
Hardness, mg/L	N	100	NR	-	-	+
Ca, mg/L	N	-	NR	-	-	+
Mg, mg/L	N	0.05	NR	-	-	+
Na, mg/L	N	-	NR	-	3 SAR	+
K, mg/L	N	-	NR	-	-	+
Fe, mg/L	N	0.3	NR	1	1 (Leaf) 5 (Others)	+
Pb, mg/L	N	0.05	NR	0.01 (0.014*)	5 -	+
Mn, mg/L	N	0.1	NR	0.1	0.2	+

Table 2.1.1 Proposed Interim National Water Quality Standards for Malaysia (continued).

K, mg/L	N	-	NR	-	-	+
Fe, mg/L	N	0.3	NR	1	1 (Leaf)	+
					5 (Others)	
Pb, mg/L	N	0.05	NR	0.01	5	+
				(0.014*)	-	
Mn, mg/L	N	0.1	NR	0.1	0.2	+
Hg, mg/L	N	0.001	NR	0.0001	0.002	+
				(0.004)		
Ni, mg/L	N	0.05	NR	-	0.2	+
				(0.9*)		
Se, mg/L	N	0.01	NR	0.037	0.02	+
				(0.25)		
Ag, mg/L	N	0.05	NR	-	-	+
				(0.0002)		
Sn, mg/L	N	NR	NR	0.05	-	+
U, mg/L	N	NR	NR	-	-	+
Zn, mg/L	N	5	NR	-	2	+
				(0.35)		
B, mg/L	N	1	NR	3.4	0.75	+
Cl, mg/L	N	200	NR	-	79	+
Cl_2, mg/L	N	-	NR	0.022	-	+
CN, mg/L	N	0.02	NR	0.0023	-	+
				(0.058)		
F, mg/L	N	1	NR	-	1	+
				(11)		
NO_3/NO_2, mg/L	N	7/3	NR	0.028	5	+
				(0.37)		
P, mg/L	N	0.1	NR	0.1	-	+
Silica, mg/L	N	50	NR	-	-	+
SO_4^{2-}	N	200	NR	-	-	+
S, mg/L	N	0.05	NR	0.001	-	+
CO_2, mg/L	N	-	NR	-	-	+
Radioactivity						
- Gross-α, becquerel	N	0.1	NR	-	-	+
- Gross-β, becquerel	N	1	NR	-	-	+
Ra-226, becquerel	N	+0.1	NR	-	-	+
Sr-90, becquerel`	N	+0.1	NR	-	-	+
CCE, µg/L	N	500	NR	-	-	+
MBAS/BAS, µg/L	N	500	NR	200	NR	+
O&G (Mineral), mg/L	N	40; NF	NR	NL	NR	+
O&G (Emulsified), µg/L	N	7000;NF	NR	NL	NR	+
PCB, mg/L	N	0.1	NR	0.044	NR	+
				(6.1)		
Phenol, µg/L	A	10	NR	-	NR	NR
				(9900)		
Pesticides						
- Aldrin/	A	0.02	NR	0.008	NR	NR
- Dieldrin, µg/L	A	-	NR	(0.2)	NR	NR
				0.13		
- BHC, µg/L	A	2	NR	(9.9)	NR	NR

Table 2.1.1 Proposed Interim National Water Quality Standards for Malaysia (continued).

- Chlordane, μg/L	A	0.08	NR	(2.2) 0.004	NR	NR
- t-DDT, μg/L	A	0.1	NR	(1)	NR	NR
- Endosulfan, μg/L	A	10	NR	- (0.01)	NR	NR
- Heptachlor/	A	0.05	NR	0.06	NR	NR
- Epoxide, μg/L	A	-	NR	(0.91)	NR	NR
- Lindane, μg/L	A	2	NR	0.38 (2.9)	NR	NR
- 2,4-D, μg/L	A	70	NR	(450)	NR	NR
- 2,4,5-T, μg/L	A	10	NR	(160)	NR	NR
- 2,4,5-TP, μg/L	A	4	NR	(850)	NR	NR
- Paraquat	A	10	NR	(1800)	NR	NR

Notes:

Class I : Conservation of natural environment water supply I-practically no treatment necessary.
Fishery I-very sensitive aquatic species

Class IIA : Water Supply II-conventional treatment required
Fishery II-sensitive aquatic species

Class IIB : Recreational use with body contact

Class III : Water Supply III-extensive treatment required
Fishery III-common, of economic value, and tolerant species livestock drinking

Class IV : Irrigation

Class V : None of the above

NV : No Visible floatable materials or debris

NOO : No Objectionable Odor

NOT : No Objectionable Taste

** : Related Parameters, only one recommended for use

@ : Maximum not to be exceeded

NR : No Recommendation

* : At hardness 50 mg/L $CaCO_3$

: 24-hr average and maximum (bracketed) concentrations are shown

NF : Free from visible film, sheen, discoloration and deposits

NL : Free from visible layer, discoloration and deposit

N : Natural levels

+ : Levels above Class IV

A : Absent

O&G : Oil and Grease

Table 2.1.2 Causes of Water Pollution in Malaysia.

Sources	Status		% of treated pollution load	Major wastewater treatment method	Significance within sector	Recent trend	Significance between sources
1) Human Settlement							
a. Sullage	partly treated	538[1]	30%[+]	some into centralized treatment system	○	increase	◎
b. Sewage	partly treated	210, 500 m^3/day[1]	60%[+] (higher in cities)	centralized treatment systems in housing estates such as oxidation ponds	◎	increase	◎
c. Solid Wastes	partly treated	3.7 million tons	50%[+]	None	◎	increase	◎
2)Agricultural /Livestock							
a. Leachate	Nil	Jinjang Area -537mg/L[2] Sungei Besi -2400mg/L[2] Tampoi -1700mg/L[2] Penang -165mg/L[2]	10%[+]	into settling ponds	○	increase	◎
b. Pig Farms		96 gm/SPP/day[3]			◎	increase	◎
3) Industry	Pollution Load in COD						
1.Palm Oil (treated)	1,600gm/SPP/day[3] at Linggi River Basin[9]: 8574.20kg/day		100%[*]	Anaerobic digestion followed by stabilization pond	△	decrease	△

Table 2.1.2 Causes of Water Pollution in Malaysia (continued).

2.Rubber Industries	Rubber Factory Effluent[4] -Latex Concentrate: 6,976mg/L -Standard Malaysian Rubber & Conventional Grade: 2,295mg/L Rubber Processing at Petaling Jaya: 1,436kg/day[5] Rubber Factory at Linggi River Basin[9] : 9,064kg/day	100%*	Anaerobic digestion followed by stabilization pond	△	decrease	△
3.Electroplating (in Penang)	-400mg/L Sludge[6]: 100mg/L	No Effluent Treatment[6+]		◎	increase	◎
(in Johor)	-5mg/L	No Effluent Treatment[8+]		◎	increase	
4.PVC Resin (in Penang) (in Johor)	-20mg/L[6] -5mg/L[8]	Treated Treated	Sedimentation Pit	△	increase	◎
5.Pesticide (in Penang)	-20mg/L	No Effluent Treatment[6]	Treatment Plant[6]	△	increase	◎
6.Textile Finishing Resin (in Penang)	-360mg/L	No Effluent Treatment[6+]		◎	increase	◎
7.Anodising (in Penang)	-135mg/L	No Effluent Treatment[6+]		◎	increase	◎
8.Plywood Adhesive (in Penang)	-350mg/L -75mg/L	No Effluent Treatment Two Discharges[6+]		◎	increase	◎

Table 2.1.2 Causes of Water Pollution in Malaysia (continued).

9.Chlor-Alkali Manufacturing (Ipoh) (Klang Valley)	Brine Solution -192mg/L[6] -32200mg/L[7]			○		◎
10.Battery Manufacturing (Klang Valley)	-31mg/L	Treated	Sediment Pits Two Discharges[7]	△		◎
11.Galvanizing (Klang Valley)	-422mg/L	No Effluent Treatment[7+]		◎	increase	◎
12.Herbicide (Klang Valley)	-2350mg/L	No Effluent Treatment[7+]		◎	increase	◎
13.Herbicide	-57mg/L	No Effluent Treatment[7+]		◎	increase	◎
14.Tile Manufacturing (Klang Valley)	-3mg/L	Treated	Sedimentation Pit[7]	△		◎
15.Vehicle Assembly (Klang Valley)	-34mg/L	No Effluent Treatment[7+]		◎	increase	◎
16.Semiconduc -tor production (Klang Valley)	-60mg/L	Treated[7]	Treatment Plant[7]	○		◎
17.Leather Tanning (in Penang)	-240mg/L	Treated[7]	Sedimentation Pit[7]	○		◎
18.Printing Ink (in Penang)	-270mg/L	No Effluent Treatment[+]		◎	increase	◎
19.Carpet Dyeing /Weaving	-81mg/L	Treated	Sedimentation Pit[7]	◎	increase	◎
20.Samsu (alcohol) Distillery	-6490mg/L	No Effluent Treatment[8+]		◎	increase	◎
21.Textile	-480mg/L	No Effluent Treatment[8]		◎	increase	◎
22.Dry Cell Battery	-33,850mg/L	No Effluent Treatment[8]		◎	increase	◎

Notes:

1. Water Quality Criteria and Standards for Malaysia, Vol.2 Review in Water Resources and General Hydrology, December 1985, pp. 43.
2. Final Report, Policy Guidelines for Collection Treatment and Disposal of Hazardous Wastes, Appendix E, Leachate Analysis
3. Development of Water Quality Criteria and Standards Phase IV (River Classification), pp.4-79.

4. National Water Resource Study Sectorial Report Water Quality, pp. SK36.
5. Urbanization and Ecodevelopment Special Reference to Kuala Lumpur, pp. 36.
6. Final Report, Policy Guidelines for Collection Treatment and Disposal of Hazardous Wastes, pp.95.
7. ibid., pp.92.
8. ibid., pp.94.
9. Linggi River Basin Study, Table 5.3: Waste volume and pollution loads from rubber factories and palm oils in the Linggi River Basin

◎Very Significant, ○Significant, △Slightly Significant, ×Insignificant

* Discharge Meets Mandatory Limits

\+ Discharged into Water Courses

Water pollution in rivers also arises from intensive land clearing, uncontrolled earthworks, mining and logging activities in water catchment areas. Soil erosion causes suspended solids as well as river siltation and sedimentation.

Solid waste pollution of rivers has also gained significance in recent years. Solid waste pollution of the Sarawak River had reached a critical level in recent years due partly to indiscriminate dumping of garbage by people living along the river banks.

A recent study conducted by the Holland-based consultants DHV (M) Sdn Bhd revealed that the oxygen concentration of certain stretches of the Sarawak River had reached a level lower than the standard limit for Class III. The study showed that 80% of the pollutants were caused by land clearance and bamboo harvesting, and 15% from sawmill waste and waste from industries operating along the riverbanks. The remaining 5% came from household waste.

2.2 The Philippines

According to the listing by the National Water Resources Board, there are 421 principal rivers in The Philippines, each having a drainage area of not less than 40 sq. km. Of these, 18 are considered major rivers, defined as having a drainage area of not less than 1400 sq. km (see Fig.2.2). It should be noted, however, that some of these rivers listed are tributaries to larger principal rivers. Moreover, most of these rivers are short in comparison to rivers in other East Asian countries. Only about a quarter of the 421 rivers have been classified in accordance with water usage criteria.

All of the three river systems in Metro Manila (Pasig San Juan Marikina, Tullahan Tenejeros and Paranaque Zapote) were determined to be "biologically dead", except for the upper reaches of the Marikina River, causing pollution stresses on the nearby Laguna Lake and Manila Bay. The same is also true with rivers in other urban centers such as Metro Cebu (Sapangdako, Kotkot, and Mananga) and Metro Davao (Talomo and Lipadas). Pollution stresses were assessed in terms of their high organic content, and high bacterial count. Obviously, population and industries have a direct correlation with pollution loadings. Esteros or natural drainage canals convey all these pollutants into the major rivers. Since waters in these esteros are practically pure sewage, particularly during dry months, it is easy to see why highly urbanized centers have rivers that are highly polluted.

Based on the monitoring data of 1991, DO concrntrations of 0 mg/L and BOD levels as high as 120 ppm, which is the same as that of weak sewage, were observed in all but a few stations in the three river systems in Metro Manila during dry seasons. Consequently, the BOD levels exceeded by about

3 to 40 times the Class C water quality standards (see Table 2.2.1 for Water Quality Criteria). This trend has been observed since 1980. Thus, the study on Industrial Efficiency and Pollution Control Programme (IEPC) commissioned by the World Bank concluded among other things that all the surface waters in Metro Manila exhibit varying degrees of degradation and almost all are highly contaminated with human wastes and pose an unacceptable risk to the public of exposure to viruses and pathogens.

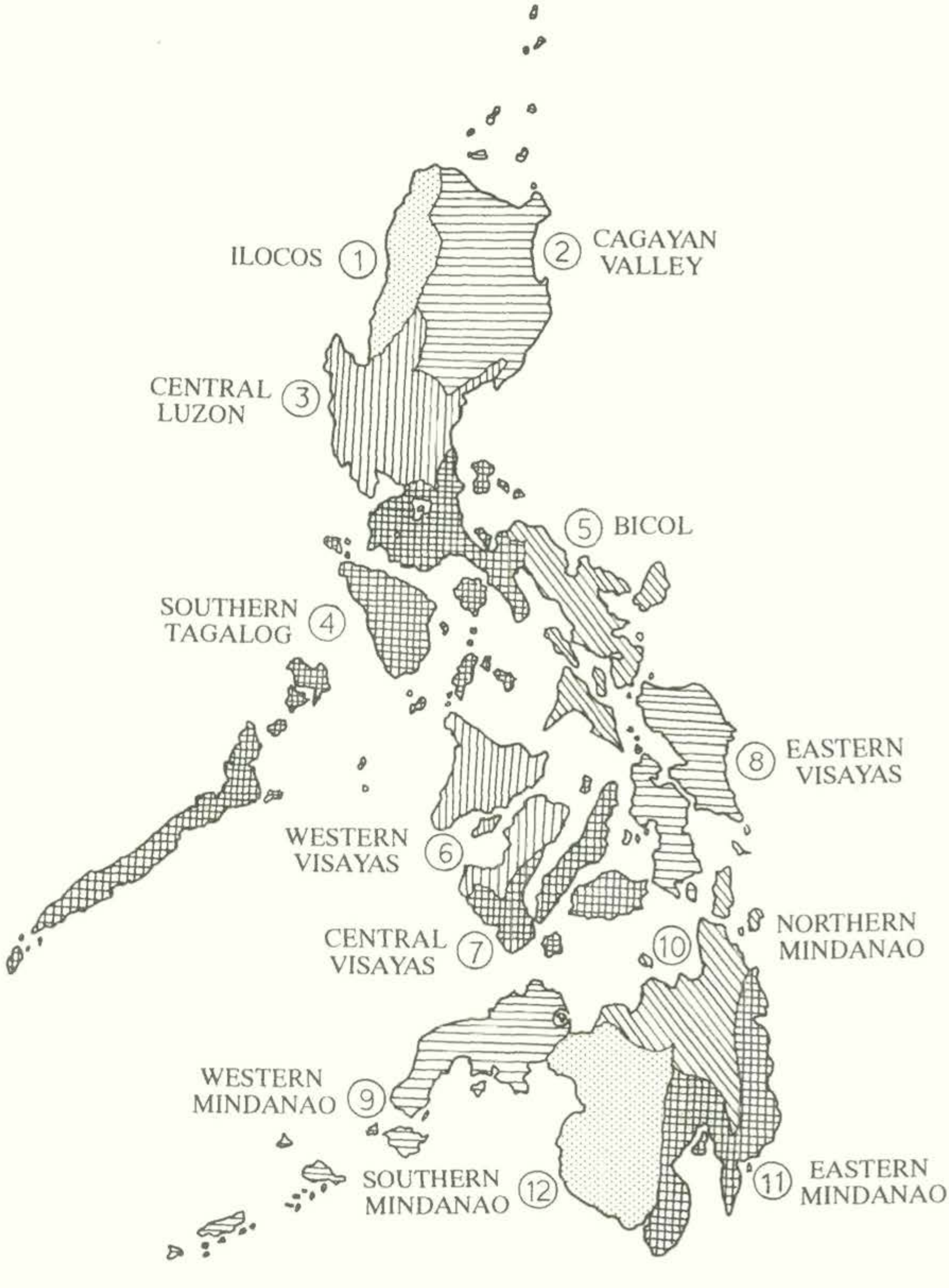


Fig.2.2 The Philippines: Water Resources Regions.

Table 2.2.1a The Philippines: Water Quality Criteria for Conventional and Other Pollutants Contributing to Aesthetics and Oxygen Demand in Fresh Waters(a).

Parameter	Unit	Class AA	Class A	Class B	Class C	Class D(b)
Color	PCU	15	50	(c)	(c)	(c)
Temperature(d) (max. rise in °C)	°C rise	--	3	3	3	3
pH (range)		6.8 - 8.5	6.5 - 8.5	6.5 - 8.5	6.5 - 8.5	6.0 - 9.0
Dissolved Oxygen(e)	% saturation	70	70	70	60	40
(Minimum)	mg/L	5.0	5.0	5.0	5.0	3.0
5-day 20°C BOD	mg/L	1	5	5	7 (10)	10 (15)
Total Suspended Solids	mg/L	25	50	(f)	(g)	(h)
Total Dissolved Solids	mg/L	500(i)	1,000(i)	--	--	1,000(i)
Surfactants (MBAS)	mg/L	nil	0.2 (0.5)	0.3 (0.5)	0.5	--
Oil/Grease (Petroleum Ether Extract)	mg/L	nil	1	1	2	5
Nitrate as Nitrogen	mg/L	1.0	10	nr	10(j)	--
Phosphate as Phosphorus	mg/L	nil	0.1(k)	0.2(k)	0.4(k)	--
Phenolic Substances as Phenols	mg/L	nil	0.002	0.005(l)	0.02(l)	--
Total Coliforms	MPN/100mL	50(m)	1,000(m)	1,000(m)	5,000(m)	--
Fecal Coliforms	MPN/100mL	20(m)	100(m)	200(m)	--	--
Chloride as Cl	mg/L	250	250	--	350	--
Copper	mg/L	1.0	1.0	--	0.05(o)	--

Notes 1:

(a) Exclude as indicated, the numerical limits in Tables 1 and 3 are yearly average values. Values enclosed in parentheses are maximum values.

(b) For irrigation purposes, SAR should have a minimum value of 8 and a maximum value not to exceed 18. Boron should not exceed 0.75mg/L.

(c) No abnormal discoloration from unnatural causes

(d) The allowable temperature increase over the average ambient temperature for each month. This rise shall be based on the average of the maximum daily temperature readings recorded at the site but upstream of the mixing zone over a period of one (1) month.

(e) Samples taken between 9:00 AM and 4:00 PM

(f) Not more than 30mg/L increase

(g) Not more than 30mg/L increase

(h) Not more than 60mg/L increase

(i) Do not apply if natural background is higher in concentration. The latter will prevail and will be used as baseline.

(j) Applicable only to lakes, reservoirs, and similarly impounded water.

(k) When applied to lakes or reservoirs, the phosphate as P concentration should not exceed an average of 0.05mg/L nor a maximum of 0.1mg/L

(l) Not to be present in concentrations hat affect fish flavor/taste

(m) These values refer to the geometric mean of the most probable number of coliform organisms during a 3-month period; the limit indicated shall not be exceeded in 20 percent of the samples taken during the same period.
(n) For spawning areas for Chanoschanos and other similar species
(o) Limit is in terms of dissolved copper
nil: Extremely low concentration and not detectable by existing equipment
--: Means standards for these substances are not considered necessary at the present time, considering the stage of the country's development and DENR capabilities, equipment and resources.
nr: Means no recommendation made

Table 2.2.1b The Philippines: Water Quality Criteria for Toxic and Other Deleterious Substances in Fresh Waters (for the Protection of Public Health).

Parameter	Unit	Class AA	Class A	Class B	Class C	Class D
As(i)	mg/L	0.05	0.05	0.05	0.05	0.1
Cd(i)	mg/L	0.01	0.01	0.01	0.01	0.05
Cr(VI)(i)	mg/L	0.05	0.05	0.05	0.05	0.1
CN	mg/L	0.05	0.05	0.05	0.05	--
Pb(i)	mg/L	0.05	0.05	0.05	0.05	0.5
Hg(total)(i)	mg/L	0.002	0.002	0.002	0.002	0.002
Organophosphate	mg/L	nil	nil	nil	nil	nil
Aldrin	mg/L	0.001	0.001	--	--	--
DDT	mg/L	0.05	0.05	--	--	--
Dieldrin	mg/L	0.001	0.001	--	--	--
Heptachlor	mg/L	nil	nil	--	--	--
Lindane	mg/L	0.004	0.004	--	--	--
Toxaphane	mg/L	0.005	0.005	--	--	--
Methoxychlor	mg/L	0.10	0.10	--	--	--
Chlordane	mg/L	0.003	0.003	--	--	--
Endrin	mg/L	nil	nil	--	--	--
PCB	mg/L	0.001	0.001	--	--	--

Note: 1. Limiting values of organophosphates and organochlorines may serve as guidelines in the interim period pending the procurement and availability of necessary laboratory equipment. For Barium, Cobalt, Fluoride, Iron, Manganese, Nickel, Selenium, Silver and Vanadium, the 1978 NPCC Rules and Regulations, Section 69 may be considered.
2. For footnotes please refer to Table 2.2.1a.

Outside Metro Manila, at least 14 rivers have been identified as suffering slight, moderate or heavy pollution from turbidity and suspended solids, organic loads or BOD, silt and heavy metals such as mercury (see Table 2.2.2).

Table 2.2.2 The Philippines: Rivers under Pollutional Stress.

Name of River	Location	Status of Pollution
1. Angat, Apo & Bicti	Central Luzon	High turbidity, High suspended solids
2. Balagtas, Marilao, Bulacan & Meycauayan	Bulacan	High BOD, low DO
3. Palico	Batangas	High BOD, low DO
4. Jalaur & Ulian	Iloilo	High BOD, low DO
5. Manulan, Lupit, Salamanca, Pontevedra & Panamangan	Negros Occidental	High BOD, low DO
6. Pampanga	Central Luzon	High BOD, high suspended solids
7. Patala, Dagupan, Agno, Bued & Amburayan	Pangasinan	High in solids
8. Sipalay	Negros Occidental	Siltation, heavy-metal contamination
9. Lawis	Zambales	Siltation, heavy-metal contamination
10. Taft	Samar	Siltation, heavy-metal contamination
11. Hijo & Libuganon	Davao del Norte	Mercury levels more than Class D
12. Cagayan de Oro	Misamis Oriental	High bacterial count
13. Mananga & Cotcot	Cebu City	Very low floral diversity, high turbidity
14. Agusan, Solibao & Waria	Agusan del Norte	High mercury concentrations

Note: "High" means exceeding the water quality criteria for all parameters except Dissolved Oxygen where the qualifier used is "low".

This information, however may not be considered as representative of the whole country since only about 10% and 20% of the 421 principal rivers had been sampled in 1990 and 1991 respectively.

The general sources of pollution are given in Table 2.2.3. Industries and human settlements have been identified as the two major sources of river pollution. In Metro Manila for example, it is estimated that 38% of the river pollution loads come from industrial sources, 40% come from domestic wastes and 22% from uncollected solid wastes that reach the waterways during the rainy periods. There are about 15,000 manufacturing firms in the country, one-third of which are large. About 60% of these industries are located in Metro Manila. The main manufacturing firms are food and beverage manufacturing, textile mills, pulp and paper mills, plastic and consumer goods processing related to raw materials available in the country, sugar mills, alcohol distilleries, coconut processing, drug manufacturing and re-packaging, and others. About half of the total national population lives in urban centers. Metro Manila alone has a total population of about 8 million. The rates of population growth of urban centers remain high.

In rural areas outside of Metro Manila and other urban centers, the major river pollution problem is siltation caused by the discharge of mine tailings or the collapse of mine tailing dams, the amount of which can reach up to more than half a million tons/day depending on the world market demand for certain ores. Organic wastes from unsewered communities also serve as major contributors to river water pollution. Small backyard or cottage industries, piggeries, poultry and other animal husbandry activities are likewise sources of organic pollutants. Automotive repair and assembly shops, electroplating, battery repair and similar other shops contribute both organic and inorganic wastes.

Table 2.2.3 Causes of Water Pollution in The Philippines.

Causes	Organic Pollution Load*		% of treated pollution load	Major wastewater treatments	Significance within sector	Actual Pollution Load*	Significance between sources
1.Human settlements							
a.Sullage, night soil	] 318		15%	Activated sludge	65%	270.3	36%
b.Sewage	] --						
c.Solid wastes	177		--	--	35%	177	23.8%
2.Agriculture /Livestock							
a.Leachate	no data		--	--	--	--	--
b.Pig Farms	162		36%	Activated sludge Lagooning	--	104.1	14%
3. Industry	Pollution Load*	Major Pollutants	Wastewater Treatment		Significance within sector	Pollution load*	Significance between sources
a.Agro-based (beverage)	192.1	BOD, SS	]	--	11.6%	192.1	26.2%
b.Chemicals	--	--	]	--	--	--	--
c.Steel & iron	22.3	Acids	]	--	8.7%	--	--
d.Machinery	16.8	Oil	]	--	--	--	--
e.Market waste	--	Solid wastes	]	--	--	--	--
f.Electronics	--	Heavy metals	]-Lagooning	--	--	--	--
g.Pulp & paper	--	Black/White liquor	]-Activated Sludge	--	--	--	--
h.Laundry	--	Total solids	]	--	--	--	--
i.Oil & gas	3.5	Oil	]- Trickling	--	1.8%	--	--
j.Electroplating	6.6 --	Acids/Alkalis HM,CN BOD, SS	]- Filters]	-- --	-- 3.4%	-- --	-- --
k.Food processing	100.9	Cr^{6+}, color	]	--	52.5%	--	--
l. Textile	24.9	--	]	--	9%	--	--
m.Other industry	17.1	BOD, SS	]	--			
n.Through public sewerage	0	--					
4. Others	--	--	--	--	--	--	--
Total	1,041	--	--	--	--	743.5	100%

*BOD tons/day. Data for Manila Bay Region only where 12.5% of the population and 60% of the industrial establishments exist.

2.3 Thailand

There are four rivers in the central basin of Thailand which are of significance to the politics and economics of the outlying communities in the area. These rivers are Chao Phraya, Tha Chin, Bang Pakong, and Mae Klong (see Fig.2.3.1). Most of the people living near the rivers and canals usually grow crops using water from these rivers and draw water from them for their consumption and other domestic needs. Industrial and agro-industrial development, which has been increasing during the last 20 years, and the urbanization which accompanies this development is also located in the major river basins, especially in the lower central river basin. The four major rivers all flow through the central plain and into the Gulf of Thailand where 70% of the development activities are concentrated. Pollutant disposal from the many development activities severely impairs the water quality of these rivers and tributaries, including the coastal waters.

A program to monitor the the water quality of these rivers has been implemented since 1981. The results indicate a trend of deterioration in their water quality, especially in the river mouth near the Bangkok Metropolitan Area (BMA). The waste loads from the four estuaries within the city have resulted in algal blooms in some parts of the Gulf of Thailand, in the Shiracha and Hua Hin areas. The severe condition of water quality indicates that some portions of the water courses have reached a crisis point and that urgent measures are needed to mitigate them.

The deteriorated conditions of these rivers may be discerned from the plots of the three major water quality parameters - BOD, DO, and total coliform bacteria (TCB) - given in Fig.2.3.2 to 2.3.10. The classifications used to describe these rivers are based on classes assigned according to their intended usage as defined by the Office of the National Environmental Board (ONEB) and given in Table 2.3.1.

The 380 km long Chao Phraya River is divided into three segments, each with its own classification. The 237 km upper segment is given a Class 2 classification, the 80 km middle segment is Class 3, and the 63 km lower segment is classified as Class 4. This river is considered to be the most polluted in Thailand. The lower segment which passes through BMA is severely polluted with discharges from both communities and industries. The DO levels have been depleted to lower than 1 mg/L, while the TCB concentration exceeded the standard limit even for Class 4 waters. BOD values have consequently increased during the past 3 years. In the upper segment where there is much less industry, the TCB concentration doubled over the 3 year period, indicating an increase in water contamination with domestic sewage.

The 325 km Tha Chin River is classified into 3 segments: the upper 123 km Class 2 segment, the middle 120 km Class 3 segment, and the lower 82 km Class 4 segment. The lower segment has been severely polluted with industrial and domestic discharges resulting in extreme depletion of DO (less than 1 mg/L). In the upper and middle segments, the TCB concentration has been increasing over the past 2 years indicating pollution from domestic sewage.

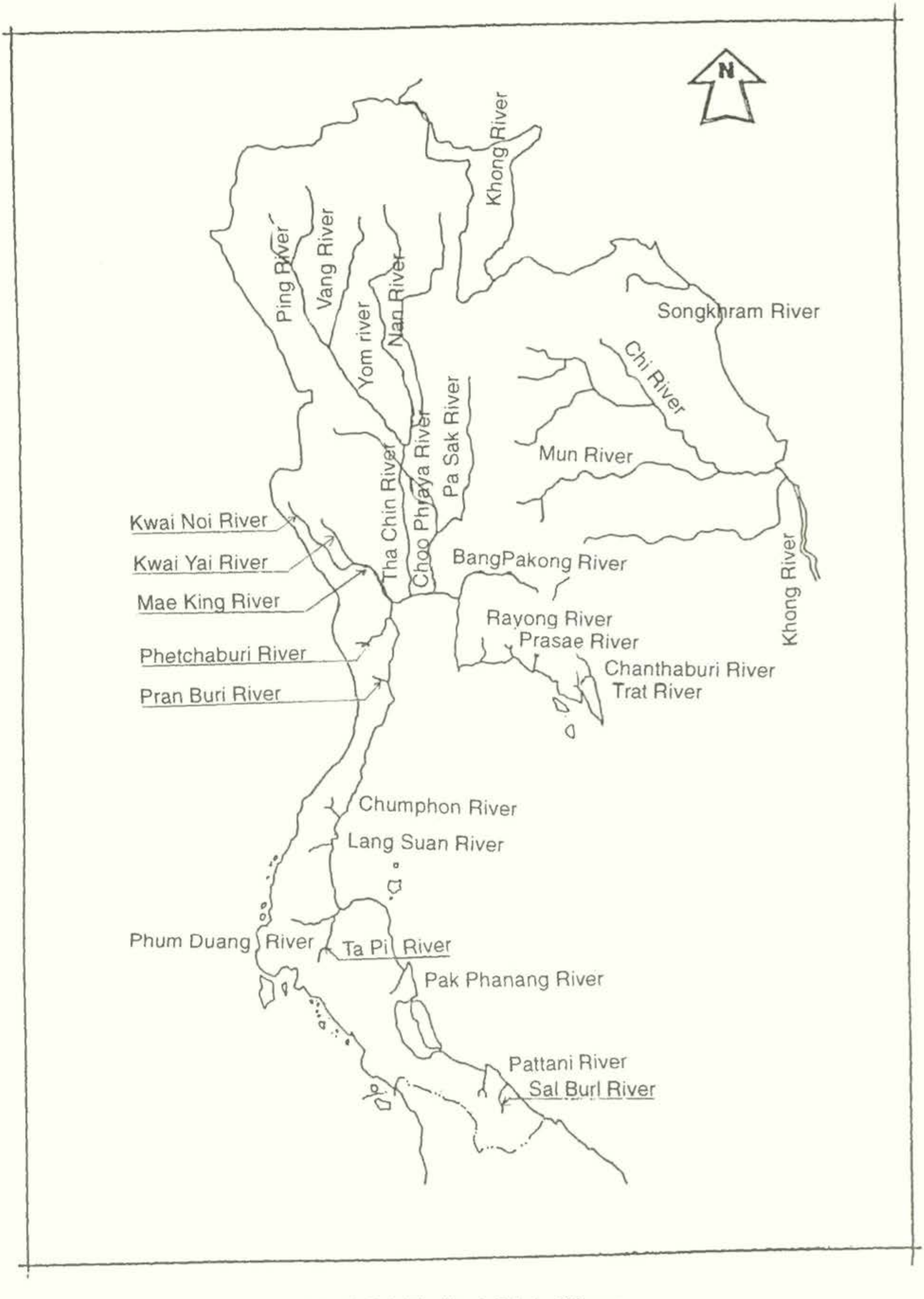


Fig.2.3.1 Thailand: Major Rivers.

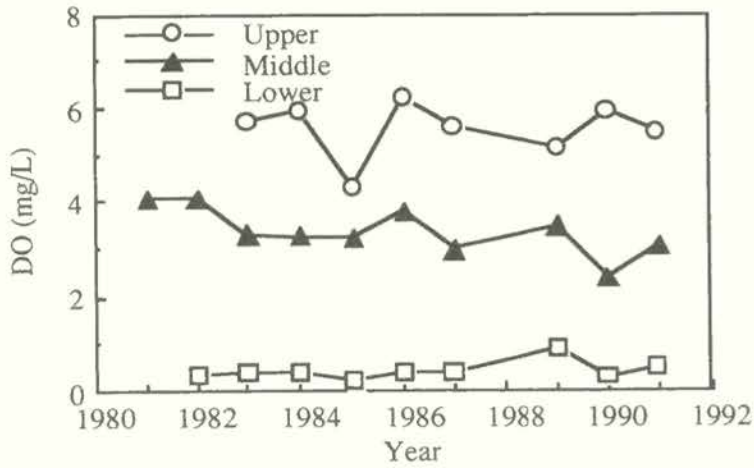


Fig.2.3.2 Thailand: Annual Average DO of Chao Phraya River.

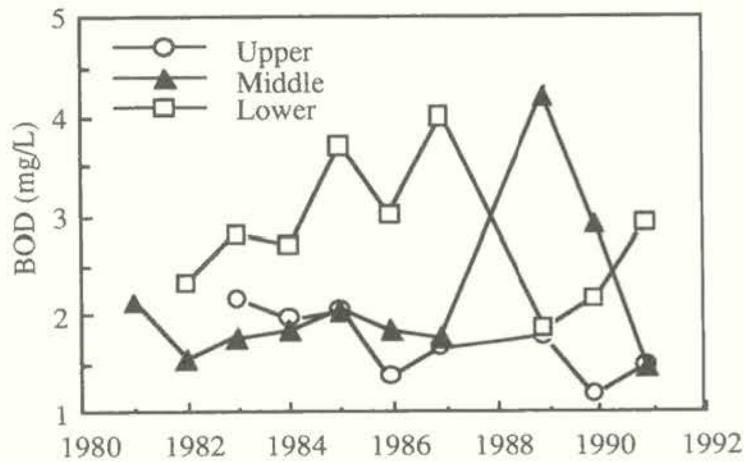


Fig.2.3.3 Thailand: Annual Average BOD of Chao Phraya River.

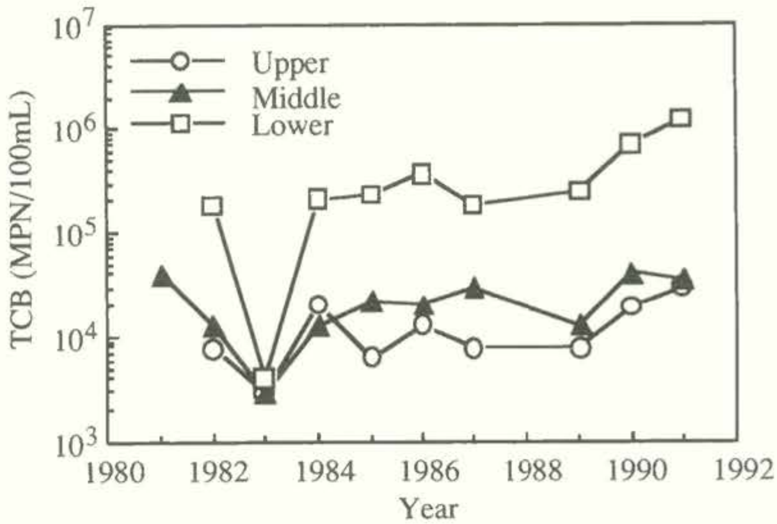


Fig.2.3.4 Thailand: Annual Average TCB of Chao Phraya River.

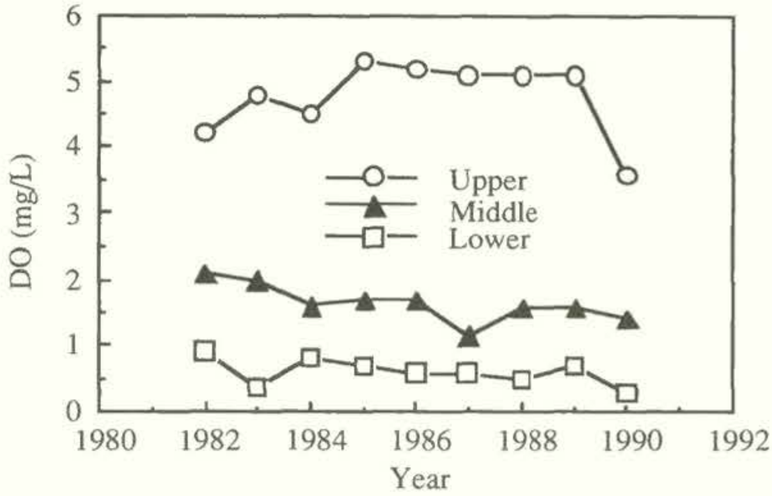


Fig.2.3.5 Thailand: Annual Average DO of Tha Chin River.

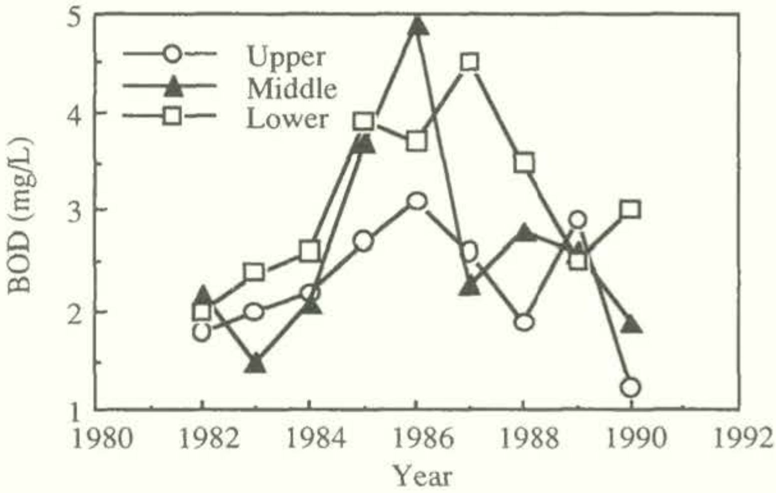


Fig.2.3.6 Thailand: Annual Average BOD of Tha Chin River.

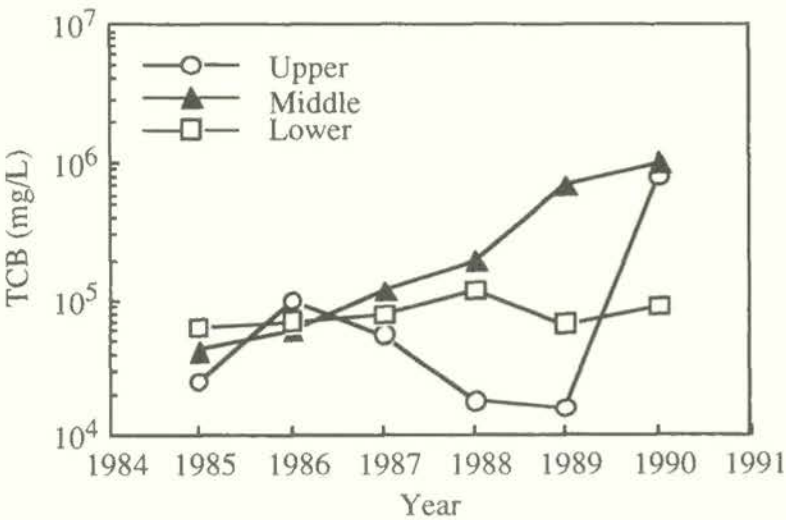


Fig.2.3.7 Thailand: Annual Average TCB of Tha Chin River.

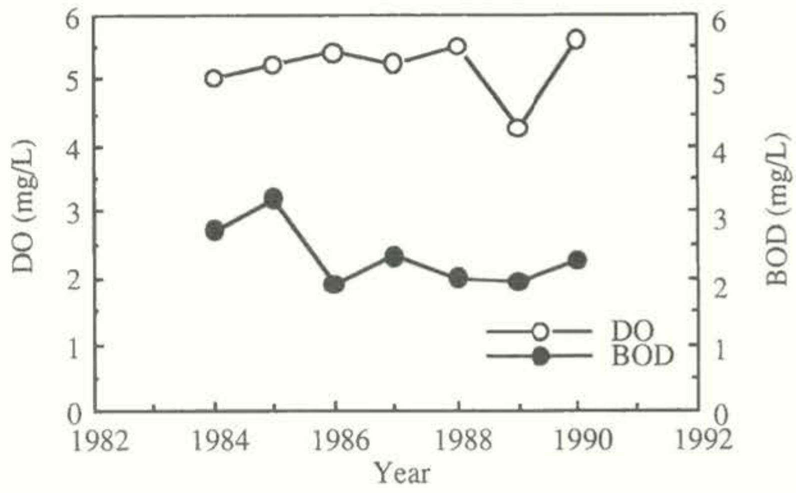


Fig.2.3.8 Thailand: Annual Average DO and BOD of Mae Klong River.

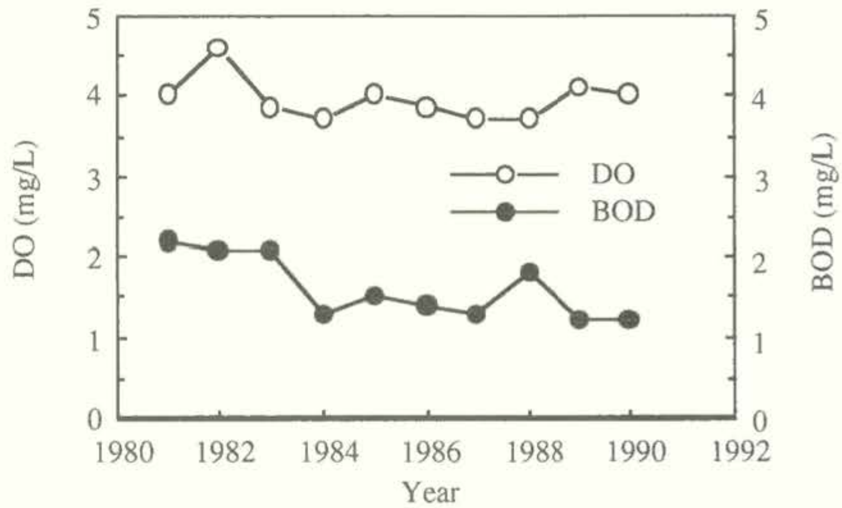


Fig.2.3.9 Thailand: Annual Average DO and BOD of Bang Pakong River.

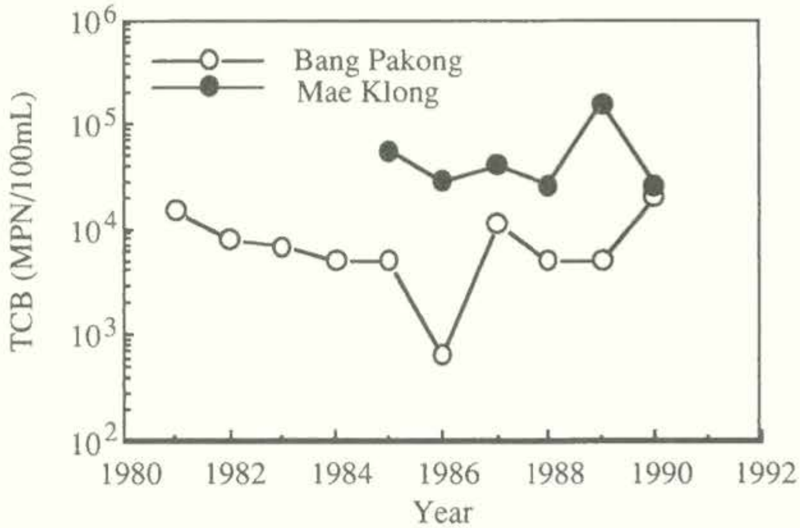


Fig.2.3.10 Thailand: Annual Average TCB of Bang Pakong and Mae Klong Rivers.

Table 2.3.1 Thailand: Classification of Fresh Water Quality from Surface Sources.
a) Standard and Class

Parameter	Standard Value / Quality Class				
	1	2	3	4	5
Temperature °C	n	n'	n'	n'	-
pH	n	5 - 9	5 - 9	5 - 9	-
DO*, mg/L	n	6	4	2	-
BOD_5*, mg/L	n	1.5	2.0	4.0	-
Coliform bacteria*					
-Total Coliform	-	5000	20000	-	-
-Fecal Coliform	-	1000	4000	-	-
NO3-N, mg/L	n	→	≤5.0	←	-
NH3-N, mg/L	n	→	≤0.5	←	-
Phenols, mg/L	n	→	≤0.005	←	-
Cu, mg/L	n	→	≤0.1	←	-
Ni, mg/L	n	→	≤0.1	←	-
Mu, mg/L	n	→	≤1.0	←	-
Zn, mg/L	n	→	≤1.0	←	-
Cd, mg/L	n	→	≤0.005[1] ≤0.05[2]	←	-
Cr(VI), mg/L	n	→	≤0.05	←	-
Pb, mg/L	n	→	≤0.05	←	-
Hg(total), mg/L	n	→	≤0.002	←	-
As, mg/L	n	→	≤0.01	←	-
CN, mg/L	n	→	≤0.005	←	-
Radioactivity					
-Gross α, becquerel/L	n	→	≤0.1	←	-
-Gross ß, becquerel/L	n	→	≤1.0	←	-
Pesticides					
-Total, mg/L	n	→	≤0.05	←	-
-DDT, µg/L	n	→	<1.0	←	-
-α BHC, µg/L	n	→	≤0.02	←	-
-Dieldrin, µg/L	n	→	≤0.1	←	-
-Aldrin, µg/L	n	→	≤0.1	←	-
-Heptachlor & Heptachlor Epoxide, µg/L	n	→	≤0.2	←	-
Endrin, µg/L	n	→	none	←	-

Note: n: naturally
n': naturally, but changing not more than 3°C
*: value of sample data at 80 percentile
1: hardness ≤ 100 mg/L as $CaCO_3$
2: hardness > 100 mg/L as $CaCO_3$

b) Order of Classification

Classification	Condition / Objectives
Class 1	Extra clean resources (unpolluted) used for (1) consumption, but require prior disinfection (2) conservation of ecosystem for naturally-living organisms
Class 2	Very clean resources (slightly polluted) used for (1) consumption, but require water treatment and disinfection (2) conservation of aquatic organisms (3) fishery (4) recreation
Class 3	Medium clean resources (moderately polluted) used for (1) consumption, but require water treatment and disinfection (2) agriculture
Class 4	Fairly clean resources (quite polluted) used for (1) consumption, but require tertiary treatment and disinfection (2) industry
Class 5	Resources not classified in Class 1-4 (heavily polluted) used for (1) navigation

Source: Water Quality of Thailand's Major Rivers in The Last Decade (1981 - 1990); ONEB, 1992.

The 140 km Mae Klong River is classified as Class 3. The water quality of this river has remained around this class over the last few years. However, the TCB concentration is higher than the standard limit for Class 3 waters owing to sewage discharged from several communities along the river banks.

The water quality of the 122 km Bang Pakong River is fairly well within the standards set for Class 3 waters. However, it still cannot be protected from being polluted by domestic sewage as indicated by its high (but within the standard limit for Class 3) TCB values.

River pollutants in Thailand include both organic and inorganic substances such as nutrients (nitrogen and phosphorus), toxic organic compounds and heavy metals. Phosphate concentrations in waters probably come primarily from domestic discharges as a result of cleaning with phosphorus-containing detergents. Minute amounts of toxic organic compounds and nutrients may also be found in agricultural runoff, as a consequence of the heavy application of pesticides, herbicides, and fertilizers to farmlands. Metals are contained in several industrial discharges, especially from electroplating industries. Heavy-metal pollutants (copper, nickel, lead, cadmium and mercury) have not yet exceeded the acceptable limits in the Chao Phraya River, but heavy metal concentrations in sediments are pronounced in the lower stretches of the river. Toxic organic compounds are also beginning to be observed in the rivers. In general, toxic organics and heavy metals in rivers do not yet pose a hazard, but a sevenfold increase in the number of industries using and disposing of these toxic substances, and the probable continuous accumulation of these substances in sediment and aquatic systems, may cause a risk to human health in the long run.

Sources and estimates of load contributions of each source of pollution in the rivers of Thailand are shown in Table 2.3.2. The three major sources of river pollution are human settlements, industry and agriculture. The rapid growth of population, especially in the industrial urban areas of Thailand, has increased the rate of water consumption and wastewater discharge coming from human settlements. Major sources of domestic pollutants are from untreated wastewater and solid wastes, which are not properly collected, treated and disposed of. The quantity of domestic sewage in the country contributed 73.2% of the combined total of wastewater coming from industries and communities. The population equivalent of BOD loading in urban areas is about 35 g per capita per day, without any treatment. The organic waste loads released to receiving wàter bodies are increasing annually. There are no existing enforcement measures of domestic effluent standards for municipal discharges from sewage treatment plants in many of the urban areas or communities. A common practice is for households to discharge their wastewaters directly into sewers which eventually end up in nearby canals and rivers. Most high-rise or large buildings are equipped with their own on-site treatment facilities, but their operation and maintenance is still considered problematical, and having final effluents which conform with existing standards is still a rarity. In 1992 in the BMA area an estimated one million cubic meters of untreated wastewater were discharged into the Chao Phraya River daily. Most of the canals in the area have turned into big open sewers, where anaerobic reactions occur resulting in black colored waters with a grimey smell.

Table 2.3.2 Thailand: Causes of Water Pollution.

Causes	BOD (tons/year)	Major treatment method	Significance within sector	Future trend
1.Human Settlement				
a)Sullage & night soil	100,375	Septic tanks	2	Declining due to sewerage systems established
b)Sewage	702,625	Aerated lagoon	1	Remote municipalities prefer this alternative
c)Garbage (only in Bangkok)	4,964	Waste stabilization pond	3	-
2.Industrial Factory		Biological and/or chemical treatment		Inefficient operation due to personnel shortage
Eastern Region				
Tapioca	400	Ponds		
Canning	29.2	Activated sludge		
Rice & noodle	3.4	Ponds		
Sugar	14.6	Waste stabilization sond		
Distillery	28.2	UASB, Activated sludge		
Fish powder	16.2	Ponds		
Miscellaneous	1.5	-		
Northeastern Region				
Paper	9.5	Chemical and biological		
Rice & noodle	1.4	Ponds		
Sugar	10	Waste stabilization ponds		
Tapioca	240	Ponds		
Distillery	16.7	UASB, Ponds		
Soft-drink bottling	0.6	Activated sludge		
Chicken slaughter	1.4	Ponds		
Textile	0.3	Ponds		
Canning	1.6	Activated sludge, Ponds		
Miscellaneous	0.5	-		

Table 2.3.2 Tailand: Causes of Water Pollution (continued).

Bangkok Region				
Vegetable oil	1.3	Activated sludge		
Pulp & paper	23.8	Chemical treatment and Activated sludge		
Slaughter house	8.9	Ponds and Activated Sludge		
Distillery	9.6	Activated sludge, Evaporation ponds		
Beverage bottling	5.5	Activated sludge		
Textile	16.9	Chemical treatment and Activated sludge		
Canning	4.8	Activated sludge		
Food additive	3.2	Activated sludge		
Tanning	300	Activated sludge		
Cold storage	5.3	Activated sludge		
Dairy product	1.8	Activated sludge		
Rice & noodle	2.7	Ponds, Activated sludge		
Miscellaneous	5.23	-		

Note: Degree of significance from 1 to 3, 1 : highest; 3 : lowest.
UASB = Upflow Anaerobic Sludge Blanket Reactor

The number of factories in Thailand is increasing rapidly. More than half of these industries are located in BMA and its suburbs. In the lower Chao Phraya River around Bangkok, it is estimated that in 1989 25% of organic waste loads and 95% of toxic and hazardous substances discharged into this part of the river came from industrial sources.

2.4 Indonesia

Indonesia is an archipelago composed of several large and small islands. Java, the site of the national capital is also the most developed of these islands. Indonesia, just like its neighboring countries, has been experiencing rapid industrial and urban development during the last few years, centered on the three provinces of West Java, East Java and Lampung. The focus of this country report will be on the status of the rivers of Java, specifically those in East and West Java and those of Lampung Province (see map in Fig.2.4.1).

West Java includes the City of Jakarta, the capital of Indonesia. The provincial area covers about one-third of the island of Java. Its population was about 34.7 million in 1989 and it is estimated that it will reach about 44 million by the year 2000. The province of East Java is a little larger than West Java. It is the most populated province in Indonesia. Lampung Province, on the other hand, is situated at the south-eastern tip of the island of Sumatra, just across a strait of water to the province of West Java.

There are 51 rivers in West Java, 3 of which flow into the Sunda Strait, 28 into the Java Sea, and 20 others into the Indian Ocean. The five biggest rivers are the Citarum, Cimanuk, Citanduy, Cisadane and the Ciliwung. These five are also the most heavily polluted rivers in West Java. The JABOTEK (Jakarta-Bogor-Tangerang-Bekasi) area and the Bandung Raya (Greater Bandung Area), through which the 5 major West Java rivers flow, constitute a constellation of the most developed and urbanized towns in West Java. There is also an agglomeration of industries in these areas.

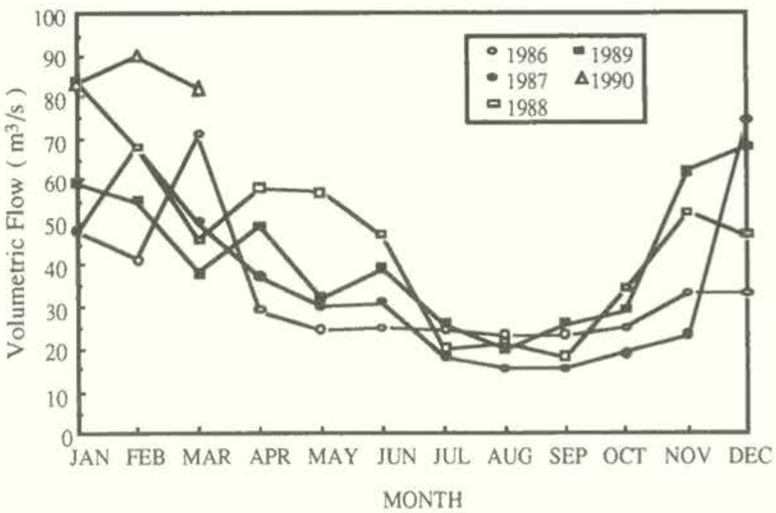
No.	Province	No.	Province	No.	Province
1	D.I. Aceh	10	West Java	19	Central Sulaweel
2	North Sumatra	11	Central Java	20	South East Sulaweel
3	Riou	12	D.I. Yogyakarta	21	South Sulaweel
4	West Sumatra	13	East Java	22	Boil
5	Jombl	14	West Kalimantan	23	Weat Nusa Tenggara
6	South Sumatra	15	Central Kalimantan	24	East Nusa Tenggara
7	Benglaulu	16	South Kalimantan	25	Moluku
8	Lampung	17	East Kalimantan	26	Irian Jaya
9	DKI Jakarta	18	North Sulaweel	27	East Timor

Fig.2.4.1 Map of Indonesia.

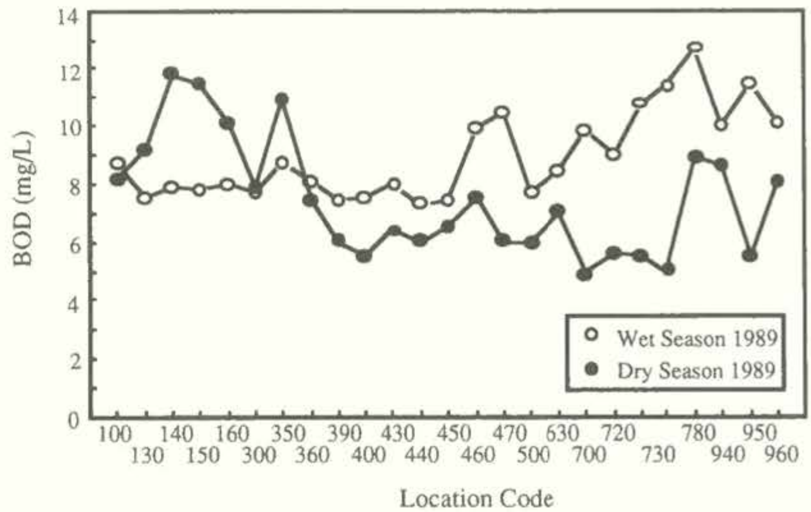
There are two big rivers in East Java; the 320 km long Brantas and the 600 km Bengawan Solo rivers. Both rivers are important sources of water for irrigation, industrial and domestic water uses in East Java.

The two most important but badly polluted rivers in Lampung province are the Way Pengubuan and the Way Seputih rivers.

The five major rivers in West Java, the two in East Java and the two rivers in Lampung Province are polluted mainly with organic pollutants. The level of BOD is high as shown by the data for the Brantas River in Fig.2.4.2. Way Pengubuan and Way Seputih have been estimated to receive a maximum of about 35,000 tons of BOD per day. However, no estimates have yet been made of the relative contributions of organic pollutants coming from domestic, industrial and agricultural (irrigation) sources.



a) Volumetric Flow of Brantas River in Perning Station



b) BOD Concentration of Upstream Brantas River

Fig.2.4.2 Indonesia: Volumetric Flow Rate and BOD Concentration in Brantas River.

2.5 Singapore

There are 2 major river systems of importance in Singapore, the Singapore and the Kallang rivers. The Singapore River and Kallang basin catchments cover about one-fifth of Singapore's total land area, on which over half of the urban area is located. Five main watercourses drain to the Kallang basin; namely, the Rochore Canal, Whampoa River, Kallang River, Pelton Canal and Geylang River. These join the Singapore River which flows into the sea through the Marina Bay (see Fig. 2.5.1). The river systems consist of 47 streams in the water catchments which discharge into 13 reservoirs. Water quality in these water bodies is regularly monitored. The water quality in the streams and reservoirs remains good at present.

In addition, there are 17 other rivers and streams in non-water catchment areas. Water quality in these watercourses is also monitored regularly. The level of pollution in these watercourses is low and they are able to sustain aquatic life. The sources of water pollution, their significance and how they are treated are set out in Table 2.5.1.

In the past, population growth, urbanization, and industrial expansion heavily polluted the Singapore

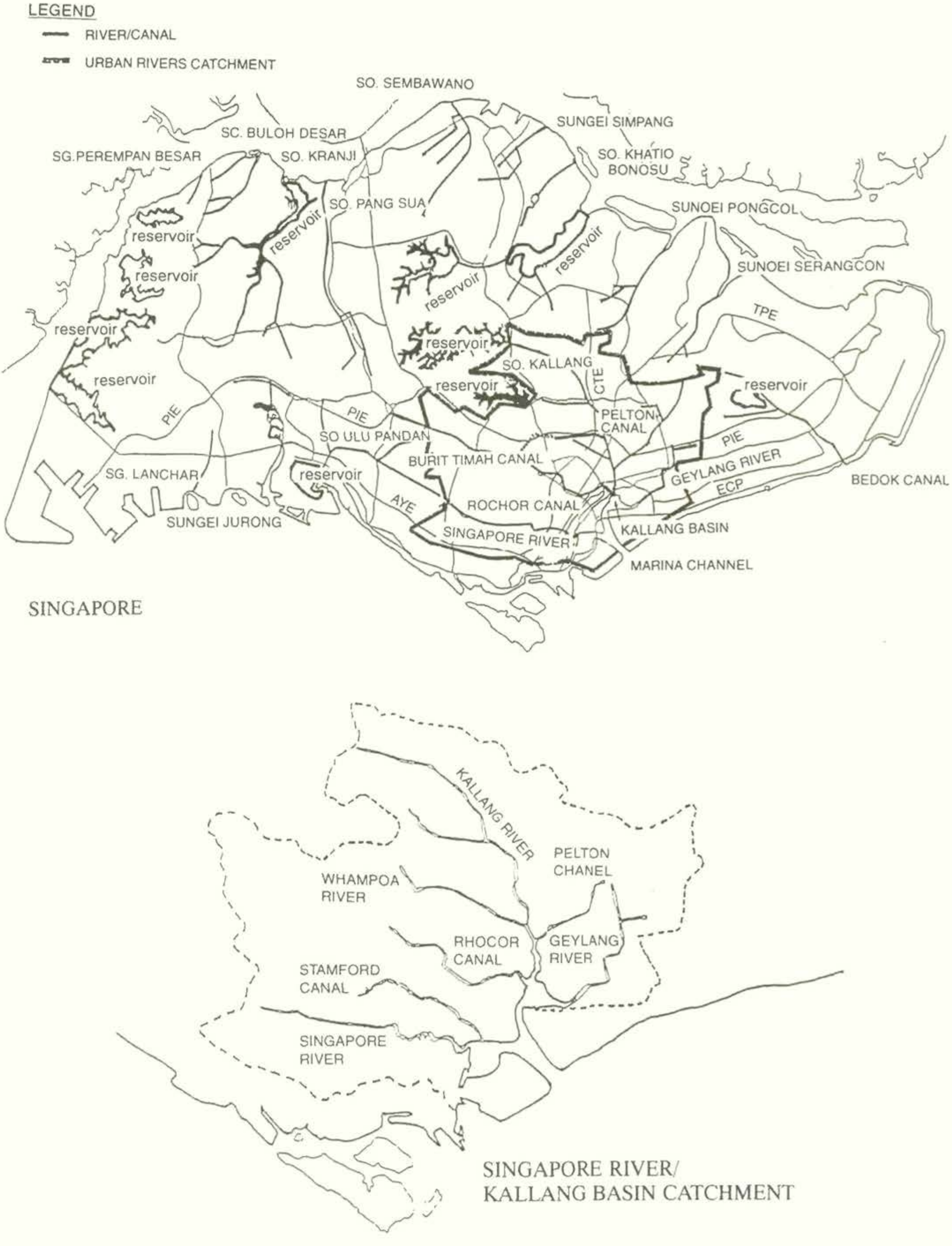


Fig.2.5.1 Singapore: Locations of River Basins.

River and Kallang basin. The Singapore River has been associated with the traditional trading and business activities of Singapore for more than a hundred years. Over the years, with population growth, urbanization and industrial expansion, the waterways degenerated into open sewers and rubbish dumps as all forms of wastes were indiscriminately discharged into them. The water in the rivers was black and foul smelling with no sign of aquatic life. The government of Singapore started a cleanup program for the Singapore and Kallang rivers in 1977. Positive developments in terms of water quality improvement have been achieved with this program. A case study will be presented in Chapter 4.

Table 2.5.1 Causes of Water Pollution in Singapore.

Sources	Status		% of treated pollution load	Major wastewater treatment method	Significance within sector	Recent trend	Significance between sources
1.Human Settlement						increase	
a.Sullage night soil	Treated Nil	1,100,000 m^3/day	100%	Activated sludge	-		
b.Sewage	Treated				◎	increase	◎
c.Garbage	Completely collected	6000t/day			X	decrease	
2.Agriculture /Livestock							
a.Wastewater	Minimal				-		X
b.Pig farms	Nil			-	-	-	
3.Industry						increase	
a.Agro-based	Not Available	--	*	Discharged into public sewerage system	X		○
b.Chemicals		COD	*		△		
c.Steel and iron		SS, COD	settlement		△		
d.Machinery servicing		Oil	oil interceptor		△		
e.Market waste		BOD	*		○		
f.Electronics		Cu, Ni	metal precipitation		○		
g.Paper		SS, BOD	*		◎	increase	
h.Laundry		Detergents	*		△		
i.Oil refining		Oil, Grease+	lagoons, oil interceptor		○		
j.Electroplating		Ni, Cr, Zn	metal precipitation		○	increase	
k.Food & beverage		BOD	*		◎	increase	
l.Textile		COD	*		○		

Note; ◎ Very significant, ○ Significant, △ Slightly significant
X Insignificant, * Discharge meets mandatory limits
+ Discharged into watercourse

2.6 Korea

Korea has four major river basins, namely, the Han, Nakdong, Geum and Yeongsan. Each of these receives a significant wastewater input, which in turn delivers substantial pollutant loads into the coastal water where they empty.

The sources of water pollution in Korea are given in Table 2.6.1. The two major sources of water pollution in South Korea are domestic sewage and industrial wastewater. In 1990, 10.2 million m^3/day of domestic sewage, 7.3 m^3/day of industrial wastewater and 87 thousand m^3/day of livestock wastewater were discharged. It has been estimated that these amounts have increased over the last few years because of further developments in industry and in living standards.

Pollution trends in the four major rivers over the last ten years are shown in Fig. 2.6.1. The water quality of the Han River has improved since 1987. That of the Nakdong River remains as it was in 1982, but that of the Yeongsan and Geum rivers has generally deteriorated. Water quality data at points along the four major rivers are presented in Table 2.6.2. A comparison of the data in Table 2.6.2 with the Water Quality Standards of Korea, given in Table 2.6.3, indicates that the Han, Nakdong and Geum rivers are Class II, and the Yeongsam River is bordering on Class II and III in most stretches.

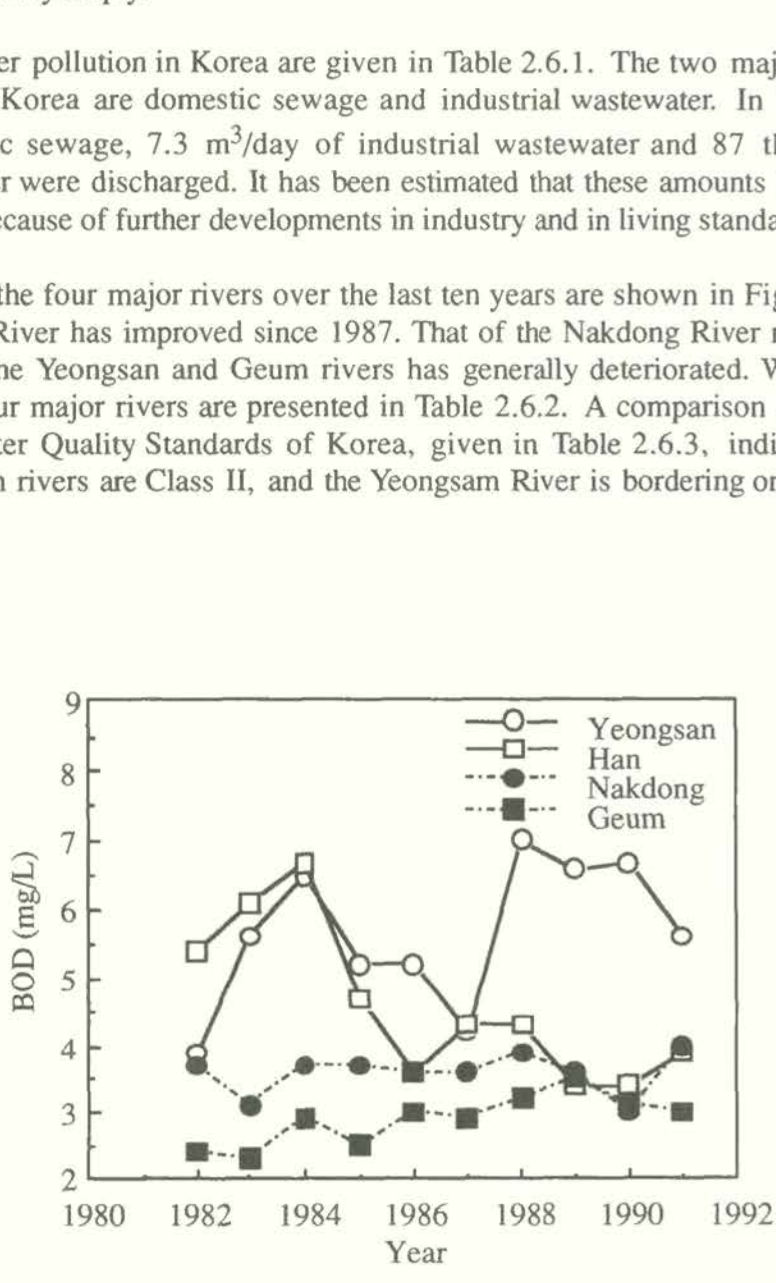


Fig.2.6.1 Korea: Trend of BOD Concentrations in 4 Major Rivers.

Table 2.6.1 Korea: Causes of Water Pollution.

Causes	Organic pollution load (BOD ton/day)		% of treated pollution load	Major wastewater treatment	signifi-cance within sector	Recent trend*	signifi-cance between sources
1.Human Settlement							
a.Sullage & night soil	not treated 351 m^3/day treated 43,579 m^3/day		92.1%	AD		grad.dec.	
b.Sewage	treated 521.2 ton BOD/day		37.0%	AS		grad.inc.	
c.Garbage	collected 90,694 ton/day not collected 1,552 ton/day		98.3%	Landfill: 96.7% Incineratio n: 1.6%		grad.dec.	
2.Agriculture /Livestock							
a. Leachate	-						
b.Pig firms	treated 35.5 ton-BOD/day not treated 12.0 ton-BOD/day		87.7%	AD+AS**: 38.7% Digestion: 49.0%			
3.Industry	Pollution Load (ton-BOD/day)	Major pollutants					
a.Agro-based	37.0	BOD, SS		AS		grad.inc.	
b.Chemicals	362.6	BOD, SS, metals		Chemical			
c.Steel & Iron	93.9	SS, metals,		Chemical			
d.Machinery							
e.Market waste	9.2	SS, metals,		Chemical		grad.inc.	
f.Electronics							
g.Pulp & paper	382.2	BOD, SS	No information available	AS		grad.inc.	
h.Laundry	0.8	BOD, SS,		AS		grad.inc.	
i.Oil and gas	17.5	SS		AS+ oil-separation		grad.inc.	
j.Electroplating						grad.inc.	
k.Food process	1,116.3	BOD, SS		AS			
l.Textile	173.0	BOD, SS, color		AS			
m.Other indust.	886.2						
n. Into public sewage							
4. Others							
Total	2,306.3 ton/day						

*gradually increased or gradually decreased

**AS: Activated Sludge, AD: Anaerobic Digestion

Table 2.6.2 BOD at the Sampling Stations of 4 Major Rivers in 1990 and 1991.

Han River			Nakdong River		
Station	1991	1990	Station	1991	1990
Cheongpyung	1.7	1.2	Bonghwa	0.8	1.0
Yangpyung	2.1	1.7	Andong	1.1	1.0
Paldang	1.1	1.0	Dalsung	1.8	1.5
Gueui	1.9	1.5	Goryung	5.8	5.4
Noryangjin	3.9	3.4	Hapchun	4.1	3.1
Yongdeungpo	4.1	3.6	Mulgeum	4.0	3.0
			Kupo	3.7	3.3

Geum River			Yeongsan River		
Station	1991	1990	Station	1991	1990
Okchun	1.6	1.5	Damyang	1.1	1.2
Daechung	1.6	1.7	Kwangju	2.8	3.4
Chungwon	3.1	3.1	Naju	5.6	6.7
Gongju	3.1	3.2	Hampyung	3.9	3.8
Gangkyung	4.9	4.5	Muan	1.5	1.2

(unit; mg/L)

Table 2.6.3a Korea: Environmental Water Quality Standards Related to the Preservation of the Living Environment.

Class	Purpose of Water use	pH	Standard Values *1			
			BOD	SS	DO	Coliform Bacteria
I	A-1 B-1	6.5 ~ 8.5	1 mg/L or less	25 mg/L or less	7.5 mg/L or more	50MPN/100mL or less
II	A-2 B-2	6.5 ~ 8.5	2 mg/L or less	25 mg/L or less	5 mg/L or less	1000MPN/100mL or less
III	A-3 B-3 C-1	6.5 ~ 8.5	6 mg/L or less	25 mg/L or less	5 mg/L or less	5000MPN/100mL or less
IV	C-2 D-1	6.8 ~ 8.5	8 mg/L or less	100 mg/L or less	2 mg/L or less	5000MPN/100mL or less
V	C-3 D-2	6.0 ~ 8.5	10 mg/L or less	*2 or less	5 mg/L or less	5000MPN/100mL or less

Note *1: The standard value is based on the daily average value

*2: Floating matter such as garbage should not be observed

A-1: Water supply class 1 (water that requires treatment by a simple cleaning operation, such as filtration)

A-2: Water supply class 2 (water that requires treatment by a normal cleaning operation, such as sedimentation and filtration)

A-3: Water supply class 3 (water that requires treatment by a highly advanced cleaning operation including pretreatment)

A-3: Water supply class 3 (water that requires treatment by a highly advanced cleaning operation including pretreatment)
B-1: Conservation of natural environment
B-2: Fishery, class 1 B-2: Fishery, class 2 B-3: Fishery class 3
C-1: Industrial water, class 1 (water given normal cleaning treatment such as sedimentaion)
C-2: Industrial water, class 2 (water given advanced treatment by chemicals)
C-3: Industrial water, class 3 (water given special cleaning treatment)
D-1: Agricultural water
D-2: Conservation of environment (Up to the limits at which no unpleasantness is caused to people in their daily life, including when walking by the riverside, etc.)
E-1: Bathing

Table 2.6.3b Korea: Effluent Water Quality Standards.

Parameters	(mg/L) except pH and Temp.
BOD (Sewage System)	20
BOD (Wastewater treatment plant)	30
COD (Wastewater treatment plant)	40
Suspended Solids (Sewage System)	20
Suspended Solids (Wastewater treatment plant)	30
pH	5 - 9
N-hexane extracts (mineral oil)	5
N-hexane extracts (animal and vegetable fats)	30
Phenols	3
CN Compounds	1
Cr compounds	2
Dissoved Fe	10
Zn	5
Cu	3
Cd and its compounds	0.1
Hg (total)	0.005
Organic P compounds	1
As and its compounds	0.5
Pb and its compounds	1
Cr(VI) compounds	0.5
Dissolved Mn	10
F	15
PCB	0.003
Temperature (℃)	40
T-Nitrogen	60
T-Phosphorus	8
Trichloroethylene	0.3
Tetrachloroethylene	0.1

Note: 1.The permissible water quality standards in this table are applicable to effluent from sewage system and wastewater treatment plants
2.T-P or T-N standards will be applied to designated zones such as Lakes by Environment Minister from January 1, 1996.

2.7 Japan

In Japan, river water pollution problems had been observed even before the industrial modernization of the country. One of the first recorded cases of river water pollution affecting human activity was the outflow of pit water from the Asio Copper Mines into the Watarase River during the late 19th century. The outflow of mine pit waters damaged paddy fields on the riverside. With the advent and growth of industrial activities, there had been a subsequent increase in wastewater flowing into rivers, giving rise to pollution problems in various parts of Japan.

During the period of industrial reconstruction after World War II, there were social disputes related to problems arising out of river water pollution by industries. Great damage to fisheries had been observed at that time as a result of wastewater from paper mills being discharged into the Edo River in Tokyo. The problem also began to affect people's health, as in the case of the Minamata incident in the late 1950s, when mercury from the chemical industry caused a previously unknown disease among people who ingested the waste-contaminated fishes caught in the area around the factory.

In the 1960s, during the period of rapid economic growth, water pollution became more widespread and severe. Reports of mercury contamination in the Agano River and cadmium in the Jinzu River were seen to lead to Itaiitai disease and Minamata disease as in earlier years.

Several measures have been taken by the Japanese government and people to control and abate water pollution, specifically that which affected human health and the living environment in water systems. These will be described in a later chapter.

Recently, there has been a general improvement in terms of controlling water pollution and raising the water quality of rivers and other water bodies in Japan. In particular, the levels of toxic substances, such as cadmium and cyanide, have decreased remarkably in water bodies (see Fig.2.7.1). The improvement of river water quality in terms of a reduction of organic waste pollutants is also seen in rivers. The compliance ratio with respect to environmental quality standards for BOD/COD invarious aquatic environments (shown in Table 2.7.1) is increasing as seen in Fig.2.7.2.

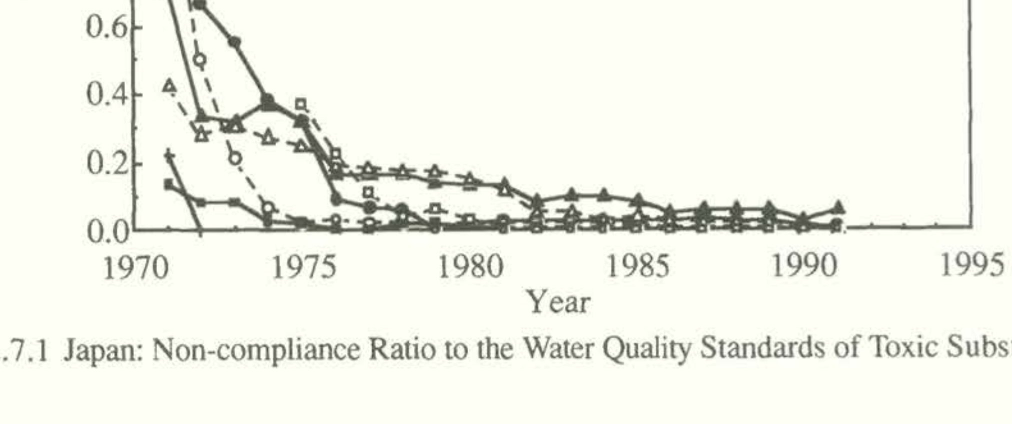


Fig.2.7.1 Japan: Non-compliance Ratio to the Water Quality Standards of Toxic Substances.

Table 2.7.1 Japan: Environmental Water Quality Standards.

a) Standards related to the protection of human health (mg/L or less)

Parameters	Standard values	Parameters	Standard values
Cd	0.01	Trichloroethylene	0.03
CN	ND	Tetrachloroethylene	0.01
Organic phosphorus*	ND	Carbon tetrachloride	0.002
Pb**	0.01	Dichloromethane	0.02
Cr (VI)	0.05	1,2-dichloromethane	0.004
As**	0.01	1,1,1-trichloroethane	1.0
Hg (total)	0.0005	1,1,2-trichloroethane	0.006
Hg (alkyl)	ND	1,1-dichloroethylene	0.02
PCBs	ND	cis-1,2-dichloroethylene	0.04
		1,3-dichloropropene(D-D)	0.002
		Thiuram	0.006
		CAT (simazine)	0.003
		Thiobencarb	0.02
		Benzene	0.01
		Selenium	0.01

* removed in the 1993 amendment

** reinforced in the 1993 amendment (the former standard values for lead and arsenic were 0.1 and 0.05 mg/L, respectively)

b) Standards for rivers related to the conservation of living environment (mg/L)

category	water use	pH	BOD	SS	DO	CG*
AA	Water supply class 1, conservation of natural environment, and uses A-E	6.5-8.5	1	25	7.5	50
A	Water supply class 2, fishery class 1, bathing, and uses B-E	6.5-8.5	2	25	7.5	1,000
B	Water supply class 3, fishery class 2, and uses C-E	6.5-8.5	3	25	5.0	5,000
C	Fishery class 3, industrial water class 1 and uses D-E	6.5-8.5	5	50	5.0	-
D	Industrial water class 2, irrigation water and use E	6.0-8.5	8	100	2.0	-
E	Industrial water class 2, conservation of environment	6.0-8.5	10	no floating matters	2.0	-

*CG: number of coliform groups, MPN/100ml

Notes 1.Conservation of natural environment: conservation of nature and natural resources

2.Water supply class 1: no or simple purification, slow sand-filtration

Water supply class 2: conventional purification, coagulation and rapid sand-filtration

Water supply class 3: advanced purification, biofilter, ozone, activated carbon, etc.

3.Conservation of environment: no unpleasant odor at riverside or beach

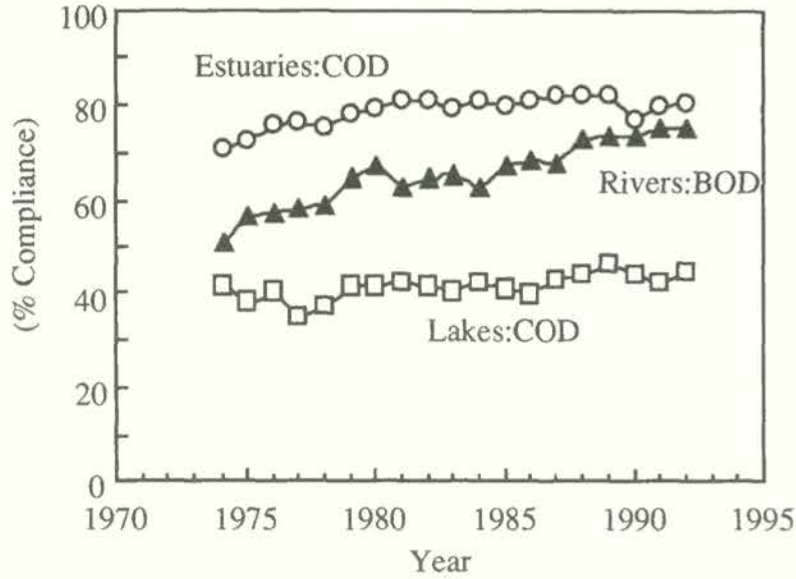


Fig.2.7.2 Japan: Compliance Ratio to River BOD and COD Standards.

CHAPTER 3

PRINCIPLES OF RIVER WATER QUALITY MANAGEMENT

3.1 General Principles

River water quality management requires a comprehensive and systematic integration of technical and scientific information, and economic and social considerations into appropriate policies and programs at all levels of government. We are assuming that the primary responsibility for river water quality management, just like the management of all other environments and resources, rests in the hands of government, both national and local. Governments play an important role in environmental protection and promotion. They provide the institutional framework for the prevention and abatement of pollution and the financial investment for needed infrastructure.

The starting point in any river water quality management attempt is to find the controllable as well as non controllable factors which affect or influence the status of river water quality. The status of a river is described by physico-chemical parameters indicating the suitability of river water for human uses. Water quality standards are usually set based on two general criteria; namely, the protection of human health and the conservation of the aquatic ecosystem and living environment. The former may include such parameters as concentration levels of toxic heavy metals (mercury, cadmium, lead and others) and concentration levels of chlorinated organic compounds in the water and sediment. The latter criteria may include such parameters as BOD, DO, suspended solids, microbiological parameters and others. The parameters that are used to describe the status of river water quality are discussed extensively in other texts (e.g. the UNEP/GEMS Water Operational Guide).

River water is used for several purposes including domestic water supply, recreation, fisheries, irrigation, and industrial water. River water quality should be maintained so that it is fit to meet the demand for its many uses as well as to preserve a requisite state of the aquatic ecosystem in general.

In many countries, water quality standards are established as desirable goals for water quality management and as targets for pollution control. In general, higher standards are applied for water used as drinking water or domestic water supply and for recreation, and lower standards are applied for water used for irrigation and for industrial processes. One river system may be divided into several segments with different classifications, in as much as river pollution is expected to be heavier in the downstream reaches of a river compared to the upstream portions.

A prerequisite for any water quality management program is a thorough knowledge of water quality, and the types - point and non-point sources - and quantity of pollutants coming into the river system. Information on river flow and other hydrological factors are also basic requirements. Good and reliable information is based on regular monitoring of both river water as well as all point source effluents entering the river system. This information needs to be available to policy makers not only to evaluate water quality but also to appraise the effectiveness of relevant policies and measures taken.

Thus, a vital component of any river water quality management program is the monitoring system.

In order to achieve and maintain water quality standards, several types of strategies are adopted by governments and other related bodies. They include:

1) regulation of discharges by effluent standards;
2) expansion and improvement of sewerage systems and sewage treatment plants;
3) land use controls;
4) non-point source controls;
5) river flow modifications;
6) dredging or removal of bottom sediments; and
7) environmental impact assessment.

Among those listed above, the control of pollutants in effluent discharges from municipal and industrial sources is regarded as one of the most effective and important measures. The construction of sewerage systems with treatment facilities is also a very effective measure for the reduction of organic pollutants. Nonetheless, the other measures listed above are also important especially in cases where rivers are already suffering from extreme pollution problems as in some ASEAN rivers.

Figure 3.1 shows a typical river water quality management system. The system includes policy formulation and planning, implementation of water quality monitoring and inspection of industries by the central and local government bodies. It also includes the operation and maintenance of sewerage systems and sewage treatment plants by public agencies and the establishment of pollution control systems in industries.

Government policies are embodied in environmental laws, regulations, standards, implementing organizations and compliance procedures. Environmental management plans such as those for river water quality management typically include legal, regulatory, financial, technical and social components. Quite often management problems occur when there is a conflict between regulation and enforcement, when government is facing financial difficulties, or when the technical capability of environmental agency personnel is inadequate.

3.2 Roles and Functions of Each Sector

Central and local governments are involved in river water quality management as mentioned above. In the usual situation, wherein a public-oriented approach to environmental protection and promotion is emphasized, the government, both national and local, plays the most decisive role in river water quality management. However, industries as well as the local populace also play important roles in river water quality management.

3.2.1 Central Government

The central government is expected to perform the following functions and tasks. Among these tasks, the institution of basic policies, including the setting of standards, is one of the most important functions of the central government. Other functions include:

1) formulation of basic policies for river water quality management;
2) planning for solving problems encountered nationwide and for river water quality management of particularly large or important areas in the contest of national economic

development plans;

3) formulation and setting of water quality standards and effluent standards;

4) technical guidance to local governments, industries, and local people and their organizations (NGOs), including institution of training programs;

5) data collection (from various local government units or local branches of agencies) and appraisal of river water quality and other related information.

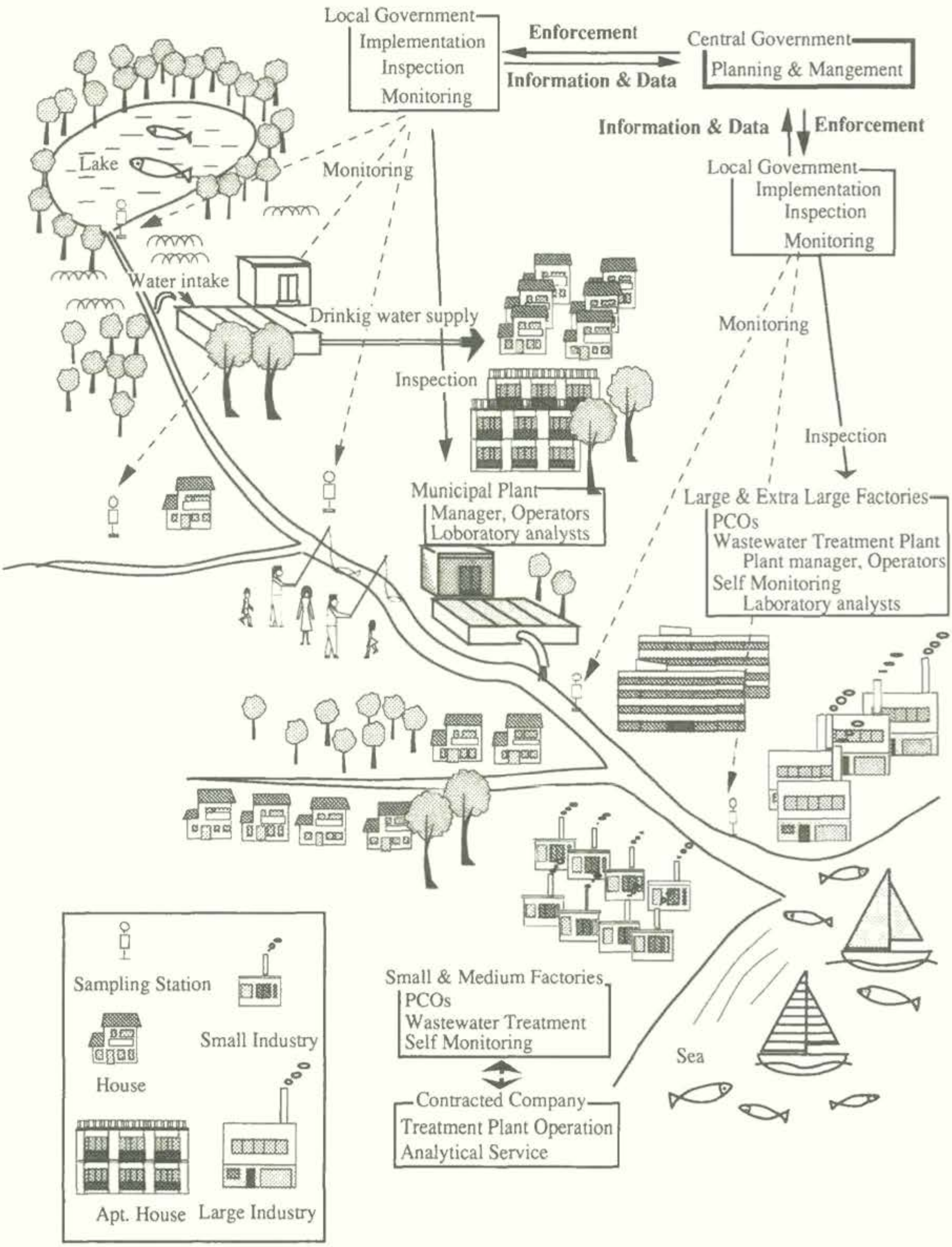


Fig.3.1 Typical River Water Quality Management System.

Central governments need to regularly evaluate policies and programs for them to be effective. Evaluations should identify the major issues arising out of practice and implementation which need to be addressed, the steps to be taken to resolve them, the sources of information and the relevant experiences that highlight the issues and the proposed solutions. Areas where relevant laws, regulations and policies coincide or conflict with practice and implementation should be indicated. In cases of conflict, evaluations should indicate how these may be resolved or harmonized.

Technical guidance is designed to improve the capability of local government bodies, industries, and the local people and their organizations (NGOs) to develop and implement effective environmental programs and plans. These in turn are expected to improve the compliance of effluent dischargers with environmental policies.

The collection and collation of monitoring data, its analysis and appraisal, are needed to obtain the environmental baseline information required in developing or evaluating river water quality policies and programs.

3.2.2 Local Government

Local governments are responsible mainly for the implementation of central government policies and programs on pollution control and abatement. Their specific functions are as follows:

1) monitoring of river water quality including sampling and determination of the various water quality parameters;
2) inspections to check on the compliance of plants, factories and establishments which discharge effluents into rivers with relevant discharge regulations and standards;
3) construction, operation and maintenance of municipal wastewater treatment facilities;
4) planning for regional or local river water quality management.

Monitoring of river water quality and gauging of river flows are activities which should be conducted regularly, at a minimum several times per year. The selection of sites for sampling, and the parameters to be determined (basic and more specific water quality parameters), are pre-determined based on the type of effluents anticipated to be present in the river segment. A detailed description and explanation of these are given in the UNEP/GEMS Water Operational Guide prepared through the joint effort of several UN and other international agencies[1].

Inspections to check on the compliance of plants, factories and other establishments with relevant legal requirements should also be done on a regular basis and not only when a complaint of possible regulatory violation has been filed with the local environmental agencies. The task of implementing the regulations, such as imposing fees and other impositions for violations, should also be integrated into these inspection functions of local government bodies.

Local government bodies should initiate the establishment of municipal sewage treatment plants, in cases where there is none, and participate in other projects which will help control and abate pollution from different sources.

Studies and implementation of formulated programs for the abatement of pollution from non-point sources (such as agriculture, aquaculture and urban communities) should also be instituted at the local government level. As an example, a campaign for a change from the use of phosphorus-containing detergents to varieties not containing phosphorus may be conducted at the local level. Similarly, campaigns to encourage organic farming to control excessive use of fertilizers may also be undertaken at the local level. Both campaigns could be carried out with, or in the absence of, national government regulations requiring compliance should these measures be required to correct of specific problem.

3.2.3 Industries

In most East Asian countries, industrial effluents taken as a whole are not the biggest sources of organic pollution. Taken singlely, however, each industry or factory would be a significant source of organic pollutants. Some industries are also the most significant sources of toxic and hazardous pollutants. Getting the cooperation of industries in controlling their effluent discharges is thus important.

Industries have a duty to keep pollutants in their effluents within the required standards. For better performance, they need a systematic approach which will prevent or reduce pollution at its source, through recycling or reclaiming industrial wastes when such is technically and financially feasible, and using cost-effective pollution abatement technologies for pollutants that cannot be avoided, recycled or reclaimed.

3.2.4 Local Populace

The local populace, especially in ASEAN countries where people live on riverbanks and discharge wastes directly into the rivers, also have an important role in river water quality management. Taken collectively, they contribute significantly to the organic pollution of rivers. On the other hand, they are also the most exposed to the hazards of a polluted river and therefore are the biggest losers if environmental protection and promotion are not pursued. An environmentally aware populace has the potential to provide considerable support to any governmental program in river water quality management.

The cooperation of the local populace in pollution control and abatement may be sought by making the public aware of the benefits of clean river water.. In cases where the infrastructure for sewage water treatment is not yet established, the control of pollution from domestic sources, including solid waste thrown into rivers, may be achieved only through the conscious effort of people in the local areas. People may also be tapped by local government bodies, through their organizations, to help in monitoring and other pollution control and clean-up activities.

1) The UNEP/GEMS Water Operational Guide may be obtained from The Director, GEMS/PAC, UNEP, P.O.Box 30552, Nairobi, Kenya.

CHAPTER 4

EXPERIENCES IN WATER QUALITY MANAGEMENT IN THE EAST ASIAN COUNTRIES

River water quality management in East Asian countries has been as varied as the differences in the social, economic and political development in each of these countries. Although most of the East Asian countries follow the same path of export-oriented industrialization with a consequent drive for modernization and social amelioration, their experiences vary as their rates of implementing their programs are also quite uneven. The differences in the levels and pace of instituting socio-economic programs and governmental reforms are likewise reflected in the levels and pace of planning and implementing countrywide environmental programs. Such is the case in the river water quality management practices and experiences of these East Asian countries.

In this chapter, several case studies in river water quality management practices in some countries of East Asia will be presented. These countries may be grouped into two general categories based on their river water quality management practices and experiences. First, there is the level of practice which relies solely or mainly on governmental and administrative controls that include instituting maximum allowable limits for pollutants in effluents discharged from industries and other sources, and imposing a system of fees or fines and other regulatory measures. Second, there is the level of practice that combines governmental controls and regulations with other governmentally or privately initiated action programs, such as investment in basic infrastructure like sewerage systems, low-cost housing, domestic water treatment plants and the like, public awareness campaigns, river clean-up projects, green projects and others activities.

Needless to say, the control and abatement of pollution in the first category of practice is dependent on the full cooperation of the populace, industries and other groups of people whose effluents end up in the rivers. It is also dependent on the efficiency and effectiveness of the law enforcement system, and therefore influenced to some extent by norms of social and political relations. The second category of practice, however, combines regulatory measures with additional institutional measures and infrastructure to ensure the treatment of wastewaters, especially those coming from human settlements.

We may anticipate the result of our case studies in this chapter by concluding that, in general, the second category of practice has a better percentage of success than the first. As presented in Chapter 2, effluents from human settlements contribute a significant, if not the largest, amount of pollutants in East Asian rivers. Without the infrastructure needed for treating wastewaters from human settlements, the difficulties anticipated in water quality management practices in the first category are quite obvious.

The current river water quality management practices and experiences in Malaysia, The Philippines, Thailand and Indonesia may be grouped in the first category, although Malaysia and Thailand have already started establishing some sewerage and domestic wastewater treatment facilities. Those of Singapore, Korea and Japan may be grouped in the second category. This grouping coincides with the level of economic development achieved by these countries. Additional institutions and infrastructure are quite costly and will require greater government investment. Investing in and building the infrastructure for the protection and cleaning of the environment is a decision often made by top-level government policy makers.

Another dimension that affects the level of practice of East Asian countries in river water quality management is a country's capability in terms of human resources for the planning and implementation of workable and effective environmental programs. This is a topic which will be presented fully in the next chapter. It should be noted, however, that river water quality management practices are invariably linked to the human resource factor, which is why in some country characterizations in this chapter mention is made of the lack of human resources.

Governments of East Asian countries have for some time realized that polluted rivers are economically detrimental to their countries in the long run. Moreover, there is a realization that polluted rivers lead to polluted lakes, bays and other environments which may add to the long-term economic and other problems of a country. Governments in these countries have thus instituted measures which in varying degrees have resulted in the abatement of pollution of their rivers.

It is a generally accepted principle that the scope of management programs which are necessary to achieve success in maintaining or restoring good river water quality will depend largely on the current conditions of water quality, on the current level of prevention measures being taken to control the inflow of pollutants, and the predetermined, current or planned usage of a river water. In Chapter 2, we presented a general description of the current conditions, status of pollution, and current usage of some of the major rivers in each of the countries studied. The general directions or goals of water quality management for rivers presented in that chapter are somewhat obvious, especially for rivers that have a well or almost well characterized condition. However, there are situations where even the conditions of the rivers are not yet known or documented.

We have mentioned earlier that a prerequisite to any water quality management program is good technical information on water quality, and the types, sources, and quantity of pollutans. Such information may be obtained with a systematic monitoring program. In this chapter, a survey of river monitoring practices and capabilities in each of the countries studied will be presented as part of their management experience

4.1 Malaysia

In Malaysia, policies related to wastewater treatment and disposal are found in various laws, regulations and enactments which provide statutory powers to specific government bodies to control pollution. The most comprehensive environmental legislation in Malaysia is the Environmental Quality Act (EQA) of 1974. The purpose of the EQA is two-fold: pollution prevention, abatement and control; and environmental enhancement. The EQA has 15 sets of regulations and orders, 8 of which relate to wastewater treatment and disposal (see Table 4.1.1). The underlying principles adopted in the formulation of the EQA are: pollution should be controlled at source; polluters must pay or bear the costs of their waste or wastewater treatment and disposal; effluent standards should be uniform for a particular source and type of industry or activity; and other standards may be introduced by the Minister of the Environment should previous measures be inadequate to maintain the conditions necessary to support the intended use of a waterbody. An Environmental Law Review Committee was established in 1991 to identify weaknesses and inadequacies of the EQA and the regulations made thereunder.

Table 4.1.1 Malaysia: Regulations and Orders Enforced by DOE.

No.	Regulations/Order	P.U.(A)	Effective Date Enforcement
1.	Environmental Quality (Prescribed Premises) (Crude Palm Oil) Order 1977	199	1 July 1978
2.	Environmental Quality (Prescribed Premises) (Crude Palm Oil) Regulations 1977 Amendment (1982)	342	4 November 1977
3.	Environmental Quality (Licensing Regulations 1977)	198	1 October 1977
4.	Motor Vehicles (Control of Smoke and Gas Emissions) Rules 1977 (made under the Road Traffic Ordinance, 1958)	414	22 December 1977
5.	Environmental Quality (Prescribed Premises) (Raw Natural Rubber) (Amendment) Order 1978	337	1 April 1979
6.	Environmental Quality (Prescribed Premises) (Raw Natural Rubber) Regulations 1978 Amendment (1980)	338	1 December 1978
7.	Environmental Quality (Clean Air) Regulations 1978	280	1 October 1978
8.	Environmental Quality (Compounding of Offences) Regulations 1978	281	1 October 1978
9.	Environmental Quality (Sewage and Industrial Effluents) Regulations 1979	12	1 January 1979
10.	Environmental Quality (Control of Lead Concentration in Motor Gasoline) Regulations 1985	296	11 July 1987
11.	Environmental Quality (Motor Vehicle Noise) Regulations 1987	244	16 July 1987
12.	Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987	362	1 April 1988
13.	Environmental Quality (Scheduled Wastes) Regulations 1989	139	1 May 1989
14.	Environmental Quality (Scheduled Wastes) Regulations 1989	140	1 May 1989
15.	Environmental Quality (Prescribed Premises) (Scheduled Wastes Treatment and Disposal Facilities) Regulations 1989	141	1 May 1989

A set of Interim National Water Quality Standards for Malaysia (shown previously in Table 2.1.1) was completed in 1986 and has been used as a guide since then. Several studies have been commissioned to classify selected river basins based on the Interim Standards. So far, 16 river basins have been classified. In the classification of these rivers, it was noted that a river system may be divided into segments falling under various classes denoting levels of pollution.

The Department of Environment (DOE) under the Ministry of Science,Technology and Environment is the leading government agency for pollution control. However, four other government departments and two local authorities are also contributing towards controlling water pollution within their specified functions and duties. Figure 4.1.1 shows the current organizational structure of the DOE. Under the DOE are 10 state environmental offices and 4 functional divisions, one each for Administration, Pollution Control, Prevention and Development.

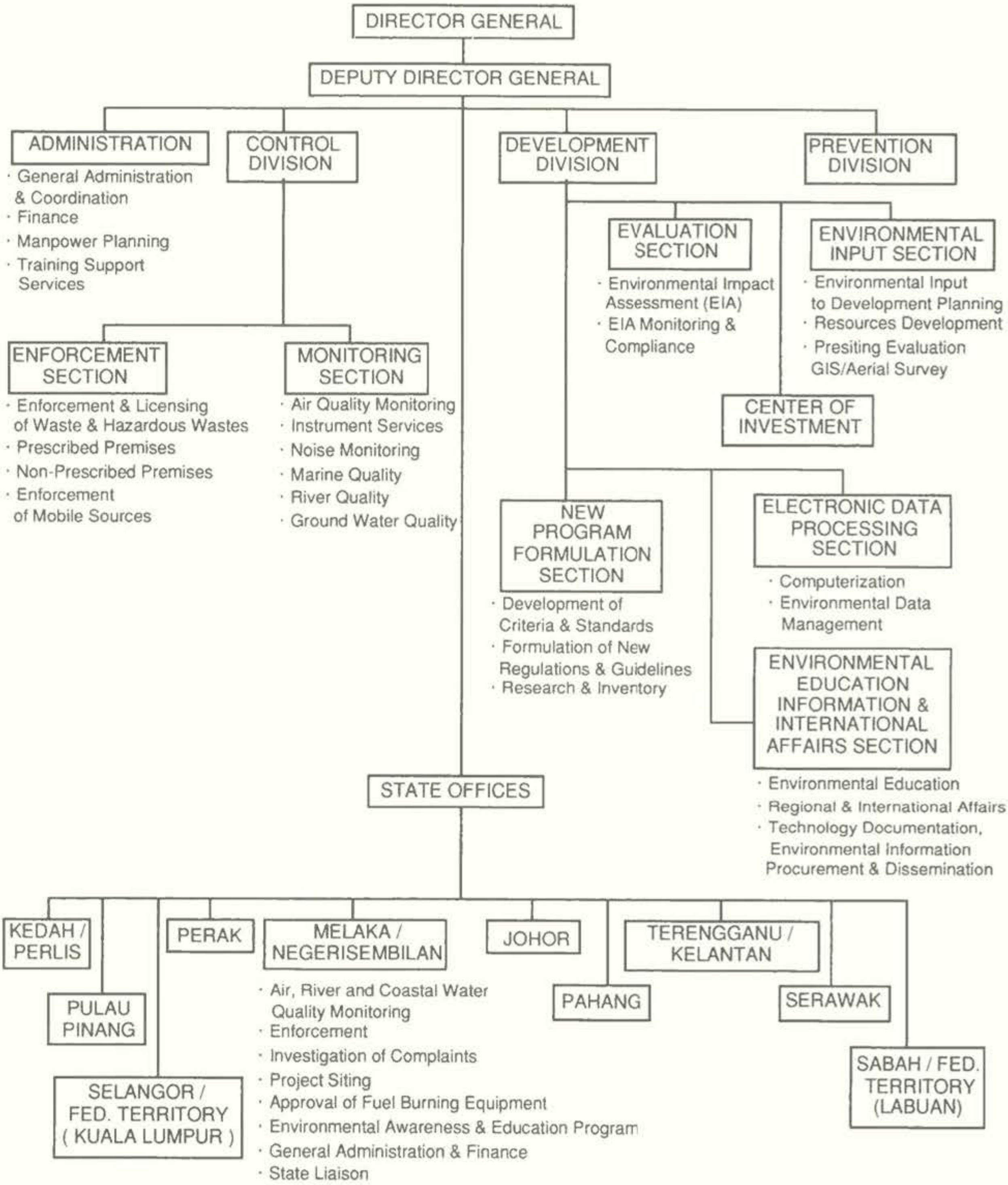


Fig.4.1.1 Malaysia: Organizational Structure of the Department of Environment.

Water quality monitoring is carried out by the DOE on a regular basis. Other departments that carry out monitoring activities are the Drainage and Irrigation Department (DID), mainly for sediments and turbidity, the Water Supply and Sanitation Section of the Ministry of Health, and some universities. The universities carry out monitoring only occasionally in relation to research that they are conducting. The monitoring data from DOE are published yearly, while data from the DID monitoring are published every 5 years. Almost all sampling activities of the DOE are done by their state environmental offices. Samples are taken to the Department of Chemistry for laboratory analysis.

A total of 87 rivers are being monitored in Malaysia, but not all the river systems have monitoring stations because of a lack of monitoring personnel to take samples. The frequency of water sampling by the DOE depends on the availability of technical manpower, equipment and budget allocations. A total of 2967 samples were taken by the DOE in 1991 from 555 sampling sites. This gives an average of 5 samples taken from each site per year. Some sites are located in difficult terrain and are far from the home base of the monitoring personnel, making the operation extremely time-consuming at this sampling frequency. Laboratory analysis of samples is also a problem as the Chemistry Department is overburdened with much work because it receives various kinds of samples from the DID and other agencies also. Delays in the laboratory analysis could be several months on some occasions, which could possibly cause errors in the results obtained for some water quality parameters measured, even if samples are preserved.

At present, factories in Malaysia, except the large ones, do not have facilities to treat their wastewaters. This causes a problem in enforcing the many regulations on effluents. This problem is compounded by a lack of DOE personnel to enforce these regulations. In the Klang Valley alone, there are more than 5000 medium- to large-scale industrial plants and many more small ones, possibly polluting the rivers in that area. However, there are only 50 officers to enforce the laws and regulations. The shortage of enforcement officers is even greater at state levels. Inspection and checking of effluents from factories is also hampered by a lack of available personnel to do the sampling and laboratory analysis. The Chemistry Department is already overburdened with water samples from river monitoring alone.

Factories are required to submit their reports of effluent monitoring to the DOE. However, very few factories have environmental officers (pollution control officers) who are qualified and are specifically assigned to do the job. Thus, monitoring of effluents is left for government enforcement personnel. As previously mentioned, these government enforcement staff are too few to adequately do this much sampling. Pollution from factory effluents is thus generally left unchecked.

All development projects and new factories are subject to environmental impact assessments (EIA). For new projects, a developer has to ensure that an EIA is carried out and approved by the DOE before the start of the project. But an EIA is only good if the provisions for pollution control and abatement are followed after the project implementation.

The enforcement of regulations for the control of industrial pollution can be greatly improved in Malaysia. One way in which the DOE is doing this is by giving industries some incentives for their effluents meeting the regulatory standards. The EQA allows for the issuing of Contravention Licences to allow polluting industries to "buy" the necessary time for further research and development or for proper design and installation of wastewater treatment or disposal facilities. In 1991, some Contravention Licences were issued, most of which were to enable industries to construct or upgrade effluent treatment plants. These licences are given with strict imposition of effluent-related fees as provided for under government regulations. During the licensing period, these industries are monitored regularly to ensure compliance with the conditions of the licences.

The EQA also provides penalties for cases of failure to comply with the regulatory standards. In 1991, 18 cases were filed in court under the Environmental Quality Regulations of 1979.

In 1974, the Ministry of Housing and Local Government stipulated that housing areas with more than 100 units must be served with centralized waterborne sewerage systems, and oxidation ponds provided. Oxidation ponds had been recommended because of their relatively low maintenance cost. As urban areas expanded, mostly in the form of contiguous housing estates, it has become easier to introduce central waterborne systems.

For housing estates with less than 100 units, septic tanks are still recommended. Most urban areas are still served by septic tanks, although the construction of centralized sewerage systems for major towns in Malaysia has been planned. A total of 17 sewerage master plans had been prepared since 1985 but most of the projects have not been implemented owing to the high cost of the projects. Up until now only six towns in Malaysia, namely Georgetown, Butterworth, Bukit Mertajam, Shah Alam, Kota Kinabalu and Kuala Lumpur have centralized sewerage systems with treatment facilities. These centralized sewerage systems have helped in the control of pollution from domestic sources.

4.2 The Philippines

Realizing the need to control pollution, the Philippine government has, by legislation and similar action, formulated policies and set up agencies to deal with the prevention, abatement and control of river water pollution. Earlier, during the 1960s, the National Water and Air Pollution Control Commission (NWAPCC) was established under RA 3931. In 1976 this was revised by PD 984 which resulted in a stronger National Pollution Control Commission (NPCC) which was then the sole agency responsible for the prevention, control and abatement of air, land and water pollution. In 1987, the NPCC together with the National Environmental Protection Council (NEPC), the then policy-making body with respect to environmental protection, were abolished. These two agencies were then absorbed by the newly organized Department of Environment and Natural Resources (DENR) by virtue of Executive Order No. 192.

The first set of water quality standards was promulgated by the NWAPCC in 1967. The standards were adopted from relevant water quality laws in the United States. These standards were revised in 1978 through a process of review by an ad-hoc committee. The ambient water quality limits in the 1978 rules were then enforced as effluent standards. Four years later, in 1982, NPCC came up with the present effluent regulations.

While the water quality standards in 1978 and 1982 were partly based on local studies previously undertaken, questions on the feasibility of attaining such limits continued even after their official publication. The year 1987 saw the reorganization of the DENR and, consequently, one of the first tasks undertaken by the new administration was the review and revision of the water quality standards. The revised standards were adopted by the DENR in 1990 and were embodied in DENR Administrative Order Nos. 34 and 35. The classifications and criteria for fresh and inland waters based on AO 34 were given previously in Table 2.2.1.

However, it is very difficult to obtain a representative picture of the water quality and classification of rivers in the Philippines since only 20% of the rivers have available water quality data. During the period 1972 to 1982, the NPCC established a monitoring program for some rivers and lakes. The design called for yearly and semestral sampling of major rivers and monthly sampling of Metro

Manila rivers. After the reorganization in 1987, increasingly constricted budgets have limited the sampling of river water to less frequent intervals on a few selected rivers nationwide. Only 27 out of the country's 421 rivers were sampled in 1990, while only 80 rivers were sampled in 1991.

The DENR is the primary government agency responsible for the conservation, management, development and proper use of the country's environment and natural resources. The current organizational structure of DENR is given in Fig.4.2.1. The offices within DENR given the tasks of environmental management and pollution control (EM/PC) are the Environment Management Bureau (EMB), the Pollution Adjudication Board (PAB) and the regional offices of the Environmental Management and Protected Areas Sector (EMPAS). Under this set-up, PAB is directly under the office of the DENR secretary, EMB is one of the 6 staff bureau, while the EMPAS regional offices are just one of the five sectors in the DENR being mirrored at the regional offices.

The main functions of EMB are policy formulation, serving as secretariat to the PAB, and overseeing the implementation of EM/PC programs and projects. The PAB is a collegial body headed by the DENR secretary and has the task of adjudication of pollution cases, although it may also take in cases involving violations of the Environmental Impact Assessment (EIA/EIS) system and the Hazardous Waste Act.

The implementation and enforcement of DENR programs and projects and DENR mandated laws rests with the 14 DENR Regional Offices (RO). Every RO consists of five implementing arms, each representing the five main concerns of DENR, one of which is environmental management and protected areas.

With the enactment of the Local Government Code, most of the line functions of DENR will eventually be devolved to the local government units (LGU); that is, provinces, cities and municipalities. These functions will include pollution control for small-scale industries employing not more than 20 persons, garbage collection, and others, but exclude policy formulation and legislation with national implications which is still a function of the national government.

Efforts at pollution control being undertaken by the government include monitoring of effluents, periodic inspections to determine compliance with effluent and discharge regulations and conformity with water quality standards, and hearing pollution cases which could result in imposition of fines or cessation of operations that cause water pollution. However, this system has not proven very effective in controlling industrial pollution.

A large percentage of industries required to have water treatment facilities still continue to operate without them. Moreover, those which have treatment facilities have not adequately treated their effluents. Industries find it "profitable" to pay the fines rather than control their pollution. Fines imposed on violators are not high enough, so polluters have opted not to spend on pollution control facilities to meet effluent standards.

Enforcement staff of the DENR have not been fully effective in catching the polluters either. Monitoring of effluents and inspections have not been done regularly as intended due to lack of available manpower and equipment, among other reasons. Quite often, inspections and monitoring of effluents are done only when complaints are filed with the DENR by affected parties. Fines and other penalties are not automatically imposed and have to be heard first by the PAB even in cases where evidence of pollution had already been established. This delay works to the advantage of the polluters.

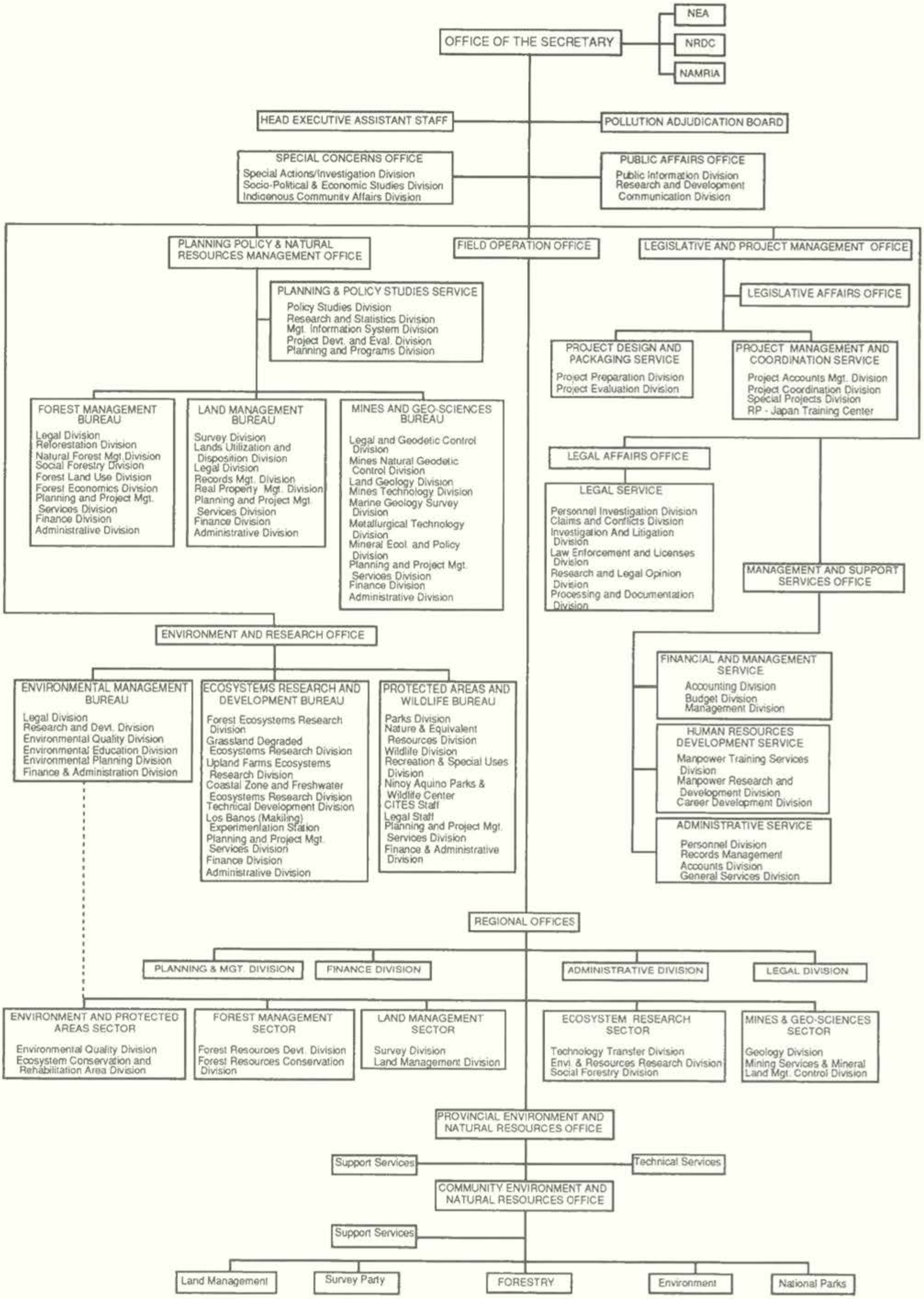


Fig.4.2.1 The Philippines: Organizational Structure of the Department of Envieonment and Natural Resources.

One of the major issues that arises with pollution control in The Philippines is that DENR alone cannot police the thousands of industrial sites all over the country, and supervise and regulate the actual operation of wastewater treatment plants. To eliminate a possible excuse of industries for not being able to comply with regulations, such as competence, or lack of it, among wastewater treatment plant operators, it was made mandatory that industry should have at least one person responsible for the implementation of a firm's antipollution program. This in turn gave rise to the requirement that each company should appoint or designate a Pollution Control Officer (PCO) to attend to the environmental activities and problems of the firm. In practice, the PCO serves as a contact person or liaison officer with the DENR and the local government units in charge of environmental protection. Only lately has DENR elevated the level of PCO to a professional status by defining the professional qualifications and accreditation of PCOs under four different types of pollution control works that a company or plant may have installed and operated. The DENR order also specifies the duties and corresponding responsibilities of an accredited PCO under three levels of classification.

The government is moving towards the granting of subsidies or soft loans to industries willing to install antipollution systems. Subsidies could come not in the form of direct financial assistance but in the form of providing project management appraisal services, free of charge, to companies to reduce pollution generation. This will come under the Industrial Environmental Management and the Industrial Efficiency and Pollution Control projects, soon to be implemented by the EMB.

New or proposed development projects which are actual or potential sources of pollution, such as industries and factories, are now required to prepare and submit an EIA prior to construction and operation to allow the government to look into possible and probable pollution implications of the projects, and how such pollution could be minimized or mitigated. Full implementation of the EIA, however, is limited by the lack of resources and trained manpower to conduct the assessments.

As the worst rivers are found in Metro Manila, as set out in Chapter 2, two river revival projects were planned several years ago for the Metro area. These two projects have been hampered by several problems such as lack of funds, weak coordination between participating agencies, and too high targets. In the Navotas-Malabon-Tullahan-Tenajeros Rehabilitation Project, for example, the Metropolitan Waterworks and Sewerage System (MWSS) was committed to implement a basin-wide septic tank desludging program in lieu of a more expensive sewerage system similarly, the government housing agency was committed to relocate the squatter shanties along the river, while the Public Works Department planned to dredge the waterway. As of late, only the DENR was able to meet its target of monitoring and controlling pollution from industries in the area.

The problem mentioned above has bearing on one of the more important concerns in river water quality management in The Philippines, particularly for rivers passing through urban centers or areas of human settlements (usually located close to industrial areas also); domestic sewage. The problem caused by domestic sewage is quite difficult to solve because this implies re-building housing for people living on riverbanks or in areas close to waterways. This also implies planning for the establishment of sewerage systems, including municipal wastewater treatment facilities which presently do not seem to be on the agenda of the MWSS, the agency in charge of establishing such facilities. These are costly investments that government agencies are not yet prepared to make in The Philippines. However, pollution from human settlements is a major environmental problem that has to be solved.

4.3 Thailand

Several laws have been promulgated in Thailand recently in order to preserve, protect, and improve the environment in the country. These are the Environmental Preservation and Promotion Act, the Public Health Act, the Factory Act, and the Hazardous Substance Act.

The first, also known as the Environmental Act, mandates the setting up of a National Environmental Board, equivalent to a ministerial cabinet committee and chaired by the Prime Minister, to formulate direction and policy on environmental management. The role of law enforcement, under this Act, is given to local government. The Environmental Act also establishes an environmental fund which is made available to local governments or private firms for projects related to protecting or improving the environment. Municipalities in need of capital to install wastewater treatment facilities will have priority in accessing grants from this fund. The fund also supports private businesses with low interest loans for the construction of treatment facilities.

The new Public Health Act is concerned mainly with sanitation in communities, sewage and solid waste collection, treatment and disposal, control of waterborne communicable diseases, and other health issues. In the 1992 Factory Act several rules related to the discharge of effluents from factories are spelled out. The new Hazardous Substance Act focuses on toxic and hazardous substances and sets out rules related to their production, importation and disposal. Other legislative actions which are environmentally related are the Building Control Act of 1979, and the Navigation in Thai Waters Act.

Pursuant to the above environmental laws, several regulations have been issued to control wastewater discharge from various sources. Examples of this are the Standards of Sewage Discharged from Buildings (Table 4.3.1) and the Industrial Effluent Standards (Table 4.3.2).

Throughout the kingdom only the national water quality standards (given previously in Table 2.3.1) are used: local governments do not issue regulations of their own. But this limitation is extended even to the enforcement of environmental laws and regulations. When environmental problems occur, local governments cannot do anything except report them to the concerned central government agency and wait for them to solve the problem.

Table 4.3.1 Thailand: Classification of, and Standards for, Sewage Discharge from Buildings.
a) Effluent standards

Parameter	Allowance/Building Classification				
	A	B	C	D	E
pH	5 - 9	5 - 9	5 - 9	5 - 9	5 - 9
BOD, mg/L	≤20	≤30	≤40	≤50	≤200
Solids, mg/L					
-Suspended solids	≤30	≤40	≤50	≤50	≤60
-Settleable solids	≤0.5	≤0.5	≤0.5	≤0.5	-
-Dissolved solids*	≤500	≤500	≤500	≤500	-
Sulfide, mg/L	≤1.0	≤1.0	≤3.0	≤4.0	-
Nitrogen-TKN, mg/L	≤35	≤35	≤40	≤40	-
Fats, Oil & Grease, mg/L	≤20	≤20	≤20	≤20	≤100

*Value increased from normal concentration of water supply.

b) Types and classification of buildings

Type	Dimension/Size	Classification
1. Commercial	<100	C
	100 - 499	B
	≥500 rooms	A
2. Hotel	<60	C
	60 - 199	B
	≥200 rooms	A
3. Dormitory	10 - 49	D
	50 - 249	C
	≥250 bed rooms	B
4. Massage parlor	1000 - 4999	C
	$\geq 5000 m^2$	B
5. Hospital	10 - 29	B
	≥30 beds	A
6. Academic institute	5000 - 24999	B
	$\geq 25000 m^2$	A
7. Governmental, State, or Private enterprise	5001 - 9999	C
	10000 - 54999	B
	$\geq 55000 m^2$	A
8. Department store	5000 - 24999	B
	$\geq 25000 m^2$	A
9. Fresh-food market	500 - 999	D
	1000 - 1499	C
	1500 - 2499	B
	$\geq 2500 m^2$	A
10. Restaurant	<100	E
	100 - 249	D
	250 - 499	C
	500 - 2499	B
	$\geq 2500 m^2$	A

Note: Approved by the Board of Pollution Control Committee, September 23, 1993; To be published in the Government Gazette.

There are six ministries in Thailand's central government that have activities in environmental pollution control. Within each ministry, there are several departments and divisions working on different aspects ranging from planning to monitoring, law enforcement and others.

The Ministry of Science, Technology and Environment (MSTE) is the key government agency for pollution control and improvement, but there are other departments and ministries having functions and tasks which overlap.

The Water Quality Management Division, Pollution Control Department (PCD) under the MSTE, is in charge of managing the water quality of major rivers in the country as one of its main tasks. However, the whole function of water pollution control is divided among several departments of

Table 4.3.2 Thailand: Industrial Effluent Standards (1982).

Parameter	Allowable concentration
pH	5 - 9
Permanganate value, mg/L	60
Dissolved solids, mg/L	
-Discharge into fresh-water courses	2000 or more,but not exceeding 5000, depending upon discharge point
-Discharge into sea or estuaries	5000 higher than dissolved solids (Salinity higher than 2000) in the sea or estuaries
Sulfide as H_2S, mg/L	1.0
CN, mg/L	0.2
Heavy metals, mg/L	-
-Zn	5.0
-Cr	0.5
-As	0.25
-Cu	1.0
-Cd	0.005
-Ba	0.03
-Se	1.0
-Pb	0.02
-Ni	0.2
-Mg	5.0
Tar	nil
Oil & Grease, mg/L	5.0 (except for crude oil refinery and lubricant blending plants-less than 15)
Formaldehyde, mg/L	1.0
Phenols & Cresol, mg/L	1.0
Free chlorine, mg/L	1.0
Insecticides and radioactive substances	nil
Suspended solids, mg/L	30 or more, depending on dilution ratios
Dilution ratio	
8 - 150	30
151 - 300	60
301 - 500	150
BOD(5days, 20°C), mg/L	20 or more, but not exceeding 60, depending upon discharge point; except for the following industries
-Fish canning	100
-Tapioca starch	100
-Noodle factory, using <500kg of rice per day	100
-Tanneries	100
-Pulp mill	100
-Seafood processing	100
Temperature,°C	<40
Color & Odor	not objectionable when mixed with receiving water

different ministries. Control of pollution from domestic sewage effluents is under the MSTE, but the Department of Industrial Works (DIW) of the Ministry of Industry is responsible for industrial effluents, while the Ministry of Public Health is responsible for effluents from hospitals. An added complication is that, while the DIW controls all factories in the kingdom in terms of compliance with effluent regulations, the Department of Ports, Ministry of Communications, is in charge of monitoring the environmental impact of all emissions to the rivers and waterways, and of all intrusions that might obstruct commercial navigation and natural water flows. Also, the task of designing and constructing sewerage systems, which was previously under the Public Works Department, Ministry of Interior, is now under the PCD, MSTE. But the local government bodies which will eventually manage the sewerage systems are all under the supervision of the Ministry of Interior. As in some other countries, this system is quite complicated, resulting in less than effective reporting and control in some caces.

Industries that generate wastewater are compelled, by the Factory Act, to treat their wastewater in their own treatment plants prior to discharging effluents into public sewers or nearby canals. The government has set standards (see above) to control the level of pollutants in industrial effluents. However, due to several factors, such as the cost of treatment and lack of technical manpower for the enforcement of regulations, industrial wastewaters still cause adverse environmental effects on rivers and canals.

Almost all industries in Thailand lack trained personnel to effectively operate their treatment plants. In some industrial plants the management has hired less qualified personnel to benefit from lower salaries. But some factories have old inefficient treatment systems which require experienced operators. The less qualified personnel can not easily remedy problems in cases of breakdown. As a result, there are episodes of pollution which are preventable.

Poor and irregular monitoring by government agencies has allowed inefficient treatment of industrial wastewaters to continue in some factories. The agencies suffer from the lack of necessary personnel and funds to carry out better compliance monitoring of industrial effluents. Heavy fines or even factory shut-downs are imposed on firms proven to be violating the regulations. However, the fines or punishments imposed on violators might differ based on the conflicting provisions of the several pieces of environmental legislation now in effect.

The government has now moved to encourage industries to treat their wastewaters by giving them incentives such as tax reductions or exemptions for imported equipment for wastewater treatment, low-interest loans for construction or upgrading of treatment facilities, and others.

The four major rivers of Thailand have been monitored regularly since 1981. River samples are analyzed for BOD, DO, and total coliform bacteria (TCB). The results were presented earlier in Chapter 2. They indicated that these rivers, and especially the lower segment of the Chao Phraya River which passes through the Bangkok Metropolitan area, are severely polluted, recording high BOD and TCB and low DO concentrations. Such results indicate that pollution control measures are not effective thus far.

The organic waste loads coming from domestic sources into rivers and canals are increasing annually. There is no enforcement of regulations on domestic effluents. Although all high-rise buildings are now required to have their own on-site treatment facilities designed according to government regulations, no checks are made on the operation and efficiency of such systems. Sewage other than that from high-rise buildings is directly discharged into sewers which lead eventually to canals and rivers. Each household normally uses a septic tank to treat only night soil or sullage from toilets.

Other wastewaters are discharged directly into the sewers without treatment. Also, many communities have traditionally used rafts floating along the river banks as houses. People living on these rafts as well as others living close by discharge their wastes directly into the rivers.

Many urban centers and communities in Thailand need centralized sewerage systems and municipal wastewater treatment plants to add to the very few that are operating at present. Many plans have already been prepared to service some urban areas with sewerage systems and wastewater treatment plants and a few are already being designed and constructed. But as well as solving the problem of sewage from households, the problem of housing for those communities living on rivers and riverbanks have to be addressed too.

4.4 Indonesia

A "River Clean-up Program" called PROKASIH was instituted by the government of Indonesia in June 1989. Eight provincial governments have reached an agreement to work together to make the program successful. Initially the program aims to improve water quality and abate the pollution coming from industrial and household sources around some twenty rivers, including the nine mentioned in Chapter 2. Several laws and decrees that had been promulgated earlier by the national and provincial governments are aimed at regulating industrial pollution of rivers in Indonesia. However, the "River Clean-up Program" is the first coordinated effort by the government to curb pollution from industries and other sources.

Teams Prokasih or local government implementation teams were established in the eight provinces involved in the program. Teams Prokasih in most provinces were headed by the provincial government officials and included academics as well as other minor local officials. So far, activities under the program have included consultations with industry representatives to inform them of government regulations, and monitoring of industrial effluents and the water quality of rivers.

Initial results, as reported by local government officials from the three provinces of East Java, West Java and Lampung, indicate that the activities conducted thus far have not yet significantly abated pollution coming from industries in these areas.

Several institutional problems and issues beset the implementation of adequate regulatory measures to control industrial pollution in Indonesia. Although all aspects of environmental impact are theoretically included in the assessments made before the issuing of licences for the establishment of an industry, specific requirements have been rarely incorporated in the plans. Also once the industry has been established, environmental consequences are rarely monitored. Ambient water quality is monitored by the Institute of Hydraulic Engineering, and at the provincial level by the Ministry of Health, for key points in Java. However, no effort is given to relating the water quality measured in rivers to particular point sources. As a result, a firm's compliance with existing regulations is not checked. One major reason for this is the lack of sufficient trained staff to implement the necessary monitoring of industrial effluents that would be required to tie in to the river monitoring effort.

The respective Teams Prokasih in each of the provinces are now studying the possibility of instituting other measures to control and abate river pollution of Indonesia's major rivers. They are also focusing on solving the problem of insufficient trained staff for river water quality management.

4.5 Singapore

Water pollution was a big problem in Singapore during the early years of its drive towards industrialization. Population, industries and agriculture were then exerting a negative impact on and polluting the water resources of the island nation. Most streams and rivers were black in color, oily and odorous. There was hardly any dissolved oxygen in these waters which were practically devoid of aquatic life.

The government of Singapore had, at the onset of its industrialization and urbanization programs, recognized the need to have good planning control and proper environmental infrastructure to tackle the problem of land-based pollution before the waterways became devastated. Singapore has embarked on an intensive program incorporating the provision of infrastructure, redevelopment, enforcement and phasing out of some of the more polluting activities and industries. The approach is multi-pronged and the objectives are achieved through the control of land-based pollution and eliminating it at source, the control and monitoring of discharges into the various streams and rivers, and the enforcement of laws on water pollution control for the protection of water and rivers.

The government of Singapore through its agencies (such as the Sewerage Branch, Public Works Department; the Public Health Department, Ministry of Health; the Housing and Development Board (HDB); and the Jurong Town Corporation (JTC)) embarked on concerted efforts to alleviate the water pollution problem and improve the environment.

Millions of dollars were spent on an accelerated sewerage expansion program, construction of new sewage treatment facilities, and expansion of existing ones. All new developments were required to connect to public sewers where available or to provide sewage treatment plants with secondary treatment capability. Industries were required to treat their wastes to prescribed standards or allowed to discharge organic wastes directly to the sewer at higher limits but only upon payment of a fee.

The HDB was set the task of developing new satellite towns to rehouse those living in slums or squatter areas. All new towns were served by modern sanitation facilities connected to the public sewer and JTC industrial estates were likewise provided with sewerage facilities. Industries were required to be equipped with effluent pre-treatment plants.

Refuse and nightsoil collection was revamped. Proper bin points and bin centers were constructed, refuse collection vehicles with compactors replaced open-top ones, and specially designed refuse bulk bins were manufactured. More night soil wagons were purchased and new night soil stations were constructed to convey the night soil to sewage treatment facilities.

Farms were regulated and, with the development of unprotected water catchments for impoundment of potable water, pig farms slowly disappeared from their former locations. Chicken and duck farms were relocated and were reared in batteries in the dry.

In 1977, the government of Singapore embarked on a 10 year program to clean up the Singapore River and Kallang Basin catchment, the two most important rivers in the island nation. The objective was to clean the waters to effect the return of aquatic life to these water bodies. A report of this program is presented in the Annex to this Chapter.

The Ministry of the Environment (ENV) was formed in 1972 to better coordinate and regulate environmental issues relating to air, water and solid waste management. It was constituted by absorbing existing organizations such as the Sewerage Branch and the Drainage and Marine Branch of the Public Works Department, and the Public Health Department and Public Health Engineering Department of the Ministry of Health.

The ENV consists of 4 divisions: the Environmental Engineering Division (EED), the Environmental Policy and Management Division (EPMD), the Environmental Public Health Division (EPHD), and the Finance and Administration Division (FAD). The organizational chart of the ENV is shown in Fig.4.5.1.

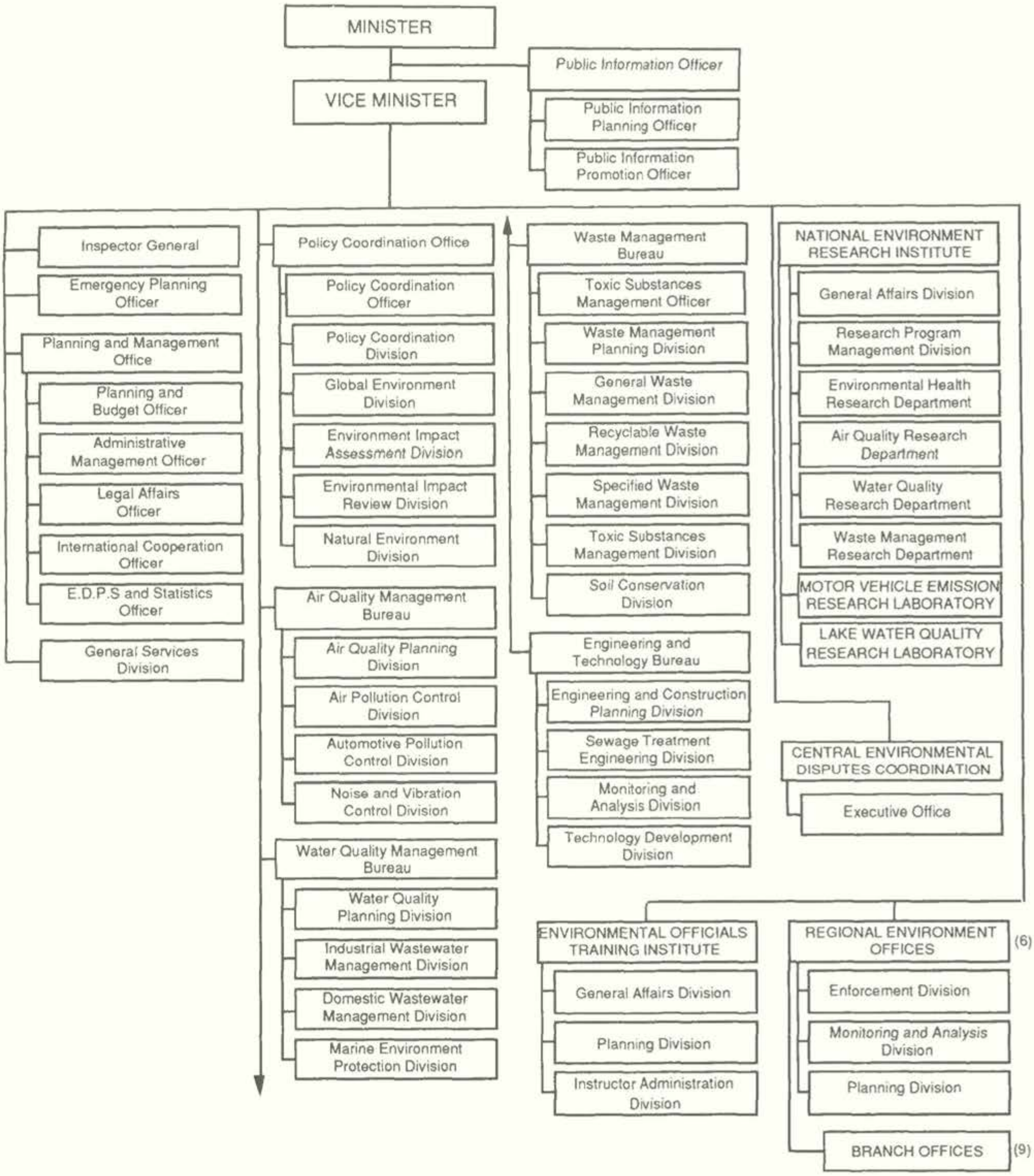


Fig.4.5.1 Singapore: Ministry of Environment.

The EED is responsible for providing, operating and maintaining the sewerage, drainage and solid waste disposal system. The EPMD is responsible for environmental policies, international and bilateral liaisons on environmental issues, air and water pollution control, hazardous substances and toxic wastes, monitoring and assessment of environmental quality, strategic planning, and applied research and development. The EPHD looks after street cleaning, solid waste collection and operation of landfills, food control, quarantine and epidemiology, vector control and research, hawkers and environmental public health. The FAD oversees and coordinates the financial, administrative and personnel aspects of ENV and its departments. It also has a Center for Environmental Training (CET) which is responsible for the training of ENV staff in the areas of environmental engineering, environmental management and environmental public health.

The government organizations responsible for pollution control of water and rivers are the ENV and the Public Utilities Board, through its Water Department. However, the major part of water and river pollution control, enforcement and water quality management is the responsibility of ENV. This function is undertaken mainly by four departments in ENV, namely, the Sewerage Department, the Drainage Department, the Pollution Control Department, and the Strategic Planning and Research Department.

The role of the Sewerage Department is mainly in the provision, operation and maintenance of the sewerage system and sewage treatment facilities. Its mission is to ensure that all wastewaters are channeled into the sewerage system, treated to a high standard and safely discharged into watercourses in non-water catchments or into the sea.

The Drainage Department on the other hand is responsible for surface water drainage of the island. It plans and develops an effective drainage system to alleviate flooding and also, in conjunction with the Water Department, reconfigures drainage patterns in unprotected water catchments to maximize water availability in the catchments. It also develops closed drainage systems to minimize the impact of water pollution as a consequence of littering especially in public housing estates and urbanized areas.

The brunt of water pollution control and enforcement falls on the Pollution Control Department. It has the task of ensuring that all premises are connected to the sewerage system, wherever it is available, and ensuring that industries comply with the Trade Effluent Regulations before they discharge effluents into the sewerage systems or, very rarely, into uncontrolled water courses. It takes enforcement action wherever and whenever required, based on relevant legislation.

The Strategic Planning and Research Department on the other hand is responsible for monitoring the quality of inland and coastal waters. This enables it to monitor and report on the state of the waters and to alert the Pollution Control Department to carry out investigations and take follow-up enforcement actions should these be warranted. In addition, it also undertakes research projects in collaboration with the local universities. Some of the topics being studied are biodiversity of flora and fauna in selected inland waters and eutrophication potential in an enclosed bay.

The powers under which the four departments of the ENV operate are conferred by the Water Pollution Control and Drainage Act (CAP 348) (WPCDA) and its attendant regulations. The three main regulations are: the Trade Effluents Regulation, 1976 (the Effluent Standards are given in Table 4.5.1); the Sanitary Plumbing and Drainage Regulations, 1976; and the Surface Water Drainage Regulations, 1976.

The Water Department operates under the Public Utilities Act (CAP 261) and Public Utilities Regulation, 1992. In addition to the above, in the event of marine pollution, the Port of Singapore

Table 4.5.1 Singapore: Allowable Limits for Trade Effluent Discharge to Sewer, Watercourse and Controlled Watercourse.

Items of Analysis	Sewer	Watercourse	Controlled Watercourse
	Units in mg/l or otherwise stated		
Temp. of discharge °C	45	45	45
Color	-	7 Lovibond units	7 Lovibond units
pH value	6 - 9	6 - 9	6 - 9
BOD_5 at 20 °C	400	50	20
COD	600	100	60
Total suspended solids	400	50	30
Total dissolved solids	3000	2000	1000
Chloride as chlorine ion	1000	600	400
Sulfate as SO_4	1000	500	200
Sulfide as sulfur	1	0.2	0.2
Cyanide as CN	2	0.1	0.1
Detergents (linear alkylate sulphonate as methylene blue active substances)	30	15	5
Grease and Oil	60	10	5
As	5	1	0.05
Ba	10	5	5
Sn	10	10	5
Iron as Fe	50	20	1
Be	5	0.5	0.5
Bo	5	5	0.5
Mg	10	5	0.5
Phenolic compounds expressed as phenol	0.5	0.2	Nil
*Cd	1	0.1	0.01
*Cr (III) and Cr (VI)	5	1	0.05
*Cu	5	0.1	0.1
*Pb	5	0.1	0.1
*Hg	0.5	0.05	0.001
*Ni	10	1	0.1
*Se	10	0.5	0.01
*Ag	5	0.1	0.1
*Zn	10	1	0.5
*Metals in total	10	1	0.5
Chlorine (free)	-	1	1
Phosphate as PO_4	-	5	2
Ca	-	200	150
Magnesium as Mg	-	200	150
Nitrate as NO_3	-	-	20

Note: *The concentration of toxic metals shall not exceed the limits as shown, individually or in total. Controlled watercourse means a watercourse from which potable water supplied by PUB under the Public Utilities Act is obtained but does not include a watercourse from which water is pumped into a main of the PUB.

Authority, which is responsible for all things maritime, has powers under its Prevention of Pollution of the Sea Act (CAP 243) and its subsidiary legislation to take the necessary enforcement actions.

In the unprotected water catchments, only developments which are compatible are permitted. Existing incompatible developments are phased out systematically. The water quality set for these catchments is to ensure that the water can be treated to World Health Organization (WHO) potable water standards. The long-term policy of water quality management for non-water catchments is that the water bodies should be able to support aquatic life and be used for recreational purposes.

The streams and rivers in Singapore are short and shallow, with small flows except after a heavy rainstorm. As a result their capacity for self-purification is limited. Under these conditions, pollutants discharged into streams and rivers will not be adequately diluted and dispersed. It is therefore essential to exercise strict control over all wastewater discharges in order to reduce the mass of pollutants being discharged into the streams and rivers. A comprehensive set of laws were drawn up with standards for the discharge of all wastewaters into watercourses.

All wastewaters, both domestic and industrial, must be discharged into the public sewerage system. Industrial wastewater must be pretreated where required to specific mandatory standards. The standards were set to protect the sewerage infrastructure and the health of workers maintaining the system, to prevent adverse effects on treatment processes at the sewage treatment facilities, and to protect aquatic life.

All the industries are required to install in-plant pre-treatment facilities where necessary to comply with the Trade Effluents Regulations. The common treatment systems adopted by these industries include oil interceptors, flow balancing, sedimentation, neutralization, chemical treatment (such as alkaline-chlorine oxidation, reduction of chromate, precipitation of heavy metals, and chemical coagulation/flocculation), biological treatment (activated sludge and biological filters) and ion exchangers. A separate effluent drain line is provided for the collection and conveyance of trade effluents. Diluting trade effluent with potable water is not allowed. Treatment plants are to be built within covered areas and provided with spill containment facilities to channel any spill back to the treatment plant for treatment. Samples of trade effluents are tested for various organic and inorganic parameters.

In non-sewered areas, industrial effluent would have to be treated to a higher standard before being discharged into a drain and watercourse (refer to Table 4.5.1 for standards). For those industries located within the water catchments, their effluent must be treated to very stringent standards before discharge. In general, polluting industries are not allowed to be sited within water catchments and industrial premises located within water catchments are served by public sewers.

Almost everyone in Singapore is served by modern sanitation and almost all industries discharge their wastewaters into the sewerage system, after pre-treatment where necessary. Singapore has now a very comprehensive sewerage and sewage treatment system. This comprises some 2300 km of sewers, 130 pumping installations and 16 major secondary sewage treatment plants. The area sewered today is about 57.5% of the total land area of Singapore.

Another municipal wastewater treatment system in use in Singapore is small treatment plants. These range in size from those serving individual households to those serving an entire housing estate. These plants provide sewage treatment in areas where no public sewer is currently available. Today, with the extension of the sewerage network, only about 400 such plants serving 50,000 persons are left. They will be further reduced when it becomes economical for the government to extend the public sewers to connect these areas to the central sewage treatment systems.

The water quality of inland streams is monitored monthly. The parameters determined include DO, BOD, ammonia and sulfide. A list of 129 pollutants, including chloroform, benzene, toluene, trichloroethane, pyrene, and chlordane, are monitored at least once a year. The results show that these pollutants are either not detectable or are only present in low concentrations with in the WHO guidelines.

Enforcement action is taken against all violators. From the time any development is completed until the building ceases to be used, it is monitored. Before any development can be occupied or a factory operated, checks are made to ensure that the proposed pollution control facilities have been provided and the wastewaters are channeled to the public sewers. Enforcement checks are then carried out periodically, the frequency depending very much on the type of waste and how well the discharger handles the waste.

4.6 Korea

Korea is one of a few countries endowed with an ample supply of clean fresh water. However, along with rapid industrialization and urbanization in the 1960s and 1970s, water pollution in many rivers and streams started to become a problem. The volume of wastewater has been increasing at a rate of 7% per year for domestic sewage and 20% per year for industrial wastewater.

After the control of water quality was intensified, including installation of wastewater treatment facilities, the quality of water in major rivers, including the Han River, improved considerably, with the level of BOD falling from 9 to 6 mg/L in the case cited.

The Ministry of Environment (ME) has given special attention to the protection of the sources of water supply in its environmental planning. The largest sources of water supply are the Paldang and Daechung reservoirs which provide drinking water for more than 18 million people and water for industries in the metropolitan area and the central region. In order to maintain the quality of the Paldang and Daechung reservoirs at the water supply-Class 1 level (refer to Table 2.6.3a for Water Quality Standards of Korea), the ME designated their basin areas as "Special Water Pollution Control Areas" in 1990. Various special measures to protect the water quality of these reservoirs are now being developed and implemented. To protect the water source, the ME prohibits the alteration of land use and the establishment of facilities discharging hazardous wastewater or of resort facilities in these basin areas. Treatment plants for municipal sewage and livestock waste have been installed upstream of these reservoirs.

Of the total pollution load of South Korea's rivers and streams approximately 70% comes from sewage and 30% from industrial wastewater (in terms of BOD contribution). Thus, the preservation of the water quality in rivers and streams depends more on the treatment of municipal sewage than on industrial wastewater.

In 1976, the first publicly owned municipal sewage treatment plant, the Cheongkyechun Sewage Treatment Plant, was constructed with a treatment capacity of 150,000 tons per day. In 1981, four other treatment plants in 3 cities were operating treating a total of 822,000 tons per day. By the end of 1990, 31% of the population were already serviced by sewerage systems and 18 cities had sewage treatment plants with a daily total treatment capacity of 5,393,000 tons.

To compensate for the still insufficient number of sewage systems and treatment facilities, night soil amounting to 13,112 kg per day was treated at 154 night soil treatment plants by the end of 1990. About 18,000 small-scale treatment plants were operated in large buildings, and about 1,331,000 additional septic tanks for households were installed and operated. The water quality standards maintained for all night soil, sewage and final industrial wastewater treatment plants are given in Table 4.6.1.

Table 4.6.1 Korea: Water Quality Standard Discharged for Waters from Treatment Plant.

(unit; mg/L)

Treatment plant	BOD	COD	SS	others
Night soil	≤40	-	≤70	
Sewage	≤30	-	≤70	
Final industrial wastewater	≤30	≤50	≤70	
				pH 5 - 9 n-hexane extracts; mineral oil ≤5 animal and vegetable oil ≤30 Phenols ≤5 CN ≤1 Cr ≤2 Fe ≤10 Zn ≤5 Cu ≤3 Cd ≤0.1 Hg ≤0.005 Organic P ≤1 As ≤0.5 Pb ≤1 Cr(VI) ≤0.5 Soluble Mn ≤10 F ≤15 PCB ≤0.003 Temperature ≤40°C

Table 4.6.2 Korea: Number of Firms Discharging Wastewater and Volume of Wastewater.

	'85	'86	'87	'88	'89	'90
No.of firms	7,375	7,900	8,570	9,522	11,203	13,504
Volume of wastewater (thousand m^3/d)	3,109	4,487	4,603	5,783	6,497	7,280

The government will now construct additional sewage treatment plants in urban areas. The coverage of the sewerage system and provision of treatment in the country will be increased upon completion of these projects to service about 75% of the population by the year 2000.

In rural areas, improperly treated livestock wastes are major sources of pollution. Large-scale livestock farms are now required to treat their wastes under current laws. However, livestock wastes from small-scale farms and individual farm households are not subject to any regulation. Thus, the greater part of wastes from these farms are not treated. The government is now planning to construct collective treatment plants for wastes from these small livestock farms.

Throughout the country, approximately 7,280,000 tons of wastewater are discharged daily from 11,200 point sources (see Table 4.6.2). The Regional Offices of the ME and those from local government periodically inspect these point sources to check their pollution control systems and to monitor their effluents for conformance with the regulatory standards (Table 4.6.3).

Individual firms may be subject to one of the four different levels of government regulation on the basis of the treatment effectiveness of their facilities. Accordingly, there are four different categories of industrial firms. Each of these groups is given unique color identification as follows:

Blue firms - possessing excellent treatment facilities (are eligible for various benefits including loans on concessional terms);
Green firms - possessing good facilities, but operation of the process(es) is inadequate (need continuous technical guidance);
Yellow firms - possessing facilities which need intensive supervision; and
Red firms - possessing defective facilities (the establishment of appropriate pollution-control facilities are required).

To ensure the efficient treatment of highly contaminated industrial wastewater at the six major industrial sites, the government has installed and operated treatment plants since 1984. While the government supports the costs associated with the installation of these facilities, the industries themselves are responsible for operational costs. A public corporation, the Environmental Management Corporation, is in charge of operating these plants. In these plants, the effluent standards applied are those given in Table 4.6.1.

Since 1980, the government of South Korea has applied a number of different principles and mechanisms to protect the environment. Some have proven to be effective, but others were ineffective for several reasons. The major mechanisms which were used for environmental management efforts are described below.

Table 4.6.3 Korea: Effluent Standard of Industrial Wastewater.
a) BOD, COD and SS (unit; mg/L)

Item	Not less than 3,000 m^3/day				Less than 3,000 m^3/day			
	I	II	III	IV	I	II	III	IV
BOD	≤50	≤80	≤100	≤30	≤50	≤100	≤150	≤30
COD	≤50	≤80	≤100	≤50	≤50	≤100	≤150	≤50
SS	≤50	≤80	≤100	≤70	≤50	≤100	≤150	≤70

Note: I; For wastewater to be discharged to public receiving waters,in which water quality of Class I of the Environmental Water Quality Standard should be maintained.
II; For wastewater to be discharged to public receiving waters,in which water quality of Class II of the Environmental Water Quality Standard should be maintained.
III; For wastewater to be discharged to public receiving waters,in which water quality of Class III, IV and V of the Environmental Water Quality Standard should be maintained.
IV; For wastewater to be discharged in industrial estates and rural and industrial parks,at which final treatment plants are installed.

b) Phenols, etc. (unit; mg/L)

Parameter	I	II	III	IV
pH	5.8 - 8.6	5.8 - 8.6	5.8 - 8.6	5.8 - 8.6
n-Hexane Ext.	≤1*/<5**	≤5*/<30**	≤5*/<30**	≤5*/<30**
Phenols	≤1	≤5	≤5	≤5
CN	≤0.2	≤1	≤1	≤1
Cr	≤0.5	≤2	≤2	≤2
Soluble Fe	≤2	≤10	≤10	≤10
Zn	≤1	≤5	≤5	≤5
Cu	≤0.5	≤3	≤3	≤3
Cd	≤0.02	≤0.1	≤0.1	≤0.1
Hg	ND	≤0.005	≤0.005	≤0.005
Organic P	≤0.2	≤1	≤1	≤1
As	≤0.1	≤0.5	≤0.5	≤0.5
Pb	≤0.2	≤1	≤1	≤1
Cr (VI)	≤0.1	≤0.5	≤0.5	≤0.5
Soluble Mn	≤2	≤10	≤10	≤10
F	≤3	≤15	≤15	≤15
PCBs	ND	≤0.003	≤0.003	≤0.003
E.coli	≤100	≤3,000	≤3,000	≤3,000
Color	≤200	≤300	≤400	≤400
Temp.	≤40	≤40	≤40	≤40
T-N	≤30	≤60	≤60	≤60
T-P	≤4	≤8	≤8	≤8
Trichloroethylene	≤0.06	≤0.3	≤0.3	≤0.3
Tetrachloroethylene	≤0.02	≤0.1	≤0.1	≤0.1

Note: 1, *; mineral oil, **; animal &vegetable oil
2, Color is applied to only a textile firm
3, T-N and T-P is going to be applied to the wastewater discharged to the "special water pollution protection areas" from Jan. 1, 1996
4, Trichloroethylene and tetrachloroethylene are going to be applied from Jan. 1,1993.

The Environmental Impact Assessment (EIA) is a very important mechanism for the prevention of possible environmental disruption from development projects. The EIA was first introduced in South Korea in 1981. According to the original system adopted by the Environmental Preservation Act, for certain major projects by the national or local governments, the developer had to prepare an Environmental Impact Statement (EIS) and submit it to the Environment Administration (the present ME) for consultation. The Administration could request the government agencies to ameliorate possible environmental problems or hazards. However, the government agencies which pursued major projects such as construction of highways, multi-purpose hydrodams, and housing projects, generally had more influence on governmental decision-making, thus weakening the effectiveness of the EIA/EIS system. In addition, there were many loopholes arising from the non-inclusion of non-governmental entities and projects in the EIA/EIS system.

The Environmental Preservation Act was amended in 1986 to include non-governmental projects in the EIA/EIS system. From 1987, major development projects by the private sector have been required to submit an EIS before final approval of their projects was granted by relevant agencies of the government. The main problem seen at that time in relation to the EIA/EIS system was that public participation was not required in the process. The recently enacted Basic Environmental Policy Act remedied this problem by bringing EISs to public notice and public hearings in certain cases. Also in January 1990 the Environmental Administration was elevated to a Ministry. As a result, it is now in a position to request other agencies to take remedial measures or even to stop construction of projects not undertaken in accordance with the approved EISs. It is now anticipated that the EIA/EIS system will become an effective tool for the realization of ecologically sustainable development.

The Ministry of Environment maintains extensive environmental monitoring systems for air and water pollution. There are 1025 water quality monitoring sites sampled by manual procedures in the major rivers and major lakes in the country. Of these, 640 and 142 sites are located in the major river basins and major lakes, respectively.

Parameters measured monthly are pH, DO, BOD, SS, *E.coli*, total-P, total-N, phenols, temperature, conductivity, and fluorine, while Cd, CN, Pb, As, Hg, ABS, Cu, and Cr(VI) are determined quarterly. PCB and organic-P are measured annually. There is no automated monitoring system yet, but ME plans to install bio-metering devices at 18 major sites to monitor spills of hazardous waste into rivers and lakes.

An effluent charge system is now widely used as a legal sanction for firms that violate environmental regulations. Some criminal penalties are also levied for the violation of environmental statutes. It is now recognized that the effluent charge system is more appropriate as an enforcement mechanism. A corollary principle used under this system is "the more one violates, the more one pays".

The government is now considering the introduction of an environmental charge system. This will levy a certain rate of tariff on consumer goods or consumer activities which pollute the air, water or soils. The revenue earned by the government will be used in the construction of sewage treatment facilities and other basic facilities for environmental protection.

The Ministry of Environment has primary responsibility for the management of the environment and environmental protection. The organizational structure of the Ministry is shown in Fig.4.6.1. In 1990, the national offices and bureau had a total of 382 officials, with 40 working at the Water Quality Management Bureau. The Ministry has six Regional Environmental Offices. A total of 649 officials work at the six regional offices.

At the local government level, there are five cities and a special municipality under the control of the central government, and nine provinces which have a Division of Environmental Protection and a Division of Enforcement in charge of environmental protection, including water pollution control. Under these local government organizations there are about 250 Urban and County Districts which also have a Division of Environmental Protection in charge of environmental protection in their own districts.

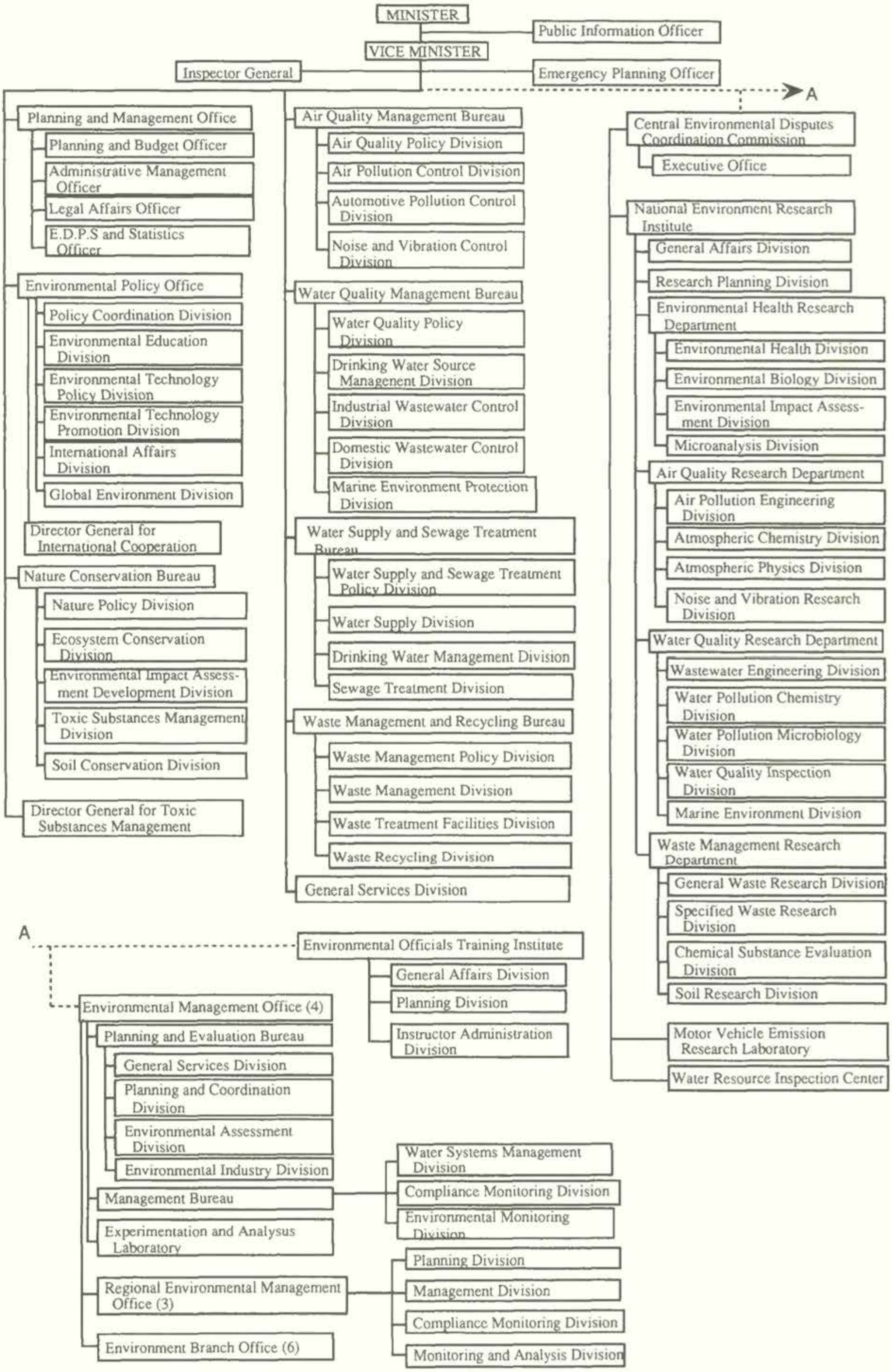


Fig.4.6.1 Korea: Organizing Structure of the Ministry of Environment.

4.7 Japan

Japan has a long and rich experience in controlling and abating river water pollution. In the 1950s, in response to the many concerns raised relating to industrial pollution, local ordinances were enacted to enable local government to take measures against water pollution. In 1958, the central government promulgated two laws on water pollution control. One dealt with water quality protection in public water areas while the other was a law regulating effluents from factories. These two laws, however, were not sufficient to prevent water pollution. The regulations were applied only to some designated water areas.

In 1967, the government enacted the Basic Law for Environmental Pollution Control to promote comprehensive measures against various forms of environmental pollution. In 1970, the so-called "pollution Diet" adopted several environmental laws to reinforce laws on environmental pollution control. Several old laws were unified in the form of a new reinforced Water Pollution Control Law. The national government then set the Environmental Quality Standards and the Effluent Standards, and enacted or revised other laws related to water quality management (see Fig.4.7.1). Local governments have likewise enacted many laws and regulations for their specific areas of concern.

The Environmental Water Quality Standards were first established by a Cabinet decision in 1970. These standards are divided into two types - those that need to be achieved and maintained to protect human health and those that need to be achieved and maintained to conserve the living environment (refer to Table 2.7.1). The standards set are almost equivalent to drinking water quality standards with regard to the items related to the protection of human health. Standards relating to the protection of human health are applied as minimum criteria nationwide, while those relating to the conservation of the living environment are set for each category according to water usage, the level of pollution, and other factors. Prefectural governments are responsible for setting standards for water bodies in their respective areas except for the 47 inter-prefectural water bodies administered by the national Environment Agency. Prefectural governments also have the power to establish standards more stringent than the national standards when the latter are not enough to conserve the water quality of public water bodies within their area of jurisdiction. Effluent standards have also been set to control discharges into public waters by factories or establishments which have specified facilities (see Table 4.7.1).

In general, measures taken by the national and prefectural governments to control water pollution and maintain the water quality of water bodies within the set standards include strict regulation of discharges, expansion and improvement of sewerage systems and treatment facilities, river flow improvement and dredging, and environmental impact assessment of new projects and facilities. A typical river water management practice at the prefectural level will be presented later using the experience of Kanagawa Prefecture.

The administration of water quality management in Japan is handled by the Environment Agency which was established in 1971 as a ministry. The Director General of the Agency is a Minister of State who is a member of the Cabinet. The Agency is responsible for the coordination and promotion of the protection of the environment as well as the implementation of pollution control. An organizational chart of the Agency is shown in Fig.4.7.2.

In the field of water quality management, the main role of the Agency is as follows: enforcement of the Water Pollution Control Law and some other laws relating to water quality management; establishment and amendment of the standards including the Environmental Water Quality Standards and the national Effluent Standards; and the promotion of research for water pollution control.

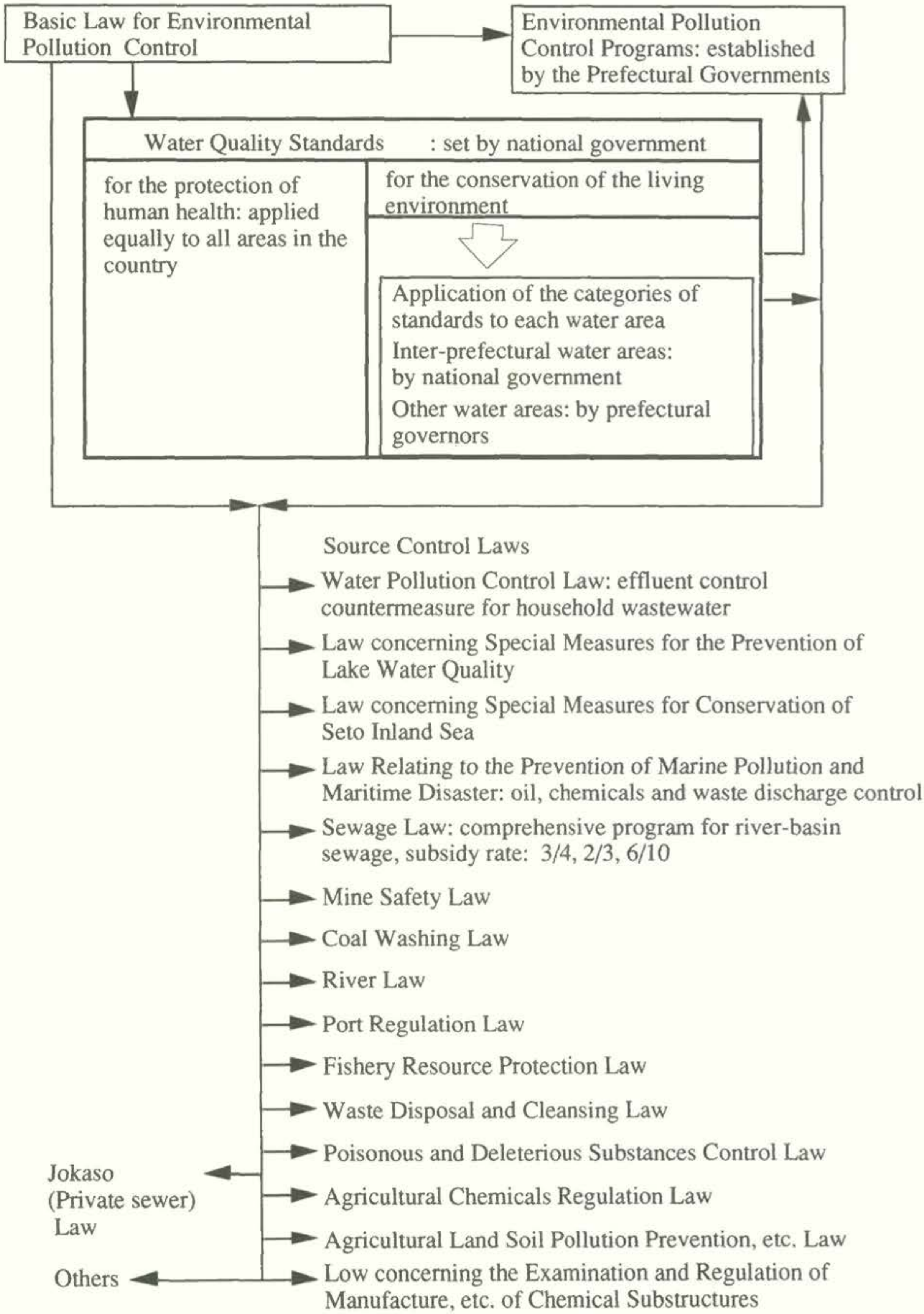


Fig.4.7.1 Japan: Legal System for Water Quality Management.

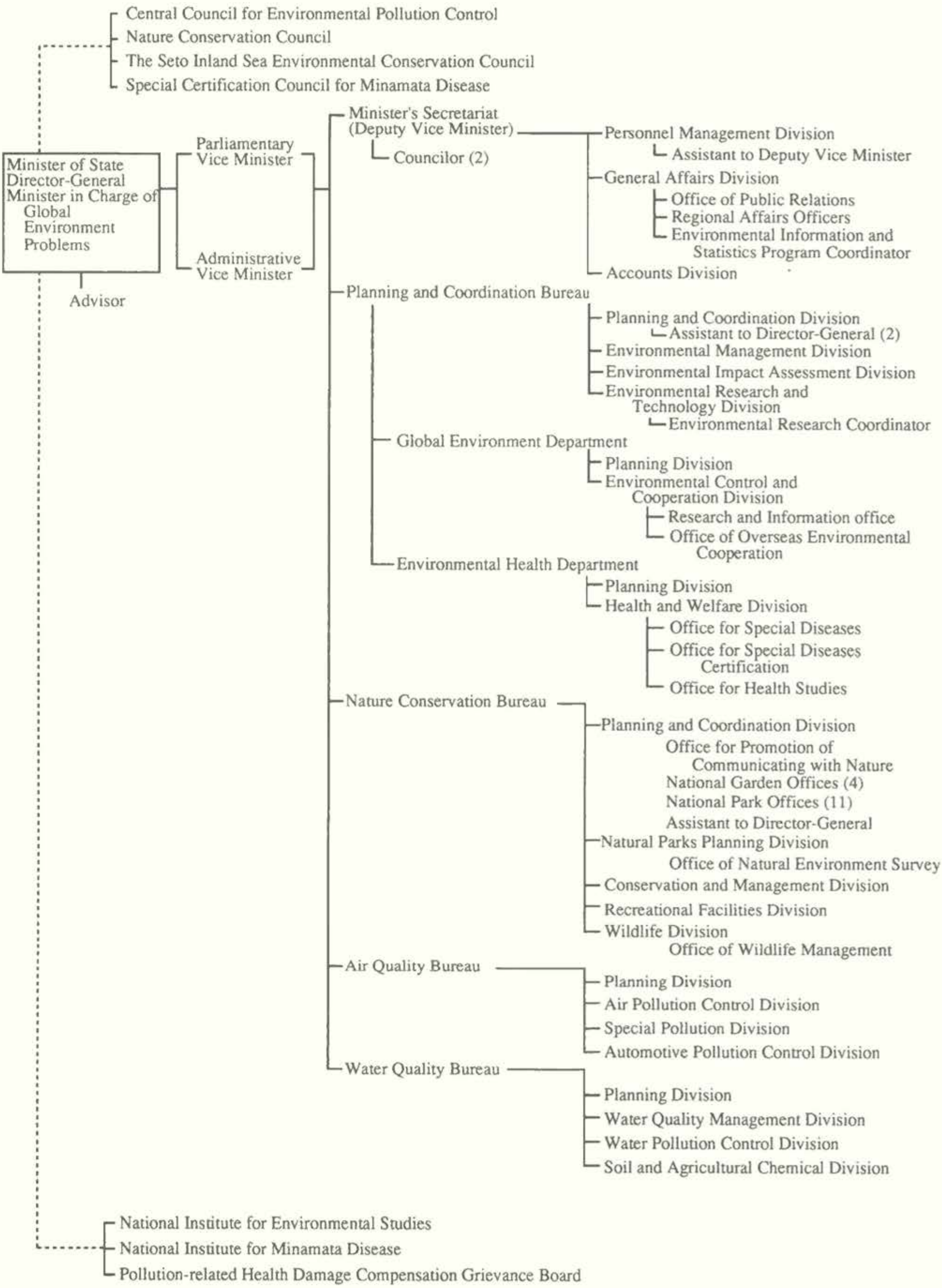


Fig.4.7.2 Japan: Organization of the Environment Agency.

Table 4.7.1 Japan: National Effluent Standards for Rivers (mg/L or less).

a) Standards related to the preservation of the living environment (mg/L or less except pH)

Parameters	Standard Values
pH	5.8 - 8.6
	5.0 - 9.0 (for estuaries)
BOD, COD*	160 (daily average: 120)
SS	200 (daily average: 150)
n-Hexane extract	5.0 (mineral oil)
	30 (animal fat and vegetable oil)
Phenols	5.0
Cu	3.0
Zn	5.0
Dissolved iron	10.0
Dissolved manganese	10.0
Cr	2.0
F	15.0
Number of coliform groups	3,000/mL (daily average)
Nitrogen	120 (daily average: 60)
Phosphorus	16 (daily average: 8)

* COD is applied to lakes and estuaries

b) Standards related to the protection of human health (mg/L or less)

Parameters	Standard Values
Cd and compounds	0.1
CN and compounds	1.0
Organic phosphorus (Parathion, Methylparathion, Methyl dimethion and EPN)	1.0
Pb and compounds	0.1
Cr (VI) and compounds	0.5
As and compounds	0.1
Hg (total)	0.005
Hg (alkyl)	ND.
PCBs	0.003
Trichloroethylene	0.3
Tetrachloroethylene	0.1
Dichloromethane	0.2
Carbon tetrachloride	0.02
1,2-dichloroethane	0.04
1,1-dicloroethylene	0.2
cis-1,2-dichloroethylene	0.4
1,1,1-trichloroethane	3
1,1,2-trichloroethane	0.06
1,3-dichloropropene	0.02
Thiuram	0.06
Simazine	0.03
Thiobencarb	0.2
Benzene	0.1
Selenium and compounds	0.1

Some ministries of the national government also have responsibilities related to water quality management. The Ministry of Health and Welfare is responsible for waste disposal and night soil treatment as well as for the protection of the drinking water system. The Ministry of International Trade and Industry is responsible for research on environmental conservation and technology and the promotion of various environment-friendly industries. The Ministry of Transport is in charge of the prevention of marine pollution by shipping. The Ministry of Construction is responsible for the sewerage system and for flood control and river flow management systems. Other ministries with responsibilities related to water quality management are the Ministry of Agriculture, Forestry and Fisheries and the Ministry of Foreign Affairs.

Prefectural governments are also playing very important roles in environmental water quality management. Their responsibilities include establishing more stringent standards, as mentioned earlier; inspection of specified factories and regulating the effluents discharged by those firms; and establishing and implementing the environmental water quality monitoring program in their localities.

Aside from prefectural governments, city governments in 71 cities specified in the Water Pollution Control Law as "designated cities" are empowered to inspect and regulate the effluent discharges of factories in their respective areas. To illustrate the water quality management practices of Japan's prefectural governments, the experience in Kanagawa Prefecture is included in this chapter.

Kanagawa Prefecture is located immediately to the south of Tokyo and is part of the national capital region (see Fig.4.7.3). It is one of the smallest of Japan's 47 prefectures but has the third largest population, centered in Japan's third largest city, Yokohama. Kanagawa has three international ports and thousands of industries, especially the so-called high-tech ones, located within its boundaries.

Kanagawa was among the first prefectures to handle industrial pollution control. An Antipollution Center, later renamed as the Environmental Research Center (ERC), was established by the prefectural government. The ERC is entrusted with tasks related to water quality management such as monitoring of water bodies, inspection and regulation of industrial effluents, research to improve or enhance pollution control measures and others.

The government of Kanagawa had enacted a Prefectural Ordinance to Prevent Pollution, a Density Regulations Ordinance and a Total Pollution Load Regulation Ordinance. Its Effluent Standards are more stringent than the national standards (see Table 4.7.2). The prefectural government, through the ERC, has also established a regular monitoring program of all public waters, including groundwater, in the prefecture. Monitoring points, monitoring paramenters and monitoring frequencies are given in Tables 4.7.3 and 4.7.4 and in Figs.4.7.4 and 4.7.5.

Pollution control measures undertaken by the prefectural government are as follows: regulating factories based on laws and ordinances; maintenance and construction of additional sewerage and sewage treatment systems; aeration of Sagami Lake; water quality purification in waterways; and control of pollution from new high-tech industries.

Reports which indicate pollution control plans and measures are required for all establishments discharging effluents into public water bodies. Such reports are examined, and the establishments inspected by the government through the ERC, before operating approval is given. Administrative disposition or guidance has been used to correct pollution problems by those establishments found violating the set standards for effluents.

Table 4.7.2 Japan: More Stringent Effluent Water Quality Standards by Kanagawa Prefectural Government: General Standards.

Parameters	"A" area	"B" area	Sea	National Effluent Standards
Cd & its compounds	ND	/	/	0.1
CN compounds	-	/	/	1
Organic phosphorus compounds	ND	0.2	0.2	1
Pb and its compounds	0.05	/	/	0.1
Cr (VI)	0.05	/	/	0.5
As and its compounds	0.01	/	/	0.1
Hg (total)	/	/	/	0.005
Hg (alkyl) compounds	/	/	/	ND
PCBs	/	/	/	0.003
Trichloroethylene	/	/	/	0.3
Tetrachloroehtylene	/	/	/	0.1
Dichloromethane	/	/	/	0.2
Carbon terachloride	/	/	/	0.02
1,2-Dichloroethane	/	/	/	0.04
1,1-Dichloroethylene	/	/	/	0.2
cis-1,2-Dichloroethylene	/	/	/	0.4
1,1,1-Trichloroethane	/	/	/	3
1,1,2-Trichloroethane	/	/	/	0.06
1,3-Dichloropropene	/	/	/	0.02
Thiuram	/	/	/	0.06
Simazine	/	/	/	0.03
Thiobencarb	/	/	/	0.2
Benzene	/	/	/	0.1
Selenium and compounds	/	/	/	0.1
pH	/	/	5.8 ~ 8.6	5.8 ~ 8.6 R.&L. 5.0 ~ 9.0 Sea
BOD	15 (10)	25 (20)	/	160 R.& L.
COD	15 (10)	25 (20)	25 (20)	160 Sea
SS	35 (20)	70 (40)	70 (40)	200
n-Hexane extracts (mineral oil)	3	/	/	5
do. (animal fat & vegetable oil)	3	5	5	30
Phenols	0.005	0.5	0.5	5
Cu	1	1	1	3
Zn	1	1	1	5
Dissolved iron	0.3	3	3	10
Dissolved manganese	0.3	1	1	10
Cr	0.1	/	/	2
Fl	0.8	/	/	15
Number of coliform group (/ml)	/	/	/	3000
(Ni)	0.3	1	1	/

ND: Not detectable
- : Prohibited to discharge by other Kanagawa Prefectural Ordinances
( ) : Daily average
(Ni): Regulated by other Kanagawa Prefectural Ordinances
R.&L.: Rivers and Lakes

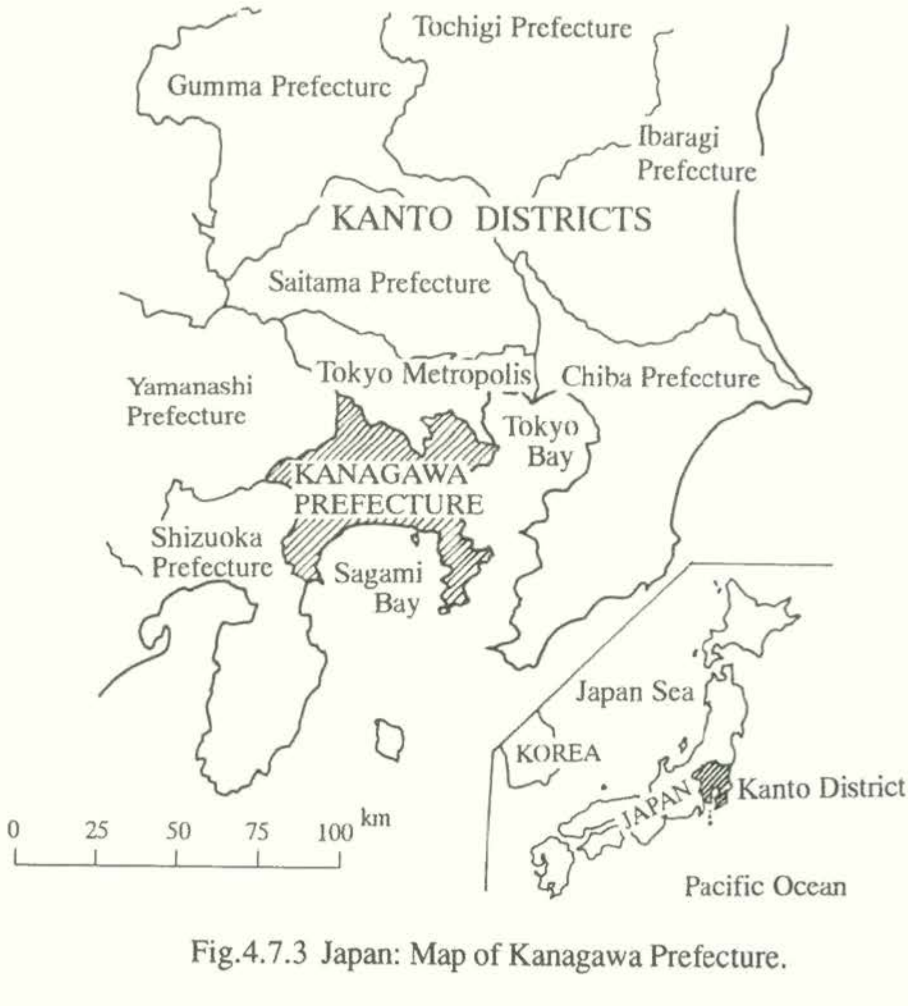


Fig.4.7.3 Japan: Map of Kanagawa Prefecture.

Table 4.7.3 Japan: Monitoring Parameters.

Categories	Parameters
Human health	Cd, CN, Pb, Cr (VI), As, Hg (total), Hg (alkyl), PCBs, Trichloroethylene, Tetrachloroethylene, Dichloromethane, Carbon tetrachloride, 1,2-Dichloroethane, 1,1-Dichloroethylene, Cis-1,2-Dichloroethylene, 1,1,1-Trichloroethane, 1,1,2-Trichloroethane, 1,3-Dichloropropene, Thiuram, Simazine, Thiobencarb, Benzene, Selenium and compounds,
Living environment	pH, BOD, COD_{Mn}, SS, DO, Number of Coliforms, n-Hexane extracts, Total nitrogen, Total phosphorus
Special items	Phenols, Copper, Zinc, Dissolved ion, Dissolved manganese, Chromium, Fluorine, Nickel, ENP
Other items	Ammoniacal nitrogen, Nitrite, Nitrate, Phosphorus, Chloric ion, Salts, 1,1,1-Trichloroethane, Anionic surfactant, Chlorophyl a
Physical items	Weather, Weather of previous day, Water depth, Sampling depth, Water flow rate, Flow, Atmospheric temperature

Table 4.7.4 Monitoring Frequency of Water Quality in Rivers, Lakes and Seas Inplemented in Kanagawa Prefecture.

Site	Frequencies
River	4 times a day at 6 hourly intervals each month and 48 times (12 days) a year
Lake and Sea	Once a day from the upper and the lower layers of water each month and 12 times a year

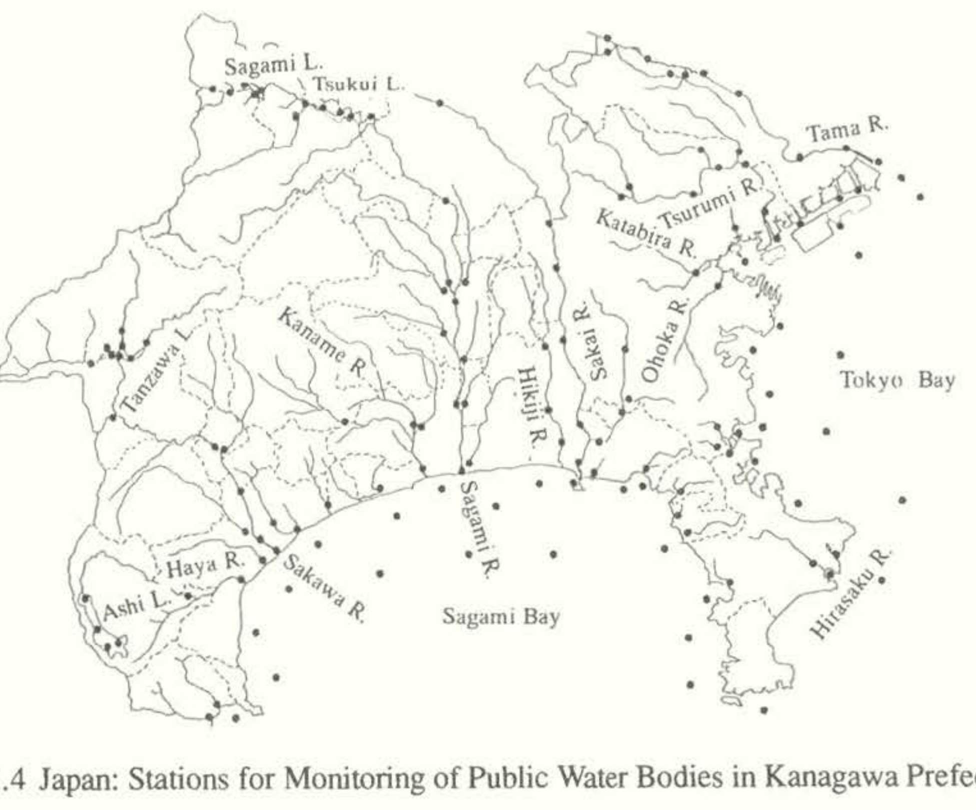


Fig.4.7.4 Japan: Stations for Monitoring of Public Water Bodies in Kanagawa Prefecture.

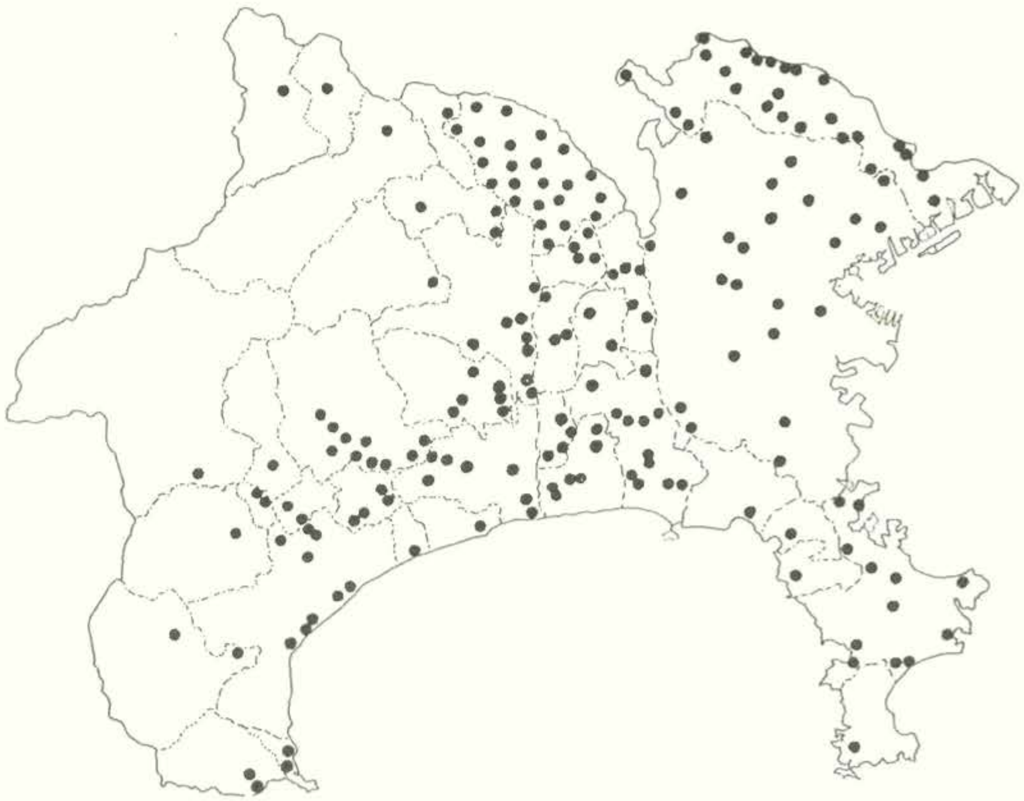


Fig.4.7.5 Japan: Stations for Monitoring of Ground Water in Kanagawa Prefecture.

To support the governmental system of environmental guidance and regulation of industries, the government has instituted a system of Pollution Control Officers (PCO) in all designated industries. The PCOs have been given the task of supervising the control of pollutants in the plants, more specifically to ensure that effluents released to water bodies are within the set standards. To become a PCO, one has to pass a qualifying examination administered by the Ministry of International Trade and Industry. There are several levels of PCOs ranging from supervisors to managers of different staff which are designated by the firms, especially in large establishments, to handle pollution control. The prefectural government institutes educational meetings yearly or more frequently for lower-level PCOs, to update their knowledge and skill in pollution control.

The prefectural government has been constructing and maintaining sewerage systems, treatment plants and special tanks for night soil and household wastewater to control pollution from domestic sources. To date, 79.4% of the population is served by a sewerage system. The cities of Yokohama and Kawasaki are almost completely sewered.

The government of Kanagawa, through the ERC, has also started studying and monitoring chemical pollutants from high-tech industrial firms such as those engaged in electronics, new materials technology and biotechnology. The government has given guidance and information on the safe use of some chemicals used in these plants. The monitoring of some chemical substances, such as tetrachloroethylene which penetrates the soil and accumulates in the groundwater, had also been conducted by the ERC. Research on how the pollutants are produced and proper disposal procedures is conducted on these chemical pollutants.

The efforts of the prefectural government in Kanagawa have produced positive results. The water quality of public water bodies in this area has been improving. The health of the people has been protected and the living environment has been conserved.

CHAPTER 5

HUMAN RESOURCE REQUIREMENTS FOR RIVER WATER QUALITY MANAGEMENT

Most Asian countries lack a core of trained manpower to work on the many aspects of environmental management. This is one of the difficulties often cited by experts as well as government leaders when they are asked about the capability of their countries to cope with growing environmental problems. It may be assumed that this condition also holds true in the area of river water quality management.

Knowing this general condition may not be enough for those of us interested in promoting the development of human resources for environmental management specifically in river water quality management. We need to make an assessment of the human resource component of river water quality management systems in each country of concern. These detailed assessments are necessary to be able to pinpoint the exact location of gaps in manpower, and assess strengths and weaknesses in the existing management systems, so as to be able to propose ways by which the deficiencies may be remedied. This chapter will deal with the human resource requirements for river water quality management in the ASEAN countries involved in this project.

5.1 Methodology and Criteria

We will present in this section our proposed methodology and criteria for estimating the gap in human resources for the proper conduct of river water quality management in each of the countries of concern.

The basic approach is to assess the difference between an intended human resource level and that which presently exists. In quantitative terms, this difference reflects the number of personnel required to complete a set of positions in the policy and implementation stages of specific river water quality management systems. The qualitative aspects of this assessment highlight the differences between an existing and a required level of performance of functions and tasks, and reflects on the necessary training and/or administrative steps needed to achieve this required level of performance.

The methodology is basically an accounting procedure involving the offices, wastewater treatment plants and analytical service laboratories involved in river water quality management, their personnel, their functions and tasks, and their performance levels. The criteria are the basic assumptions we have made in terms of functions, tasks, and levels of performance to be able to ditermines the required number of personnel, and the educational background and/or training required.

In drawing up the criteria for the assessment of required human resources, we make use of the principles of river water quality management discussed in Chapter 3 of this manual, and some generalizations which can be deduced from the current practices in the different countries as presented in Chapter 4. In most of the countries studied, control and regulation of effluent discharged both from industrial and domestic sources, and the expansion and improvement of sewerage systems and sewage treatment plants are regarded as among the most effective and important measures for water pollution control in rivers. In this light, we will focus on the fields of environmental monitoring; inspection and regulation; operation and maintenance of municipal wastewater treatment plants; management of industrial wastes through a system of Pollution Control Officers (PCOs); and the operation and maintenance of industrial wastewater treatment plants in the private sector.

The general functions and tasks in river water quality management are easily divided into four general function headings, namely:

1) Planning and Management;
2) River Water Quality Monitoring;
3) Industrial Pollution Control ; and
4) Municipal Wastewater Treatment.

These serve as the general criteria for our proposed assessment of the human resources needed in each of the countries we have studied.

Under the general heading Planning and Management are personnel whose functions and tasks include the following:

i) policy and institutional development, wherein legal, regulatory, technical, financial and social factors related to river water quality management are identified and dealt with through policy and/or institutional solutions;
ii) technical functions, wherein water quality assessments are performed and/or analyzed to identify sources of pollution and quantities of pollutants, and wherein waste minimization programs are formulated, and specific technical assistance and training programs are planned and implemented; and
iii) administrative functions, wherein an organizational system to support the efficient management of policy, personnel and resources for river water quality management is set in place.

The extent to which specific functions and tasks are defined under the heading Planning and Management is dependent on the existing water quality condition of rivers, the specific goals set by the central government and the functional capabilities of the implementing institutions in each of the countries.

Planning and management in all countries we have studied are handled by agencies or offices of the government, either at the national or local level, that have river water quality management as their main mandate or as one of their mandates. There are apparently sufficient personnel actively involved in planning and management in all the countries we have studied, since no mention was made in any of the reports regarding gaps in the performance of these two related functions.

The second general heading, River Water Quality Monitoring, may be divided into two task categories; namely, the sampling task and the laboratory determination of water quality parameters. We have to account for the following items in estimating the required personnel for this task: the number of monitoring or sampling stations under four station categories (non-polluted areas, main water intakes, downstream of major sources of pollution, and outlets to the sea); the parameters determined under each sampling station category; frequency of sampling each station; and the number of personnel involved in the sampling process. Items which have to be considered in estimating the required personnel for the laboratory determination of water quality parameters are: the number of analytical laboratories performing the analysis of river water samples; the number of laboratory personnel (chemists, microbiologists and technicians); and the average efficiency or number of samples analyzed per day by each laboratory staff member.

Typical monitoring parameters and frequencies of sampling in each category of sampling stations, based on the GEMS/Water Operational Guide, are given in Table 5.1.1. These may be used as a reference in the assessment of river water quality monitoring needs of each country. The typical workload of analysts presented in Table 5.1.2 is also a useful reference for those laboratories carrying out water quality analysis. The workloads in this table are not typical for developing countries, though, because of the many difficulties faced by laboratories in these countries such as the lack of necessary equipment, chemicals, etc. which cause delays in the laboratory analysis of river water samples.

Table 5.1.1 Monitoring Parameters and Frequencies (example).

Sampling stations / Parameters*	Non polluted areas	Main water intakes	Down stream of major pollution sources	Outlets to sea
Basic	Monthly	Monthly	Monthly	Monthly
Microbial	-	Monthly	-	-
Chemical	-	Annually	Annually	-
Heavy metals	-	Annually	Annually	-
Gauging	Monthly	Monthly	Monthly	Monthly

*Analytes in Each Monitoring Parameter

Parameters		Analytes
Basic	on site	pH, temp., EC, DO, color, transparency
	laboratory	BOD, COD, NH_4-N, TS, hardness
Microbial		Coliforms, SPC (standard plate count)
Chemical		PCB, DDT, BHC, other chlorinated organics
Heavy metals		Mg, Cd, As, Cu, Cr, (CN)

The specific tasks to consider under the general heading, Industrial Pollution Control, are the wastewater treatment and regular monitoring of effluents done by factory personnel, and the regular plant inspections and monitoring of effluents done by personnel from government regulatory agencies. The items to consider in the accounting of human resource requirements for this function are: the number of factories having wastewater effluents, categorized as either small, medium, large or extra large (see Fig.5.1.1); the number of factories with Pollution Control Officers (PCOs); the number of factories with wastewater treatment facilities; and the number of personnel handling wastewater treatment operations in each factory category. Items to include under government inspection and regulation are the number of government inspectors doing plant visits, their average plant visiting schedule (number of visits per year per plant) and the kind of inspection they do or the things they check in their plant visits.

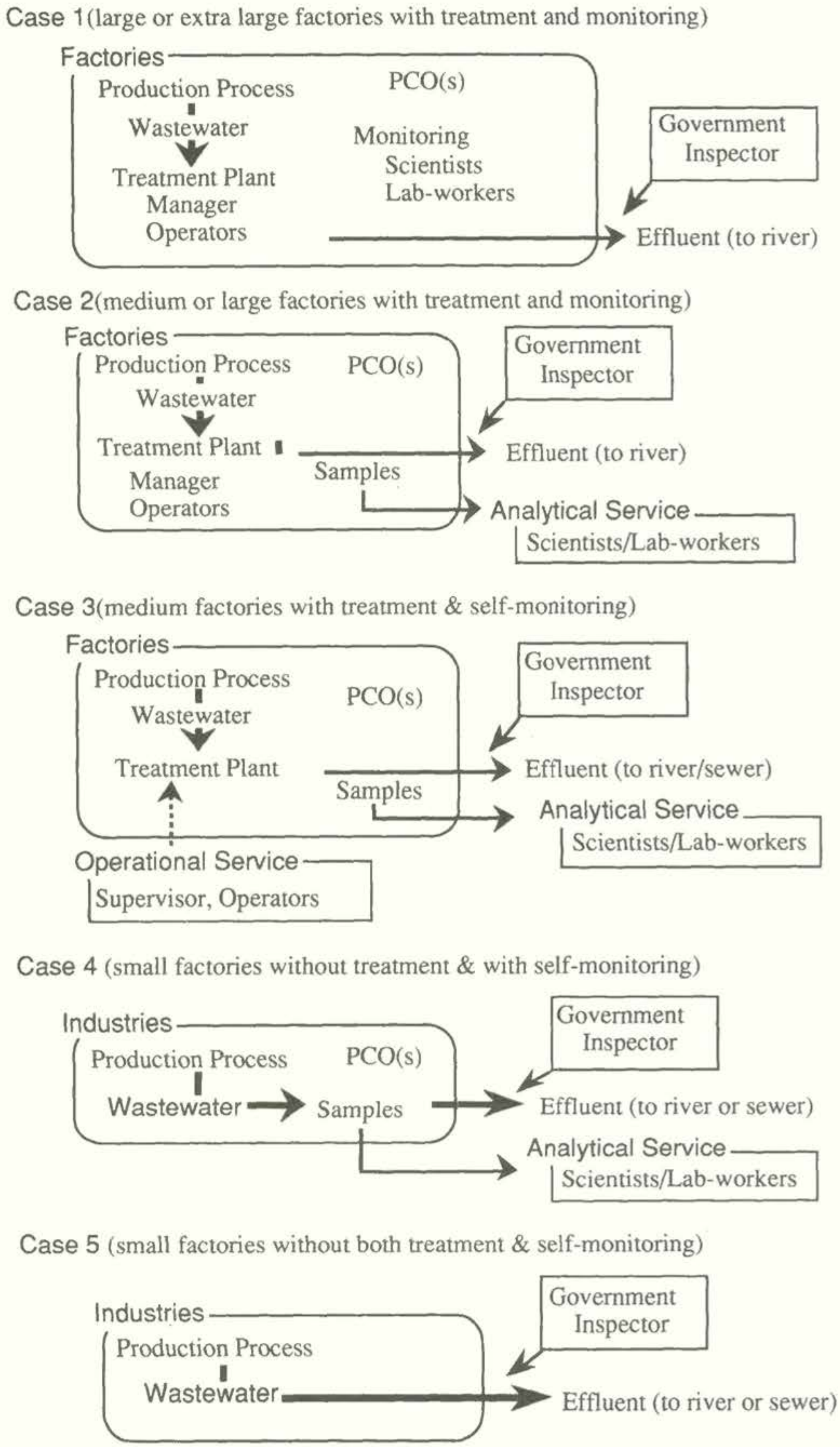


Fig.5.1.1 Human Resource Requirements in Industries and in Government Inspection Units. Industries are Classified Based on Size, Wastewater Treatment and Self-monitoring Systems.

Table 5.1.2 Workload of Analysts in Terms of the Number of Samples per Person per Day (example).

Parameters* \ Qualification	Scientists		Technicians		Sampling & gauging
	Chemistry	Microbiology	Chemistry	Microbiology	
Basic	5	-	5	-	5
Microbial	-	10	-	20	
Chemical	10	-	10	-	
Heavy metals	10	-	10	-	
Gauging	-	-	-	-	

*See Table 5.1.1

Typical source monitoring frequencies for factories with or without wastewater treatment facilities, based on the experience of some developed countries, are given in Tables 5.1.3 and 5.1.4. Typical personnel requirements for wastewater treatment plant operations in developed countries are also given in Table 5.1.5. These tables may be used as references when assessing the capabilities of industrial factories to cope with pollution control requirements and the human resource needed for such operations.

Monitoring of industrial effluents is ideally conducted both by factory and government personnel. While the government monitoring personnel may only be interested in sampling the final effluent, monitoring by industrial plant personnel may include several points in the waste stream before reaching the final effluent so as to check the efficiency of the treatment facility or waste minimization activities. Laboratory analyses of effluent samples are typically done by factory laboratories in large or extra large factories, but this job may be contracted to some private laboratories in the case of small and medium-sized factories. In any case, the items to consider in the assessment of effluent monitoring are similar to those outlined for river water quality monitoring. Compare Tables 5.1.1 and 5.1.3/5.1.4 for example.

Table 5.1.3 Source Monitoring Frequency for the Factories with Wastewater Treatment (example).

Parameters*	Size of plants / Wastewaters	Small ($10\text{-}50m^3/d$)	Medium ($51\text{-}500m^3/d$)	Large ($501\text{-}5000m^3/d$)	Extra-Large ($5001< m^3/d$)
Basic	Organics*2	-	Monthly	Monthly	Weekly
	Heavy metals*3	Quarterly	Monthly	Weekly	Weekly
Microbial	Organics*2	-	Monthly	Monthly	Monthly
	Heavy metals*3	-	-	Monthly	Monthly
Chemical	Organics*2	Annually	Semiannually	Monthly	Monthly
	Heavy metals*3	Quarterly	Monthly	Weekly	Weekly
Heavy metals	Organics*2	Annually	Semiannually	Monthly	Monthly
	Heavy metals*3	Monthly	Monthly	Weekly	Weekly
Gauging	Organics*2	-	Semiannually	Monthly	Daily
	Heavy metals*3	Quarterly	Monthly	Weekly	Daily

*See Table 5.1.1, Wastewaters: *2easily treated, *3including hazardous chemicals

Note: - represents parameters not required to be analyzed

Table 5.1.4 Source Monitoring Frequency for the Factories without Wastewater Treatment (example).

Parameters*	Size of plants / Wastewaters	Small (10- 50m^3/d)	Medium (51-500m^3/d)	Large (501-5000m^3/d)	Extra-Large (5001< m^3/d)
Basic	Organics*3	Annually	Monthly	Monthly	--
	Heavy metals*4	Quarterly	Weekly	--	
Microbial	Organics*3	-	Monthly	Monthly	
	Heavy metals*4	-	Monthly	--	
Chemical	Organics*3	Annually	Semiannually	Monthly	
	Heavy metals*4	Monthly	Weekly	--	
Heavy metals	Organics*3	Annually	Semiannually	Monthly	
	Heavy metals*4	Monthly	Weekly	--	
Gauging	Organics*3	-	Semiannually	Monthly	
	Heavy metals*4	Monthly	Weekly	--	

*See Table 5.1.1.

Note: - represents parameters not required to be analyzed and slanting lines out of consideration.

Table 5.1.5 Estimation of Personnel Requirements in Wastewater Treatment Plants for Each Type of Industry (example).

Duties	Size of plants / Wastewaters	Small (< 50m^3/d)	Medium (51-500m^3/d)	Large (501-5000m^3/d)	Extra-Large (5001< m^3/d)
Supervisor*	Organics*3	1/plant	1/plant	1/plant	1/plant
	Heavy Metals*4	1/plant	1/plant	1/plant	3/plant
Operator*2	Organics*3	1/plant	1/plant	3/plant	6/plant
	Heavy Metals*4	1/plant	3/plant	6/plant	12/plant

Qualification: *Diploma or MS, *2 Vocational school, on the job training and trained in training center.
Wastewater: *3 wastewater treated easily, *4 including heavy metals and hazardous chemicals

Municipal wastewater treatment operations are essentially the same as industrial wastewater treatment plant operations in factories having only organic wastes to treat. The items to be considered in the assessment of personnel needs in this area are thus the same as those presented earlier under the heading, Industrial Pollution Control, in Table 5.1.2.

In the following sections, we will present the national assessments of human resource requirements for river water quality management for some countries in the East Asian region. Although some assessments were not as extensive as we wished them to be, the information given in these sections provides an initial estimation of the human resource requirements in the countries participating in this project.

5.2 Malaysia

Malaysia requires a large number of trained personnel for the management of river water quality at present and more in the future. The main goals and policies for river water quality management have been formulated and, based on the assessment of their local experts, seem adequate to meet their requirements. However, it is in the area of implementation, more specifically in the area of river water quality monitoring, industrial pollution control, and the development and implementation of sewage treatment systems where they need to focus more attention.

As mentioned in Chapter 4, the main responsibility for monitoring river water quality rests upon the Department of Environment (DOE), although the Ministry of Health also undertakes monthly monitoring of river water at the main intake points for domestic water, and regular river flow gauging is done by the Drainage and Irrigation Department (DID).

Sampling of river water is carried out regularly by DOE personnel in regional offices. In 1991, a total of 2967 samples were taken by DOE personnel from 555 sampling stations in the 89 river systems being monitored. The distribution of sampling stations and frequency of sampling at each station is given in Table 5.2.1. An averaged frequency of sampling at each type of station is given in Table 5.2.2. At present about 125 of the 490 DOE personnel do river sampling. They basically take samples for laboratory analysis and conduct some on-site determinations of water quality parameters. River water samples are preserved and sent to the Department of Chemistry in Kuala Lumpur for laboratory analysis. The parameters used to determine water quality are given in Table 5.2.3.

On average, 5 samples are taken per site per year and based on the information in Table 5.2.1, only 6 rivers are sampled monthly. The efficiency of sampling operations is probably adequate considering that some sampling sites are located in difficult terrain and are far from the home bases of the DOE personnel, rendering sampling difficult and time-consuming. This means that to support monthly sampling of the sites an additional 125 DOE personnel will be required, of which one-third, i.e. around 40 people, should be adequately trained in river water quality monitoring and analysis.

Laboratory analysis of samples is probably the bottleneck in the river water quality monitoring process in Malaysia. The Chemistry Department which does the analysis of river samples also does all laboratory analysis of samples sent in by all government and quasi-government organizations in Malaysia. In 1990 the Chemistry Department took in about 79,400 samples. While only 4% or fewer of the samples taken in by the Chemistry Department were river water samples from DOE, it took months before the analyses were finished. The already heavy workload of their 200 or so staff, about 50 of whom are analysts and the rest technicians, would probably preclude their accepting more river samples. The alternative is for DOE to form a laboratory unit of its own within or without the Chemistry Department to analyze river and other water samples. This will require adding another 50 DOE laboratory personnel, about 20 of whom should be qualified water analysts.

Pollution control is not yet a norm in many industries in Malaysia. However, the situation is now slowly changing because of stringent environmental regulations imposed by the government, tax incentives and grants, and the development of privately operated pollution control or wastewater treatment systems set up by some large organizations.

As such, estimates of human resource requirements for industrial effluent treatment operations should be based on the total number of factories, or more appropriately on the projected total number of factories to be established within the next few years. The use of such a basis is also justified by a lack of information on the wastewater treatment activities in industries in Malaysia.

Table 5.2.1 Malaysia: Water Quality Monitoring Stations by State, 1991.

State	WQR	River Basin	Number of Stations	Sampling Frequency
Perlis	1	Perlis	5	6
	2	Kuar	0	0
Kedah	3	Kedah	12	6
	4	Merbok	7	6
	5	Muda	8	12
Pulau Pinang	6P	Prai	8	12
	6J	Juru	5	6
	7	Jejawi	4	6
	8	Kerian	3	6
Perak	9	Kurau	4	6
	10	Sepetang	8	6
	11	Bruas	2	6
	12	RajaHitam	3	6
	13	Perak	28	2
	14	Bernam	6	2
Selangor	15	Tengi	1	6
	16	Selangor	6	6
	17	Buloh	5	6
Federal Territory (KL)	18	Kelang	22	12
	19	Langat	11	6
Selangor	20	Sepang	4	6
Negeri Sembilan	21	Binggi	15	12
Melaka	22	Malaka	8	6
	23	Duyong	2	6
	24	Kesang	3	6
Johor	25	Muar	16	6
	26	Batu Pahat	12	6
	27A	Air Baloi	3	4
	27B	Benut	6	6
	28A	Pontain Besar	5	4
	28B	Pontian Kecil	2	4
	28C	Skudai	10	12
	28D	Tebrau	4	4
	29	Johor	16	6
	30A	Sedili Besar	9	4
	30B	Sedili Kecil	4	6
	31	Mersing	2	4
	32	Endau	10	6

Table 5.2.1 Malaysia: Water Quality Monitoring Stations by State, 1991 (continued).

Pahang	32	Anak Endau	2	5
	32/33	Pontian	5	5
	33	Rompin	5	5
	34	Bebar/Merchong	5	5
	35P	Pahang	25	5
	35B	Bera/Serting	9	5
	35M	Mentiga	3	5
	35L	Lepar/Bekapor	9	5
	35CH	Bertan	10	5
	36	Kuantan	12	5
	37	Balok	5	5
Terengganu	38	Kemaman	8	6
	39	Chukai/Kertih	5	4
	40	Paka	3	4
	41	Dungun	4	6
	42	Ibai/Marang	3	4
	43	Terengganu	6	6
	44	Setiu	2	4
	45	Keluang	0	0
	46	Besut	3	6
Kelantan	47	Kemasin/Senerak	4	4
	48	Kelantan	13	6
	49	Golok	3	4
Sarawak	50	Batang Kayan	4	4
	51	Sarawak/Samarahan	10	12
	52	Batang Sadong	6	4
	53	Batang Lupar	6	4
	54	Batang Saribas	2	4
	55	Kerian	3	4
	56	Batang Rajang	13	4
	57	Batang Oya	3	4
	58	Batang Mukah	4	4
	59	Batang Balingian	2	4
	60	Batang Tatau	1	4
	61	Batang Kemena	3	4
	62	Similajau	1	4
	63	Suai	1	4
	64	Niah	3	4
	65	Sibuti	4	4
	66	Miri/Lutong	4	4
	67	Baram	4	4
	68	Limbang	6	4
	69	Trusan	1	4
	70	Lawas	2	4

Table 5.2.1 Malaysia: Water Quality Monitoring Stations by State, 1991 (continued).

	71	Mengalong	3	6
	72	Padas	7	6
	73	Membakut	1	6
	74	Kimanis	0	0
	75	Papar	1	6
	76	Putatan/Moyong	5	6
	77	Damit/Turan	4	6
	78	Kadamaian	1	6
	79	Bingkongan	2	6
	80	Rakit	0	0
	81	Bengkoka	0	0
	82	Paitan	0	0
Sabah	83	Sugut	8	6
	84	Labok	4	6
	85	Kaya	0	0
	86	Kinabatangan	1	1
	87	Segama	1	6
	88	Silabukan	1	6
	89	Tingkayu	0	0
	90	Kalumpang	1	6
	91	Tawau/Apas	2	6
	92	Merotai Besar	0	0
	93	Umas-Umas	1	6
	94	Brantian	1	6
	95	Kalabakan	1	6

Table 5.2.2 Monitoring Parameters and Frequencies.

Sampling Stations/ Parameters*	Non polluted Areas (control sites)	Main Water Intakes	Downstream of major pollution sources	Outlets to sea
Basic	1 in 6 - 12 months	Monthly	1 in 2 months	1 in 2 - 6 months
Microbial	1 in 6 - 12 months	Monthly	1 in 2 months	1 in 2 - 6 months
Chemical	1 in 6 - 12 months	Monthly	1 in 2 months	1 in 2 - 6 months
Heavy metals	1 in 6 - 12 months	Monthly	1 in 2 months	1 in 2 - 6 months
Gauging	1 in 1 - 6 months	Monthly	1 in 1 - 3 months	-

Note: Groundwater samples are taken as and when necessary to check on microbial counts.

The government has projected that by the year 2000, there will be a total of 20,000 small and medium-scale factories, 3000 large factories and about 150 very large factories operating in Malaysia. The very large factories anticipated are those which will be engaged in shipbuilding, steel milling, and the processing of agricultural products.

Table 5.2.3 Analytes in Each Monitoring Parameter.

Parameters		Analytes
Basic	On-site	pH, temp, DO, conductivity, color, smell
	Laboratory	BOD, COD, NH_4-N, TSS, hardness
Microbial		Total and Fecal Coliforms (SPC)
Chemical		Mostly PCB and chlorinated organics(depending on beneficial uses).
Heavy Metals		Mg, Cd, As, Cu, Pb, Cr, (most of the major metals).

Some experts from Malaysia have suggested that instead of in-house treatment facilities for each small to large factory, one large privately operated treatment facility may be used to serve 100 small and medium-scale factories, or 3 large factories. This will mean establishing about 200 treatment facilities for all the small and medium-scale industries and 1000 treatment facilities for all projected large factories. The very large factories are expected to have their own in-house treatment facilities. (This may be quite a conservative estimate given the rate of industrial grouth in Malaysia.)

The personnel requirements for these treatment plants may be deduced from Table 5.1.5. The 1200 large privately owned treatment facilities will require, at a minimum, 1200 plant supervisors and 4800 plant operators while the 150 very large in-house treatment facilities will require at least 200 supervisors and 1200 plant operators. Since we do not know the types of pollutants to be treated in each of these plants, an average figure, higher than the requirement for an organic wastewater treatment facility but lower than that for a heavy-metal treatment facility in Table 5.1.5, was used in the estimate.

The monitoring of pollution control by these factories will be done as at present by DOE personnel. The DOE has recently recommended increasing its staff by about 1000 technical people. This number would probably be enough to include the 125 people suggested earlier for river water monitoring, the 50 laboratory staff, and the 119 vacant positions that the DOE have not yet filled at present. It is expected that at least half of this number should be technically qualified engineers or science graduates.

For municipal wastewater treatment, a total of 77 treatment facilities are expected to be needed to treat waste in the same number of major towns and cities in Malaysia by the year 2000. At present, the total sewage load in terms of BOD is estimated at 385 tons/day. This is expected to increase to about 480 tons/day assuming the current population growth of 2.4% per annum.

Six previously operating municipal treatment facilities and four more which have recently been built have a total manpower component of 10 managers/supervisors and about 60 plant operators. Adding 67 more plants will mean a requirement of 67 supervisors and 402 plant operators. Just as in the case of industrial wastewater treatment, some of the municipal wastewater treatment facilities will probably be privately owned and operated.

In summary, Malaysia will need at the minimum 1000 new DOE personnel, half of whom should be engineers or science-trained graduates, and a total of 1467 wastewater treatment plant supervisors and about 6402 plant operators for the treatment facilities, whether government or privately owned, to service both industrial and municipal wastewater treatment needs by the year 2000.

5.3 The Philippines

The Philippines lacks trained manpower in many areas of river water quality management. Government agencies in charge of monitoring the water quality of rivers and effluents need more personnel, among other things, for them to be able to perform all their monitoring and regulatory functions. Industries need to increase their trained personnel, as well, for pollution control. More wastewater treatment facilities have to be established and with them a complement of supervisors and trained plant operators should be available.

A system of monitoring river water quality has yet to be set up. The description below is a proposal for such a system, including the manpower requirements of such a plan.

The Philippines has 421 principal rivers whose lengths are less than 100 km. The number of monitoring stations is estimated by assigning one station for every 10 km for rivers in urban areas (see Table 5.3.1), and, for rivers in rural areas, one station for every 50 km length and an additional one (at the mouth) for rivers greater than 50 km in length, or one station if the river is less than 50 km in length. For the whole country, there will be 80 monitoring stations needed for urban rivers and 514 stations for rural rivers.

Table 5.3.1 The Philippines: Ten Highly Urbanized Cities and their Rivers.

Major Cities	Rivers
Metro Manila	Pasing-San Juan-Marikina (28km), Tullahan-Tinajeros (20km), Paranaque-Zapote (10km)
Cebu	Sapangdako (28km), Kotkot (14km), Mananga (14km)
Davao	Talomo (40km), Lipadas (30km)
Zamboanga	assume 50km total length
Bacolod	assume 50km total length
Iloilo	assume 50km total length
Cagayan de Oro	Cagayan (105km)
Angeles	assume 50km total length
Butuan	assume 50km total length
Iligan	assume 50km total length
Gen. Santos City	Silway (50km), Makarbuayan (20km), Little-Lun (68km)

Note: Urban rivers - one station for every 10km length

Rural rivers - The Philippines has 421 principal rivers whose lengths are less than 100km. The estimate of the number of stations was done by assigning stations to a particular river based on the criteria of one station for every 50km of river length plus 1 (at the mouth) or one station if river length was equal to or less than 50km. For the whole country the estimate of the number of stations is given as: Urban rivers - 80 stations; Rural rivers - 514 stations. Total - 594 stations

The monitoring parameters and frequencies for the different types of sampling stations are given in

Table 5.3.2a. The analytes to be determined under each measuring parameter are given in Table 5.3.2b. Based on these criteria the total number of samples per year (assuming a triplicate taking of samples) for the different measuring parameters can be calculated to be about 21,400 for basic tests, 10,200 for microbial tests, and 1300 for chemical and heavy-metal determinations.

These stations are scattered throughout the country and hence could not be easily reached if the personnel doing the sampling were concentrated in just a few locations. The system calls for at least 18 sampling teams, one for each region in The Philippines, each team with at least two people (one chemist and one technician/driver). These sampling teams will take about 5 samples per day, each working day of the year.

Table 5.3.2a The Philippines: Monitoring Paramenters and Frequencies.

Sampling Stations Parameters*	Rural Non pollution Area	Rural Main Water Intake	Outlet to sea	Urban Down stream of major source pollution
Basic	Monthly	Monthly	Monthly	Monthly
Microbial	-	Monthly	Monthly*	Quarterly
Chemical	-	Annually	Annually	Annually
Heavy metals	-	Annually	Annually	Annually
Gauging	Monthly	Monthly	Monthly	Monthly

Note: **during dry season
* Analytes in each measuring parameter

Table 5.3.2b The Philippines: Analytes in Each Monitoring Parameter.

Parameters		Analytes
Basic	on site	pH, temp., EC, DO, color, transparency
	laboratory	BOD, COD, NH_4-N, TS, hardness
Microbial		Coliforms, SPC (standard plate count)
Chemical		PCB, DDT, BHC, other chlorinated organics
Heavy metals		Hg, Cd, As, Cr, (CN)

Table 5.3.3 The Philippines: Workload of Analysts in Terms of Number of Samples per Person per Day (given).

Qualifications Parameters	Scientists		Technicians
	Chemistry	Microbiology	
Basic	5	--	5
Microbial	--	10	20
Chemical	10	--	10
Heavy metals	10	--	10

Table 5.3.4 The Philippines: Corrected Central Government Human Resources Rrquirement for Water Quality Monitoring.

Qualifications Parameters	Scientists		Technicians
	Chemistry	Microbiology	
Basic	18	--	18
Microbial	--	6	6
Chemical	6	--	6
Heavy metals	6	--	6

The laboratory complement for such a system, assuming an average workload for each analyst and technician given in Table 5.3.3, is given in Table 5.3.4. The numbers for Table 5.3.4 were estimated by further assuming that there will be 18 (mostly small) regional laboratories doing the basic and microbial tests, and 6 centrally located ones, being larger and better equipped, handling the chemical and heavy-metal determinations.

The human resource requirements for industrial pollution control are estimated based on the total number and types of factories at present. Table 5.3.5 gives the total and the manufacturing sub-sectoral breakdown of firms now operating in The Philippines.

Table 5.3.5 The Philippines: Manufacturing Sub-Sector Breakdown.

Industries	No. of Large Firms	No. of Small Firms
Food Manufacturing[1]	3,070	30,359
Beverage[1]	103	884
Textile[2]	547	1,316
Leather & Leather Products[2]	561	1,912
Wood & Wood Products[2]	682	2,043
Pulp & Paper[1]	176	145
Chemicals & Plastic Products[2]	716	235
Petroleum Refineries[2]	4	2
Others[3]	5,629	30,254
Total	11,488	67,150

Note: 1.Producing generally predominantly organic wastewater
2.Having heavy metal substances in the wastewater
3.No. of establishments cited are those in the manufacture of tobacco products, clothing, footwear, furniture, etc., having insignificant contributions to water pollution

The suggested human resource requirements for industrial wastewater treatment plant operations are given in Table 5.3.6. Based on the information in Table 5.3.5, there are a total of 3349 factories with organic effluents, while there are a total of 2510 establishments with predominantly heavy-metal-containing effluents. The human resources for industrial effluent treatment in all these factories are thus calculated to be a total of 10,879 supervisors and 28,528 plant operators. It may be assumed that almost 70% of the industrial firms required to have treatment facilities already do so. These complying firms are assumed to have their full complement of manpower for effluent treatment. Therefore, the present total manpower needs of The Philippines for industrial effluent treatment staff remains at about 3264 plant supervisors and 8556 plant operators. The Pollution Control Officer or PCO is assumed to come from the supervisors. There may be additional people, however, who can act as technical consultants to these industrial firms, over and above this staffing complement.

Table 5.3.6 The Philippines: Modified Human Resource Requirements in Wastewater Treatment Plant Operation and Maintenance for Each Type of Industry.

Category	Size of Establishment Type of Wastewater	Large
Supervisor[1]	Organics[3] Heavy Metals[4]	1/plant 3/plant
Operator[2]	Organics[3] Heavy Metals[4]	5/plant 6/plant

Note; 1.Diploma or MSc
2.Vocational school, on the job training
3.Easily treated
4.Including hazardous chemicals

In-house factory personnel to work on sampling the effluents can be estimated also. It is assumed that for large establishments an average of 3 effluent sampling stations are used and that all samples are again taken in triplicate. The numbers of samples taken in all the factories per year are calculated to be about 1.8 million samples for basic tests, about 400,000 samples for microbial tests, about 1 million samples for chemical and heavy-metal determinations and about 2.5 million flow gauging tests. Assuming that a team composed of one chemist and a technician can sample 9 sampling stations per day, it will require a total of about 789 sampling teams to fulfill all the effluent sampling needs of all the factories. Also, assuming that the workloads of industrially based laboratory analysts and technicians are the same as those already presented in Table 5.3.3, the numbers of analysts and technicians carrying out effluent sample analyses can be estimated as given in Table 5.3.7.

Table 5.3.7 The Philippines: Estimate of Human Resource Requirements for the Private Sector Water Quality Monitoring.

Qualifications Parameters	Scientists		Technicians
	Chemistry	Microbiology	
Basic	1422	--	1422
Microbial	--	164	82
Chemical	391	--	391
Heavy Metals	391	--	391

Note; The numbers in Table 5.3.7 represent laboratory personnel either employed full-time by the establishment or contracted outside from private laboratories. Assuming there is a laboratory supervisor for every 5 scientists (chemists and microbiologists) there will be 474 supervisors throughout the country.

The numbers in Table 5.3.7 represent laboratory personnel either employed full-time by the industrial firm or in private laboratories contracted to do wastewater analysis. A laboratory supervisor is normally assigned for every 5 analysts, thus there will be an additional 474 lab supervisors needed.

Again, we assume a 70% compliance by industries at present. This means that only 30% of the numbers given above are required to be trained.

For this total number of firms, there will be a total of 11,488 once-a-year routine inspections by government functionaries (normally before a permit is renewed). Added to these are about 200 more specialized inspections or an average of 2 inspections for every 100 factories per year (based on statistics from the Pollution Adjudication Board) to follow up on complaints or other problems related to wastewater treatment activities in factories. This makes a total of 11,688 government inspections of factories per year. If one inspection team (composed of one engineer and one technician/driver) visits 2 factories in one day, and assuming that this team goes out 4 days in a week, with one day devoted to the writing of reports, the number of inspection teams required to visit all the factories in one year is 28. This team can also do the sampling of industrial effluents as set out above.

The government mandated component of the samples taken during inspections is estimated on an annual basis to be about 20,200 samples for basic and microbial tests, and about 14,300 samples for chemical and heavy metal determinations. The analysis of this number of samples almost doubles the number of laboratory analysts and technicians needed in government-run laboratories presented earlier.

Table 5.3.8 The Philippines: The Ten Most Highly Populated Urban Centers in The Philippines, 1990.

Cities/Metro	1990 Population	Remarks
Manila (Metropolitan)	8 million	16 STP
Cebu (Metropolitan)	1.5 million	3 STP
Davao	1 million	2 STP
Zamboanga	0.5 million	1 STP
Bacolod	0.4 million	1 STP
Iloilo	0.3 million	1 STP
Cagayan de Oro	0.3 million	1 STP
Angeles	0.2 million	1 STP
Butuan	0.2 million	1 STP
Iligan	0.2 million	1 STP
Total=28 STP		

Note; There will be a total of 28 supervisors and 168 plant operators for the municipal sewage treatment plants. Using the ratios derived in industrial pollution control there would be about one sampling team for these 168 operators in the entire Philippines. This is not practical; it is therefore assumed that there will be one sampling team (1 chemist + 1 technician) per STP. Hence there will be 28 chemists + 28 technicians required. Assume the same number of chemists and technicians will be in the laboratory doing the analysis of the samples. It is assumed that these local STP laboratories are supervised by the central government.

In The Philippines there is a need to service all highly populated urban centers with sewerage systems. The ten most highly populated urban centers in The Philippines are given in Table 5.3.8. It is suggested that one treatment plant be established for every community or group of communities in these urban centers having a population of half a million. On this basis we need to have a total of 28 sewage treatment plants.

Assuming that the operation of a municipal treatment facility is the same as that in a large factory, one municipal treatment facility will require 1 supervisor and 6 plant operators, or a total of 28 supervisors and 168 plant operators to work in the projected 28 municipal treatment facilities needed for the country.

Table 5.3.9 The Philippines: Estimation of Human Resource Requirements.

Summary	Estimated	Existing	Gap
Central Government			
Lab. scientific personnel			
(Water quality monitoring)	36		
(Ind. pollution control)	36		
Lab. technician (WQ + IPC)	68		
Lab. supervisor	18		
Inspectors	28		
Inspection-aide/driver	28		
Total	214	262**	
Industry			
Lab. scientific personnel	2,368		
Lab. technicians	2,286		
Lab. supervisors	474		
Sampling chemists	789		
Sampling technicians	789		
WTP supervisors	10,879		
WTP operators	28,523		
WTP consultants	92		
Total	46,200	1/3 of estimate	30,800
Local Government			
WTP supervisors	28		
WTP operators	168		
WTP sampling chemists	28		
WTP sampling technician	29		
Lab. chemists	28		
Lab. technicians	28		
Total	308		308
Grand total	46,722		approximately 31,000

Note: **This number includes personnel at the central office doing the policy studies, formulating guidelines/legislations, and providing secretarial assistance to the Pollution Adjudication Board. The jobs of these personnel are not exclusively for water quality management but include air pollution control and management, environmental impact assessment, etc.

In summary, the estimated total number of personnel needed to effectively manage river water quality in The Philippines is given in Table 5.3.9. The existing government personnel under the Environmental Management Bureau include personnel at the central office doing policy studies, formulating guidelines/legislation, and providing secretarial assistance to the Pollution Adjudication Board. Those assigned in field offices have jobs which are not exclusively for water quality management but also for air pollution control and management, EIAs, etc. It is thus suggested that the estimated number of personnel shown be considered as the minimum number of dedicated water quality personnel needed.

Since a 10% per annum rate of increase in the number of factories is projected for the country, about a 7% increase in personnel numbers will be needed for industrial pollution control in the future.

5.4 Thailand

Thailand, just like Malaysia and The Philippines, does not have enough manpower to implement its river water quality management programs for pollution control from identified point sources.

The four main rivers of Thailand, described in Chapter 2, receive loads of pollutants from various point and non-point sources. Monthly monitoring of these four rivers by personnel from the Water Quality Management Division (WQM), Ministry of Science, Technology, and Environment (MSTE) has given some evidence of the deteriorating conditions (in terms of BOD, DO, and total coliform bacteria) in these waters.

The Water Quality Management program has thus far managed to cope with the task of monitoring the four main rivers for a few basic water quality parameters with a total personnel complement of only 22 people. However, for a more comprehensive assessment of river water quality (that is by increasing the number of sampling stations and increasing the analytes determined to describe river water quality), there is certainly a need to strengthen the manpower capability of Water Quality Management program.

Based on the current water classification of river segments and the lengths of each segment of the four rivers (refer to appropriate sections in Chapter 2), it is necessary to have at least 12 monitoring stations for the Chao Phraya River, 12 for the Chin River, and 4 each for the Mae Klong and Bang Pakong rivers. The numbers of sampling stations to be monitored using the suggested water quality parameters in Table 5.1.1 will require additional manpower: perhaps a little more than double the number of present Water Quality Management program staff (around 30 technically trained samplers and analysts).

Focusing on the manpower requirements for source pollution control activities in Thailand, the human resource requirements for the treatment of effluents from industries, high-rise buildings, hospitals and municipalities are presented below.

Many new factories have been established in Thailand over the last few years and more are expected to be established in the near future. Table 5.4.1 shows that from 1987 the number of factories has been increasing at an annual rate of about 4.2%.

The number of factories required by the Ministry of Industries to control industrial discharges, based on existing regulations, is about 4.1% of the total number of factories in the years 1989, 1990 and 1991. The estimated and projected numbers of factories with wastewater treatment plants of various capacities (see Table 5.4.2) were assessed on the basis of a study of investment costs for new factories. The human resource requirements (plant supervisors and operators) for the given number of industrial wastewater treatment plants may be calculated using the estimates given in Table 5.4.3 on the staff requirements for treatment plants of various sizes. The results of the calculations are given in Table 5.4.4. It should be noted that the tendency for factories to install small treatment plants corresponds to a greater need for junior and senior technician plant operators compared to environmental engineers or scientists.

Table 5.4.1 Thailand: Predicted Cumulative Number of Industrial Factories.

Year	Factories	Factories with Wastewater Treatment Plant
1987	87222	N.A.
1988	91088	N.A.
1989	94772	3705
1990	98995	3982
1991	102723	4458
1996	126003	5154
2001	154559	6321
2006	189587	7754
2011	232552	9511

Note: N.A. - Not available

Source: Factory Control Division, Department of Industrial Factory, Ministry of Industry.

Table 5.4.2 Thailand: Predicted Number of Industrial Wastewater Treatment Plants with Different Capacities.

Capacity (m^3/d)	Number/Year				
	1991	1996	2001	2006	2011
<500	2869	3317	4068	4990	6121
<1000	274	317	390	479	585
<2500	308	357	437	536	658
<7500	377	436	535	656	805
<20000	240	277	340	417	512
<50000	149	172	210	258	318
<100000	194	225	276	338	414
<200000	23	27	33	40	49
<300000	12	13	16	20	25
<400000	12	13	16	20	24

Table 5.4.3 Thailand: Requirements and Criteria for Wastewater Treatment Plant Operator Staff.

Plant Capacity (m^3/d)	Env. Engineer	Env. Scientist	Senior Tech.	Junior Tech.
<500	-	-	-	1
500 to <1000	-	-	1	1
1000 to <2500	-	1	1	1
2500 to <7500	1	1	1	2
7500 to <20000	1	2	2	4
20000 to <50000	1	2	3	6
50000 to <100000	2	4	5	8
100000 to <200000	3	6	8	10
200000 to <300000	4	8	10	12
300000 to <400000	5	10	12	14

Table 5.4.4 Thailand: Predicted Cumulative Requirements for Environmental Operators of Industrial Wastewater Treatment Plants.

Year	Env.Eng	Env.Sci	Senior Tech.	Junior Tech.
1991	1331	2593	3304	8153
1996	1533	2987	3807	9411
2001	1880	3662	4668	11539
2006	2307	4494	5729	14157
2011	2830	5513	7026	17368

The high-rise building is another point source of a considerable amount of organic pollutants. High-rise buildings in Bangkok are normally used as offices, supermarkets, movie theaters or a combination of any of these uses. There is a rapid increase in high-rise buildings in Bangkok as shown in Fig.5.4.1. The projections beyond the present were based on an analysis of building sizes and cost of land, which is increasing each year. High-rise buildings are required to have their own wastewater treatment facilities and, as might be expected, these are small. In terms of human resources required to operate these treatment plants, we may assume that only one senior technician is needed per treatment plant. This means then that the current and projected numbers of high-rise buildings correspond also to the total number of senior technicians required to operate the treatment facilities.

Another type of big facility required by law to control its effluent discharges is hospitals with more than 10 beds. Since there are no sewerage systems yet in place where they are located, they have to construct their own treatment facilities.

The current and predicted numbers of hospitals in Thailand are shown in Fig.5.4.2. Estimates of the size of treatment facilities for these hospitals were made based on an average sewage production rate per hospital bed per day. The estimates are given in Table 5.4.5. Treatment plant operators (engineer/scientist and technician) needed for hospitals were calculated based on the numbers required for plants of different sizes as given in Table 5.4.3. The results are set out in Table 5.4.6.

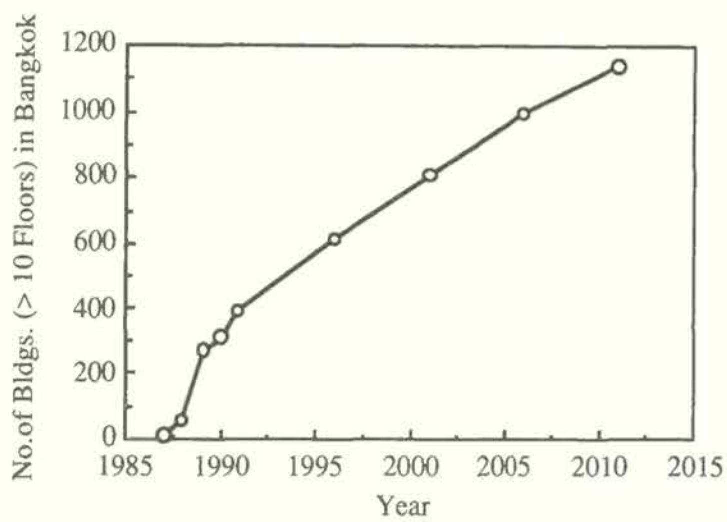


Fig.5.4.1 Thailand: Predicted Number of High-rise Buildings (>10 floors) in Bangkok.

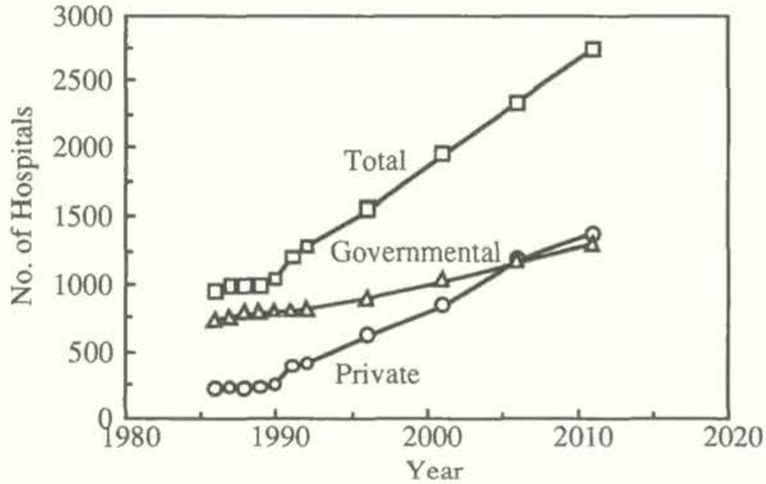


Fig.5.4.2 Thailand: Predicted Number of In-patient Hospitals in Bangkok.

Table 5.4.5 Thailand: Predicted Number of Hospitals.

Year	Number/Sewage flow (m^3/d)		
	<500	<1000	<2500
1991	1172	24	6
1996	1506	31	8
2001	1862	38	10
2006	2232	46	12
2011	2619	54	14
Σ	9391	193	50

Table 5.4.6 Thailand: Predicted Cumulative Requirements for Environmental Operators of Hospital Wastewater Treatment Plants.

Year	Environmental Engineer	Environmental Scientist	Senior Technician	Junior Technician
1991	-	6	30	1202
1996	-	8	39	1545
2001	-	10	48	1910
2006	-	12	58	2290
2011	-	14	68	2687

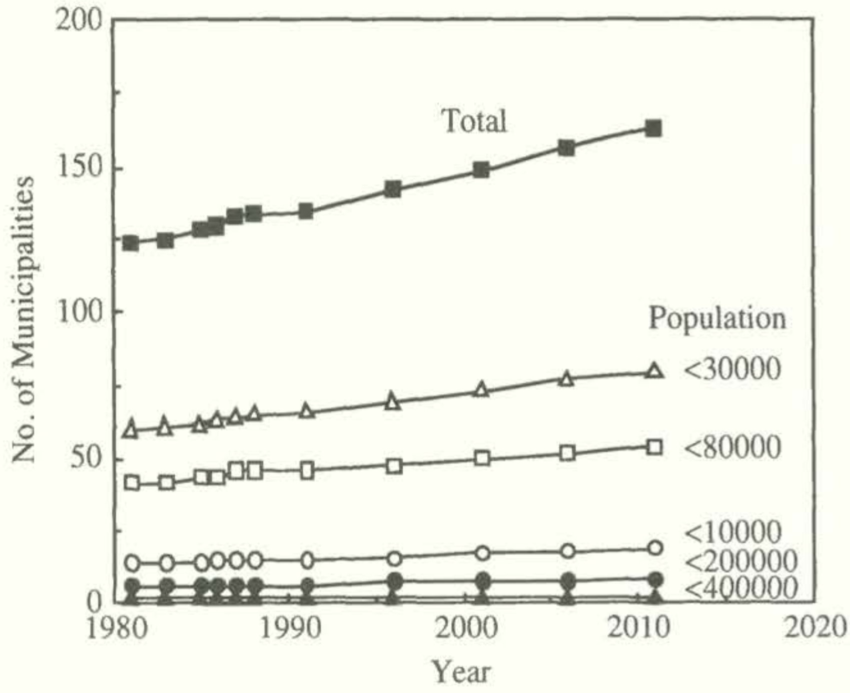


Fig.5.4.3 Thailand: Predicted Number of Municipalities.

Table 5.4.7 Thailand: Requirements for Environmental Operators of Bangkok's Wastewater Treatment Plants.

Plant	Capacity (m^3/d)	Environmental Engineer	Environmental Scientist	Senior Technician	Junior Technician
Bang Na	1300	-	1	1	1
Huay Kwang	3000	1	1	1	2
Siphraya	30000	1	2	3	6
Ratburana	30000	1	2	3	6
Ratanakosin	40000	1	2	3	6
Nong Khaem	157000	3	6	8	10
Yannawa	195000	3	6	8	10
Rama IX	280000	4	8	10	12
Mugkasun	280000	4	8	10	12
BMA II	350000	5	10	12	14
		23	46	59	79

The government of Thailand has made it a policy that all municipalities must have sewerage systems and treatment facilities. The current and projected numbers of municipalities in Thailand are shown in Fig.5.4.3. The administrative units within the Bangkok Metropolitan Administration (BMA) area are not included in this figure. The BMA area has 28 administrative units at present. It plans to construct 10 sewage treatment plants of various sizes (see Table 5.4.7) to service its residents.

Based on the number of municipalities and the BMA plans, the numbers of treatment plants of various sizes needed to service all municipalities as well as the BMA area are estimated and given in Table 5.4.8. The number of treatment plant personnel needed for these are given in Table 5.4.9.

The cumulative requirements for wastewater treatment plant personnel servicing factories, high-rise buildings, hospitals and municipalities are summarized in Table 5.4.10. As we have noted earlier, the number of technicians is significantly higher than the number of engineers, which corresponds to the many small-scale plants that are expected to be established.

Table 5.4.8 Thailand: Predicted Numbers of Public-Owned Treatment Works in BMA and Municipalities.

Plant Capacity (m^3/d)	Number of Public-Owned Treatment Works/Year				
	1991	1996	2001	2006	2011
1000 to <2500	16	17	18	19	20
2500 to <7500	66	69	72	77	80
7500 to <20000	44	46	49	51	54
20000 to <50000	9	10	10	10	11
50000 to <100000	2	2	2	2	2
100000 to <200000	2	2	2	2	2
200000 to <300000	2	2	2	2	2
300000 to <400000	1	1	1	1	1

Table 5.4.9 Thailand: Predicted of Cumulative Requirements for Environmental Operators of Municipal Wastewater Treatment Plants Including the BMA.

Year	Environmental Engineer	Environmental Scientist	Senior Technician	Junior Technician
1991	142	234	255	452
1996	148	244	266	473
2001	158	254	276	492
2006	161	264	286	511
2011	168	276	299	536

The monitoring of the operations and effectiveness of the many treatment plants for the whole of Thailand will require an equally large number of personnel. Assuming a complement of monitoring personnel equal to that given in Table 5.4.11, the total number of monitoring staff needed (excluding those for river water quality monitoring, although their numbers are insignificant compared to the numbers estimated for source pollution control) are calculated and shown in Table 5.4.12. The overall totals for water quality management personnel needed by Thailand, at present and projected to the year 2011, are given in Table 5.4.13.

Table 5.4.10 Thailand: Predicted Cumulative Requirements for Environmental Operators of All Wastewater Treatment Plants.

Year	Environmental Engineer	Environmental Scientist	Senior Technician	Junior Technician
1991	1473	2833	3968	9807
1996	1681	3239	4717	11429
2001	2034	3926	5806	13941
2006	2468	4770	7052	16958
2011	2998	5803	8502	20591

Table 5.4.11 Thailand: Expected Qualifications of Monitoring Staff to Inspect Wastewater Treatment Plants.

Staff	Plants per month	Plants per year
Junior Technician	15	180
Senior Technician	10	120
Environmental Scientist	10	120
Environmental Engineer	5	60

Remark: An on-site wastewater treatment plant in a high-rise building requires an environmental senior technician to perform monitoring visits 4 times per year.

Table 5.4.12 Thailand: Predicted Cumulative Requirements for Environmental Monitoring Staff.

Year	Environmental Engineer	Environmental Scientist	Senior Technician	Junior Technician
1991	163	172	80	142
1996	186	196	98	167
2001	224	236	121	204
2006	272	287	145	248
2011	331	349	172	300

Table 5.4.13 Thailand: Predicted Cumulative Requirements for Environmental Personnel.

Year	Environmental Engineer	Environmental Scientist	Senior Technician	Junior Technician
1991	1636	3005	4048	9949
1996	1867	3435	4815	11596
2001	2258	4162	5927	14145
2006	2740	5057	7197	17206
2011	3329	6152	8674	20819

5.5 Singapore

Singapore has in the last three decades developed a large industrial base which generates a lot of industrial effluent. There has also been a large increase in domestic wastewater from the growing population and related commercial activities. Despite the pollution generated from these sources, Singapore has been able to keep all of its rivers and streams clean. The strategies and activities drawn up and implemented to abate the pollution of rivers and streams and the government organization to manage water quality has been presented in the previous chapter. We will now present the human resources mobilized to carry out Singapore's water management program.

The Ministry of Environment (ENV), set up in 1972 and charged with the protection and improvement of the environment, is responsible for river water quality management. ENV has a staff of some 2700, of whom about 230 are engineers and scientific officers, and about 900 are technical personnel and public health officers.

Monitoring and pollution control are administered by engineers and technical staff of the Pollution Control Division (PCD), ENV. River water quality monitoring and assessment is carried out by scientific officers and laboratory staff of the Strategic Planning and Research Department (SPRD) of the same ministry.

The monitoring parameters and frequency of sampling of river waters are presented in Table 5.5.1. The SPRD, which carries out the monitoring of rivers and streams, has 43 staff members, 8 of whom are chemists or chemical engineers and 35 are civil or sanitary engineers. No additional staff are required at present nor in the near future, as this number of people is presumed sufficient to carry out the department's tasks.

Table 5.5.1 Singapore: Criteria to Estimate Human Resource Requirements; Monitoring Parameters and Frequencies.

Parameters*	Sampling Stations	
	Water Catchment Rivers	Non-water Catchment Rivers
Basic	Fortnightly	Monthly
Microbial	-	Quarterly
Chemical	Yearly+	-
Heavy Metals	-	-
Gauging	-	-
No. of Sampling Points	45	42

*Analytes in each measuring parameter

Parameters		Analytes
Basic	On Site	pH, temperature, DO
	Laboratory	BOD, COD, NH_4-N, TS, pH, DO
Microbial		Fecal Coliforms, (membrane method)
Chemical		Selected chlorinated organics+
Heavy Metals		-

Unlike most other countries, Singapore does not require its industries to have a comprehensive set-up to operate and monitor the performance of their waste treatment plants. There are only 15 factories with organic waste which need or have chosen to treat their own wastes. Industries are permitted to discharge their organic wastes and sludges into the sewers for a fee. Effluents from the food, beverage and pharmaceutical industries constitute nearly all the industrial organic effluent. Non-biodegradable wastewaters have to be pre-treated, where necessary, before they are allowed to be discharged into the sewers. Hardly any industrial wastewater is discharged into streams or rivers. This is because all industries are served by the sewerage system, similar to the service provided to almost all communities. The sewage coming from the industries drains into six large treatment facilities, and treated effluents from ENV's treatment facilities are mostly discharged into the sea.

PCD, with a staff of about 54 people, is in charge of the measurement of pollution loads from industries and the computation of tariffs. The staff, few as they would seem, have thus far functioned well in their tasks. The PCD is supported by about 1500 PCOs employed by the industries and responsible for pollution control in each of the factories they work in.

As mentioned earlier, almost all of the population of Singapore is served by a sewerage system. There are six large treatment facilities receiving a total of a little more than 1 million cubic meters of wastewater daily. The treatment facilities are provided with facilities for preliminary treatment, primary treatment, secondary treatment using activated sludge, anaerobic sludge digestion of the primary and secondary sludges and mechanical sludge dewatering.

For each of the treatment facilities, an engineer with several years of experience is appointed as manager or supervisor of the plant. The manager is responsible for the efficient operation of the plant and ensures that the treated effluent meets the designed standards. The manager is supported by three teams of technical staff which operate the treatment works. A team of laboratory staff monitors the unit processes and the final effluent quality.

In the course of bringing sewage to the six treatment plants through a network of some 2300 km of sewers, linked by 130 pumping stations, a sewer maintenance section led by an engineer manages is reqired. The maintenance section carries out regular maintenance, attends to choked sewers and repairs or replaces damaged sewers to ensure free sewage flows that minimize overflows. Another team of engineers and technical staff operates and maintains the pumping installations.

The work of the PCD and SPRD is supported by the Water Department of the Public Utilities Board which is responsible for the impoundment of surface waters in protected catchments and, in collaboration with ENV, selective impoundment of waters in unprotected and urban catchments. Selective abstraction from some rivers is also practiced. The Water Department monitors the water quality in all their impoundments and river abstraction facilities to ensure the quality and suitability of the waters for treatment to potable water standards. They operate the water treatment plants in Singapore. Like ENV, they also operate their own analytical laboratories (central and a few local), but call on the services of private and other government analytical laboratories for specialized analyses as necessary.

5.6 Japan

Japan has achieved considerable success in its river water quality management program. One of the main factors that led to this success is the close attention that was given to developing and harnessing the combined capabilities of its technical as well as other personnel in both government and private institutions and firms. In this section, we will present the human resource capabilities of Kanagawa prefecture as a typical example of the overall human resource capabilities of Japan for river water quality management.

The formulation of policies, regulations and programs on water pollution control is the responsibility of the prefectural governor. Laws and ordinances are reviewed by appropriate prefectural agencies and revised or amended as needed. The implementation is carried out by prefectural agencies, city government agencies, or private entities contracted by the prefectural or city governments.

There are 84 river sampling stations where river water quality is measured. The Kanagawa Prefectural Government had promulgated a plan that analytes listed in Table 5.6.1a should be monitored and assessed by government monitoring teams. The frequencies of sampling these stations are given in Table 5.6.1b.

In sampling these stations, a team composed of 2 chemists and a driver is presumed to be able to sample 3 stations within 2 days. Sampling includes the measurement of *in situ* physical parameters. The laboratory analysis of samples from 3 stations takes 6 days for parameters related to human health, 6 days for those related to the living environment, 3 days for special parameters, and another 3 days for other parameters. Considering the sampling and analysis of samples for all the 84 river stations, there is a need for about 30 chemists to complete these analyses.

The numbers of factories and private entities required by law to control their effluents are shown in Table 5.6.2. These factories and private entities are inspected by government functionaries at least once per year. Assuming that a team of 2 inspectors can visit and sample the effluents of 4 factories in a day, it will take 30 inspectors to do all the inspections and monitoring for all specified sites in Kanagawa. The analysis of effluents from 4 factories can be done by 2 chemists in 3 days. Thus it will take a total of 61 analysts to deal with the effluent samples from all specified factories and private entities in Kanagawa.

The existing number of government personnel (at both the prefectural and city levels) is given in Table 5.6.3a for administrative offices and Table 5.6.3b for government laboratories. It was estimated earlier that 30 chemists were needed for river water quality sampling, 30 inspectors for yearly factory inspections and monitoring and 60 analysts for effluent quality monitoring. There are only 66 government laboratory personnel at present but this does not pose a problem because a lot of river water quality analyses are contracted to environmental measurement and certification companies which are privately run laboratories. The inspections however are all done by those in the administrative offices.

In addition, personnel of the Kanagawa Environmental Research Center inspect the laboratories of factories, their wastewater treatment facilities, and their documents or records relating to self-monitoring of effluents.

The treatment of industrial and other effluents of private firms is done by each of these factories or entities. In Table 5.6.4, estimates of the required personnel for industrial effluent treatment facilities are given. Estimates of the required personnel for self-monitoring of effluents and treated wastewater are given in Table 5.6.5.

Table 5.6.1a Japan: River Water Quality Monitoring Program in Kanagawa Planned by the Prefectural Government Based on the Water Pollution Control Law for 1994 Fiscal Year.

Monitoring Stations	
Standards	34
Other	50
Total	84

Frequency	
Times a day	4
Month	12
Total	48

Parameters	
Category	Analytes
Physical*1	12
Human Health*2	23
Living Environment*3	9
Special*4	11
Other*5	4
Total	59

Analytes in Each Measuring Parameter

*1

Weather
Weather on previous day
Depth
Depth for collection
Flow speed
Temperature
Water temperature
Hue
Visual penetration
Odor
Appearance

*2

Cd
Total cyanide compound
Pb
Cr (VI)
As
Hg (total)
Hg (alkyl)
PCB
Dichloromethane
Carbon Tetrachloride
1,2-Dichloroethane
1,1-Dichloroethylene
cis-1,2-Dichloroethylene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethylene
Tetrachloroethylene
1,3-Dichloropropene
Thiuram
Simazine
Thiobencarb
Benzene
Selenium

*3

pH
BOD
COD
SS
DO
Number of coliform groups
n-Hexane extracts
Total nitrogen
Total phosphorus

*4

Phenols
Cu
Zn
Dissolved iron
Dissolved manganese
Cr
EPN
Fe
Ni
Nitrite
Nitrate

*5

Ammoniacal nitrogen
Phosphorus
Chloric ion
Anionic surfactant

Table 5.6.1b Japan: Monitoring Parameters and Frequencies.

Parameters		Frequency		Stations
		Times per day	Month	
Physical 12	(1)	1	12	84
	(11)	4*	12	84
Human Health 23	(2)	1	2	34
	(2)	2*	12	84
	(8)	1	12	84
	(11)	1	2	84
Living Environment 9	(5)	4*	12	84
	(2)	2*	12	84
	(1)	1	12	84
	(1)	2*	2	84
Special 11	(2)	1	2	34
	(2)	1	12	84
	(6)	1	6	84
	(1)	1	2	84
Other 4	(1)	2*	12	84
	(2)	1	12	84
	(1)	1	6	84

* In cases where the frequency is 4 or 2 times per day, it is expected that measurements will be taken at 6 or 12 hour intervals.

Table 5.6.2 Monitoring at Factories and Municipal Plants Specified by Water Pollution Control Law in Kanagawa Prefecture at March 31, 1994.

Wastewaters \ Size of plants		Small <50 m^3/d	Medium 51-500 m^3/d	Large 501-5000 m^3/d	Extra-Large >5001 m^3/d	Total
Factories	Organics	7268	1275	312	20	8875
	Heavy Metals*[1]	634	165	132	35	966
Municipal Plants	Organics*[2]	0	2	8	0	10
	Heavy Metal*[3]	0	1	1	33	35
Total		7902	1443	453	88	9886

* [1]:including hazardous chemicals

* [2]:Night Soil Treatment Facilities

* [3]:Sewage Treatment Facilities

Table 5.6.3a Existing Number of Personnel in Charge of Water Quality Management in Kanagawa Prefectural Government and 5 Big Cities. (Administrative Offices)

Major Field / Qualification	Chemistry & Chem. engg.	Microbio-logy	Civil & Sanitary engg.	Other enggs.	Pharmacy	Other fields	Total
Ph D							
MSc							
Diploma (BSc)	23		1	4	5	13	46
Senior high school							
Others							
Total	23	0	1	4	5	13	46

Table 5.6.3b Existing Number of Personnel in Charge of Water Quality Management in Kanagawa Prefectural Government and 5 Big Cities. (Laboratories)

Major Field / Qualification	Chemistry & Chem. engg.	Microbio-logy	Civil & Sanitary engg.	Other enggs.	Pharmacy	Other fields	Total
Ph D					3	1	4
MSc	3					1	4
Diploma (BSc)	38		1	2	7	6	54
Senior High school	4						4
Others							
Total	45	0	1	2	10	8	66

At present, there are 6981 registered supervisors and 8086 treatment plant operators in industrial wastewater treatment facilities in Kanagawa. The details of the existing manpower for industrial effluent treatment are given in Table 5.6.6. It should be noted that a significant shortage of personnel exists in the small factories and entities, which discharge mostly organic waste. Most of these are restaurants, apartment houses and other small businesses.

A questionnaire survey conducted by the Kanagawa Environmental Research Center among 30 government inspectors in two cities in Kanagawa verifies that the lowest percentage of firms undertaking self-treatment of effluents and self-monitoring is among small businesses (see Table 5.6.7).

The slight gap in personnel among medium-scale and large factories is not of great concern at present because a number of labor-saving devices for treatment operations and monitoring have been installed in many of these factories. Also, a number of companies contract out the operation and maintenance of treatment facilities, and monitoring of effluent quality. Overall, the human resource requirements for river water quality management in Kanagawa prefecture seem to have been met.

Table 5.6.4 Required Personnel for Operation of Treatment Facilities in Industries.

Wastewater \ Size of plants		Small <50, m^3/d	Medium 51-500, m^3/d	Large 501-5000, m^3/d	Extra-Large >5001, m^3/d	Total
Factories	Organics	7268 7268	1275 1275	312 936	20 120	8875 9599
	Heavy Metals*1	634 634	165 495	132 792	105 420	1036 2341
Municipal plants	Organics*2		2 2	8 24		10 26
	Heavy Metals*3		1 3	1 6	99 396	101 405
Total		7902 7902	1443 1775	453 1758	224 936	10022 12371

Note; Upper: Supervisors, Lower: Operators

*1:including hazardous chemicals

*2:Night Soil Treatment Facilities

*3:Sewage Treatment Facilities

Table 5.6.5 Required Personnel for Effluent Water Quality Monitoring by Factory.

Wastewater \ Size of plants		Small <50, m^3/d	Medium 51-500, m^3/d	Large 501-5000, m^3/d	Extra-Large >5001, m^3/d	Total
Factories	Organics	267 801	94 281	23 69	3 9	387 1160
	Heavy Metals*1	47 139	24 73	39 116	10 31	120 359
Municipal plants	Organics* 2		0 1	1 2		1 3
	Heavy Metals*3		0 1	0 1	10 29	10 31
Total		314 940	118 356	63 188	23 69	518 1553

Note; Upper:Supervisors, Lower:Operators

Estimated numbers of personnel are allocated on the basis that 25% are supervisors and 75% are operators.

*1, *2, *3 ; same as Table 5.6.4.

Table 5.6.6a Existing Personnel in Specified Factories in Kanagawa.

Wastewater \ Size of plants		Small <50, m^3/d	Medium 51-500, m^3/d	Large 501-5000, m^3/d	Extra-Large >5001, m^3/d	Total
Factories	Organics	4215 4215	1122 1377	568 924	51 111	5956 6627
	Heavy Metals*1	418 412	153 219	253 411	93 200	917 1242
Municipal plants	Organics*2		2 1	15 24		17 25
	Heavy Metal*3		1 1	2 3	88 188	91 192
Total		4633 4627	1278 1598	838 1362	232 499	6981 8086

Note; Upper:Supervisors, Lower:Operators
*1, *2, *3 ; same as Table 5.6.4.

Table 5.6.6b Additional Personnel Required in Factories in Kanagawa Prefecture.

Wastewater \ Size of plants		Small <50, m^3/d	Medium 51-500, m^3/d	Large 501-5000, m^3/d	Extra-Large >5001, m^3/d	Total
Factories	Organics	7535-4215 =3320 8069-4215 =3854	1369-1122 =247 1556-1377 =179	335-568 =233 1005-924 =81	23-51 =28 129-111 =18	9262-5956 =3306 10759-6627 =4132
	Heavy Metals*1	681-418 =263 773-412 =361	189-153 =36 568-219 =349	171-253 =82 908-411 =497	115-93=22 451-200=251	1156-917 =239 2700-1242 =1458
Municipal plants	Organics*2		2-2=0 3-1=2	9-15=6 26-24=2		11-17=6 29-25=4
	Heavy Metals*3					
Total		8216-4636 =3586 8842-4627 =4215	1561-1278 =283 2131-1598 =533	516-838 =-322 1946-1362 =584	247-232 =15 1005-499 =506	10540-6981 =3559 13924-8086 =5838

Note; Required - Existing = Lacking, Upper :Supervisors, Lower :Operators
*1, *2, *3 ; same as Table 5.6.4.

Table 5.6.7 Comparison of Rates of Self-operation of Treatment Plants and Self-monitoring of Effluent Water Quality by Factories in Kanagawa Prefecture.

Size of plants / Rates, %	Small <50, m^3/d	Medium 51-500, m^3/d	Large 501-5000, m^3/d	Extra Large >5000, m^3/d
Self-operation of treatment plants	16	59	78	89
Self-monitoring of water quality	1	12	31	57

CHAPTER 6

HUMAN RESOURCE DEVELOPMENT

There is a clearly identified need for trained manpower in river water quality management in several East Asian countries. The human resources needed must be supplied if these countries are to address the many problems they now face and will face in the future relating to the water quality of their major rivers. The shortage of manpower is generally acute as we have shown in the previous chapter.

Human resource development is crucial in the proper conduct of river water quality management. A core of trained manpower is needed to provide expert decisions on what policies to formulate, regulations to implement and guidelines to follow. Many trained and educated people in the fields of environmental science and engineering are required to implement the tasks of monitoring rivers and effluents, wastewater treatment operations, and many other related tasks. Technical training is constantly needed to upgrade the knowledge and skills of personnel presently having responsibilities in pollution control.

To recapitulate the gaps in manpower which we have presented in Chapter 5, Malaysia needs by the year 2000 about 1000 new personnel for the government agency responsible for water quality management of their rivers, and about 1500 plant supervisors and 6400 plant operators for the many wastewater treatment plants they will require for their industries and municipalities; The Philippines at present needs about 200 more government agency personnel for river water quality management, and about 38,000 industry personnel and 300 local government personnel for industrial and municipal wastewater treatment plant operation and monitoring; and Thailand needs about 16,500 technicians and 5200 engineers and scientific personnel for the wastewater treatment works and monitoring that their country presently requires. The numbers will surely be much higher in just a few more years.

6.1 Institutions for Human Resource Development

The development of human resources in almost all fields of specialization or areas of interest, including water quality management, in most East Asian countries, is primarily undertaken by educational institutions. Thus, it is the educational institutions in these countries that are set to take the role and responsibility of molding the potential of their human resources and provide the numbers of trained manpower for the river water quality management needs of their countries.

There is a dearth of qualified personnel in almost all areas of river water quality management, but we have identified several critical areas on which attention should be focused initially. These specific areas are: pollution control engineering, environmental (pollution) chemistry, aquatic ecology (particularly of rivers and lakes), and watershed management, wherein the first two areas are considered of greatest concern. Also, specialized training should be given in the following fields (specifically intended for those who are to work as technicians in these fields): wastewater treatment operations, river water and effluent sampling, and water quality analysis.

The vast numbers of people who need to be trained in the areas mentioned, in just the three countries we have cited, require national and even regional strategies for manpower development (education and training) in river water quality management. However, we need to look briefly into the status of institutions for education and training in the areas of concern so as to assess their capability and preparedness in handling such a task.

Institutions for education and training include not only schools and universities, both public or private, but also professional organizations, private organizations or non-governmental organizations whose range of activities includes the training of people or the imparting of environmental awareness to the public.

6.1.1 Malaysia

The present educational system in Malaysia is not sufficiently development oriented to be able to produce the types of workers required for specific technological fields, much less for pollution control generally. Although there are substantial numbers of students in the high schools and vocational schools, none are trained in pollution control. Assistance is needed to identify and set up courses most suited for high schools and vocational schools which may help equip the students with knowledge of basic environmental concerns as well as with the skills needed for specific pollution control activities.

At present, only the Agricultural University of Malaysia has a Department of Environmental Science. Other universities, such as the University of Technology of Malaysia, have just started their environmental studies programs at the BA (Bachelor of Agriculture) or BSc levels. An MSc and PhD program is also offered in Environmental Engineering and Soil and Water Engineering by the Faculty of Engineering of the Agricultural University of Malaysia. Courses offered at the BSc level include those on Environmental Chemistry, Water Pollution Control Technology, Environmental Planning and Management, EIA and other related courses such as those in air pollution and control.

Vocational and technical education is provided by a limited number of vocational schools (57 in 1992) and a few technical colleges. Other centers offering technical training are the industrial training institutes (10 in 1992), Center for Instruction and Advanced Skills Training (CIAST) run by the Ministry of Human Resources, the youth training centers run by the Ministry of Youth, Culture and Sports, and Pusat Giat MARA run by MARA. All of them provide technical training outside the mainstream of formal education. However, none of these training centers has given any training in water pollution control or water quality monitoring.

In general, while the educational system emphasizes good formal education, the system has very little room in their courses and syllabus to cater for environmental studies and skills development. Meanwhile, on-the-job training seems to be the only way to immediately train the needed personnel to undertake the different activities related to river water quality management.

6.1.2 The Philippines

The necessity for an aggressive public environmental education program in The Philippines is recognized by government policy makers. PD 1152, otherwise known as the Philippine Environment Code of 1977 mandated the Department of Education, Culture and Sports (DECS) to integrate the subject of environmental education into its school curricula at all levels. It also emphasized the need for work in special community education emphasizing the relationship of man and nature. It also stipulated that other government agencies, particularly the Department of Environment and Natural

Resources (DENR), undertake public information activities to stimulate greater public awareness. In reality, however, very little has yet been done to instill in Filipino students, much less the general public, the importance and urgency of facing up to the many environmental problems facing The Philippines. Moreover, interest, knowledge and environmentally needed skills are in short supply among teachers in secondary schools or those entrusted with the task of imparting environmental awareness outside of the educational system.

There is still a shortage of undergraduate and graduate courses on environmental management although many schools have already integrated environmental engineering courses with sanitary engineering (producing graduates with BSc degrees in Environmental or Sanitary Engineering). Environmental engineering *per se* is available only at the University of The Philippines at Diliman (UPD), while Miriam College is offering training in Environmental Planning. The University of The Philippines at Los Banos (UPLB) is offering a course leading to a degree in Environmental Science and Management.

At the graduate level, the Philippine Women's University (PWU) is offering a master' s program in environmental management with emphasis on industrial pollution control. UPD is offering a graduate program in urban and regional planning through its School of Urban and Regional Planning (SURP). A number of other schools offer degree programs in environmentally related sciences and engineering and most of these schools are in the Metro Manila Area.

Because of the lack of graduates in the environmental management field, other professional groups are taking on the job and these are mostly from engineering fields (e.g. civil/sanitary engineering, chemical engineering, and mechanical engineering), or other fields of science (e.g. physics, chemistry, and biology). Those with master' s and doctoral degrees tend eventually to become consultants.

There is a need today for training programs on various aspects of industrial environmental management. Some environmentally related training programs already exist. For example, UPLB offers a short course on the EIA process, and UPD through the National Engineering Center (NEC) has been offering short courses on pollution control topics, etc. Some of the training programs have been handled by industry associations via the Pollution Control Association of The Philippines, Inc. (PCP). Just recently the Environmental Management Bureau (EMB, DENR) has consented to PCAPI's PCO training program being accredited under the Revised Guidelines on PCO Accreditation.

PCAPI has developed three levels of PCO training courses; namely, the Basic course, Advanced course and Management of Environmental Department course. Each course runs for one week and covers such topics as the duties and responsibilities of PCOs, the functions of government environmental agencies, air and water quality standards, treatment technologies, sampling techniques, crisis management, etc. There are about fifty participants in each class, and ten classes have been completed since the program was started in 1992.

PCAPI also assisted in the organization of VOICE or Voluntary Organization of Industries for a Cleaner Environment, a consortium of industries along the badly polluted rivers of Metro Manila, whose purpose is to address industrial pollution problems as part of the overall river rehabilitation program.

Some associations have managed within themselves to conduct, at least, an environmental awareness seminar, inviting speakers from EMB or DENR. These are mostly student organizations, industry associations, professional organizations, etc. Other private professional organizations have started integrating environmental concerns into their activities. These include the Philippine Society of Mechanical Engineers, the Philippine Institute of Civil Engineers, the Philippine Institute of Chemical Engineers, the Chemical Society of the Philippines (KKP) and others.

Programs and projects such as environmental training courses frequently suffer from budgetary cuts because of the apparent low priority given to environmental programs by the government. Procurement of training equipment and facilities generally gives way to more highly prioritized activities and/or programs. Training facilities often depend on support from foreign institutions and private enterprises. In addition, training materials such as books and equipment are commonly inadequate.

Many environmental non-governmental organizations (NGOs) have been formed in The Philippines during the last 5 years. Some of them are small and are local in coverage, but others are large with chapters in many parts of the country. Among the more active and better known are the Haribon Foundation, the Philippine Ecological Network, the Philippine Environmental Action Network, the Center for Environmental Concerns and others.

6.1.3 Thailand

In Thailand, the three-year secondary school or high school is usually for students who intend to study further at the college or university level. Some aspects of environmental awareness are taught in these schools but no specific environmental skills are imparted to secondary school students.

Vocational schools are for those students who want to acquire some specific technical knowledge. Students in vocational schools also spend three years in school and receive a Certificate of Vocational Education (Cert. Voc.) after graduation. However, there is no vocational education program in environmental studies.

While secondary school students may continue to pursue a further degree in a college or university, those with a Cert. Voc. may pursue higher vocational studies for another two years to graduate with a Diploma in Vocational Education (Dip. Voc.). At present, only one vocational school, the Ratmongkol Institute of Technology (Chiang Mai Campus) offers a Dip. Voc. program in Sanitation and Environment. However, only 13 students per year, on average, graduate from this program. The rarity of graduates from this program and the absence of environmentally related courses in both the Cert. Voc. and Dip. Voc. programs in other schools contribute to the slow development of much needed technical personnel for the planned establishment of wastewater treatment plants in Thailand.

Environmental studies in Thai universities range from BSc programs in Environmental Engineering and Environmental Science to PhDs in these fields of study. Course content in Environmental Engineering emphasizes the design, construction and operation of waste treatment facilities, while the Environmental Science program stresses monitoring, laboratory analysis of environmental parameters and EIA. Graduate studies provide a wide variety of in-depth environmental studies.

On-the-job training for people already employed in private firms is lacking. However, some government agencies and universities such as Chulalongkorn University offer training programs and short courses regularly. The Environmental Research and Training Center (ERTC) under the Department of Environmental Quality Promotion, MSTE, offers two training programs - on Waste Management and on Operation and Maintenance of Waste Treatment Plants - twice a year to interested environmental practitioners. Each class can accommodate 30 to 40 people, but the number of graduates from these programs is still low compared to the numbers of staff required by present developments in Thailand.

Non-governmental organizations also contribute to human resource development in Thailand. One outstanding NGO in the environmental field is the Environmental Engineers Association of Thailand (EEAT). EEAT organizes conferences and seminars which are open to the public, and publishes a monthly newsletter which contains items on environmental protection, water and wastewater treatment, and EIA among many other topics. EEAT also organizes training programs for industries and other groups. Another NGO which helps in building public environmental awareness is the Magic Eyes Foundation. They have launched "Save the Environment" campaigns and together with the EEAT have sponsored awards for the best treatment plants which it publishes to make the public aware of the need for better water pollution control.

6.2 Programs on Human Resource Development

Based on our brief description of the status of educational and training institutions in the three countries, it appears that national strategies for human resource development should start with the development of the very institutions needed for the education and training of the required personnel for river water quality management. Areas of immediate concern are those related to the strengthening of university and college-based environmental education, institutionalization of vocational education focussing on the skills needed for environmental monitoring and protection, and the encouragement and better integration of privately initiated programs (those of professional organizations, NGOs, and others).

In strengthening university and college-based environmental education, three items should be given attention: improvement of curricula, faculty development, and provision of better facilities for education.

Curriculum improvement may be attempted by calling a conference for this purpose of all teachers and faculty from different universities and institutions which are already offering and handling environmental courses and programs. The development of a syllabus and course materials for specific courses could also be undertaken by such a conference.

Further development could be undertaken by offering fellowships and scholarships to interested and qualified students. The governments and institutions of higher learning in advanced countries should be asked to expand their current programs of offering scholarships and fellowships for students from less developed countries. However, development of recognized programs in national institutions, through faculty exchanges, etc., would be preferable.

In the institutionalization of vocational education focussing on the skills needed for technical operations in monitoring and wastewater treatment activities attention should be given to the development of training modules, and the facilities needed for training.

It is essential to increase the opportunities for training not only of vocational school students but also of those who are already employed in government and private institutions engaged or intending to engage in river water quality management. An environmental training center established and managed by the government can be a core facility for training activities. A center with accommodation facilities can provide training courses to staff of local government and industries, even these located at a distance from educational centers.

In Thailand, Indonesia and China, the Environmental Research and Training Centers have been established with Japanese grants and technical cooperation. Training activities are being carried out in these centers. Similar centers should be established in other countries based on the requests of recipient countries. Singapore has established such a center by itself. Other countries also hope to establish similar centers and assistance programs to promote such establishment should be further strengthened.

For the sharing of experiences and technologies, "networks" should be developed among these training centers and related organizations. The UNEP International Environmental Technology Center established in 1992 could be a core facility for such a network in the East Asian region.

The development of training modules could be shared among training centers within the network. Such modules could include positive experiences from the many countries involved in the network. Also, standardization of monitoring methods, methods of laboratory analysis and data evaluation may be facilitated through this network. Provision for the sharing of experts to teach in regional or national training centers is also quite possible with this network.

APPENDIX I

WHERE TO SEE TO SEEK WHAT YOU WANT

APPENDIX II

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APPENDIX III

ABBREVIATIONS USED

AD	Anaerobic Digestion
ADB	The Asian Development Bank
AS	Activated Sludge
ASEAN	Association of Southeast Asian Nations
ASEAN5	ASEAN without Brunei
BHC	Benzenehexachloride (Hexachlorocyclohexane)
BMA	The Bangkok Metropolitan Administration
BOD	Biochemical Oxygen Demand
BSc	Bachelor of Science
CCE	Carbon Chloroform Extract
CIAST	Center for Instruction and Advanced Skills Training (Singapore)
COD	Chemical Oxygen Demand
COD_{Mn}	COD measured with potassium permanganate method
DDT	Dichlorodiphenyltrichloroethane
DECS	The Department of Education, Culture and Sports (The Philippines)
DENR	The Department of Environment and Natural Resources
DID	The Drainage and Irrigation Department (Malaysia)
DIW	The Department of Industrial Works of the Ministry of Industry (Thailand)
DO	Dissolved Oxygen
DOE	The Department of Environment of MSTE (Malaysia)
EC	Electro-conductivity
EEAT	Environmental Engineers Association of Thailand
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EM/PC	Environmental Management and Pollution Control
EMB	The Environment Management Bureau (The Philippines)
EMPAS	The Environmental Management and Protected Areas Sector (The Philippines)
ENV	The Ministry of the Environment (Singapore)
EPN	Ethylparanitrophenyl
EQA	Environmental Quality Act (Malaysia)
ERC	The Environmental Research Center (Kanagawa, Japan)
ERTE	The Environmental Research and Training Center (Thailand)
GDP	Gross Domestic Product
GEMS	Global Environmental Monitoring System
GNP	Gross National Product

HBD	The Housing and Development Board (Singapore)
HDI	Human Development Index
HRR	Human Resource Requirement
IEPC	Industrial Efficiency and Pollution Control Programme
IMF	International Monetary Fund
JSWE	Japan Society on Water Environment
JTC	The Juron Town Corporation (Singapore)
LGU	Local Government Units (The Philippines)
MBAS	Methylene Blue Active Substance
ME	The Ministry of Environment (Korea)
MSTE	The Ministry of Science, Technology and Environment (Malaysia)
MWSS	The Metropolitan Water Works and Sewerage System (The Philippines)
NEC	The National Engineering Center (The Philippines)
NEPC	The National Environmental Protection Council (The Philippines)
NGO	Non-Governmental Organization
NICs	The Newly Industrialized Countries
NPCC	National Pollution Control Commission (The Philippines)
NPCC	The Nation Pollution Control Commission (The Philippines)
NWAPPC	The National Water and Air Pollution Control Commission (The Philippines)
ONEB	The Office of the National Environmental Board (Thailand)
PAB	Pollution Adjudication Board (The Philippines)
PCB	Polychlorinated biphenyl
PCD	Pollution Control Department of MSTE (Malaysia)
PCD	The Pollution Control Division of ENV (Singapore)
PCO	Pollution Control Officer
PWU	The Philippine Women's University
ROAP	The UNEP Regional Office for Asia and the Pacific
SPRD	The Strategic Planning and Research Department of ENV (Singapore)
SS	Suspended Solid
TCB	Total Coliform Bacteria
TS	Total Solids
TSS	Total Suspended Solids
UASB	Upflow Anaerobic Sludge Blanket Reactor
UNDP	The United Nations Development Programme
UNEP	The United Nations Environment Programme
UPD	The University of The Philippines at Diliman
UPLB	The University of The Philippines at Los Banos
VOICE	Voluntary Organization of Industries for a Cleaner Environment (The Philippines)
WB	The World Bank
WHO	World Health Organization
WPCDA	The Water Pollution Control and Drainage Act (Singapore)

ASSESSMENT AND PROMOTION OF HUMAN RESOURCES FOR RIVER WATER QUALITY MANAGEMENT