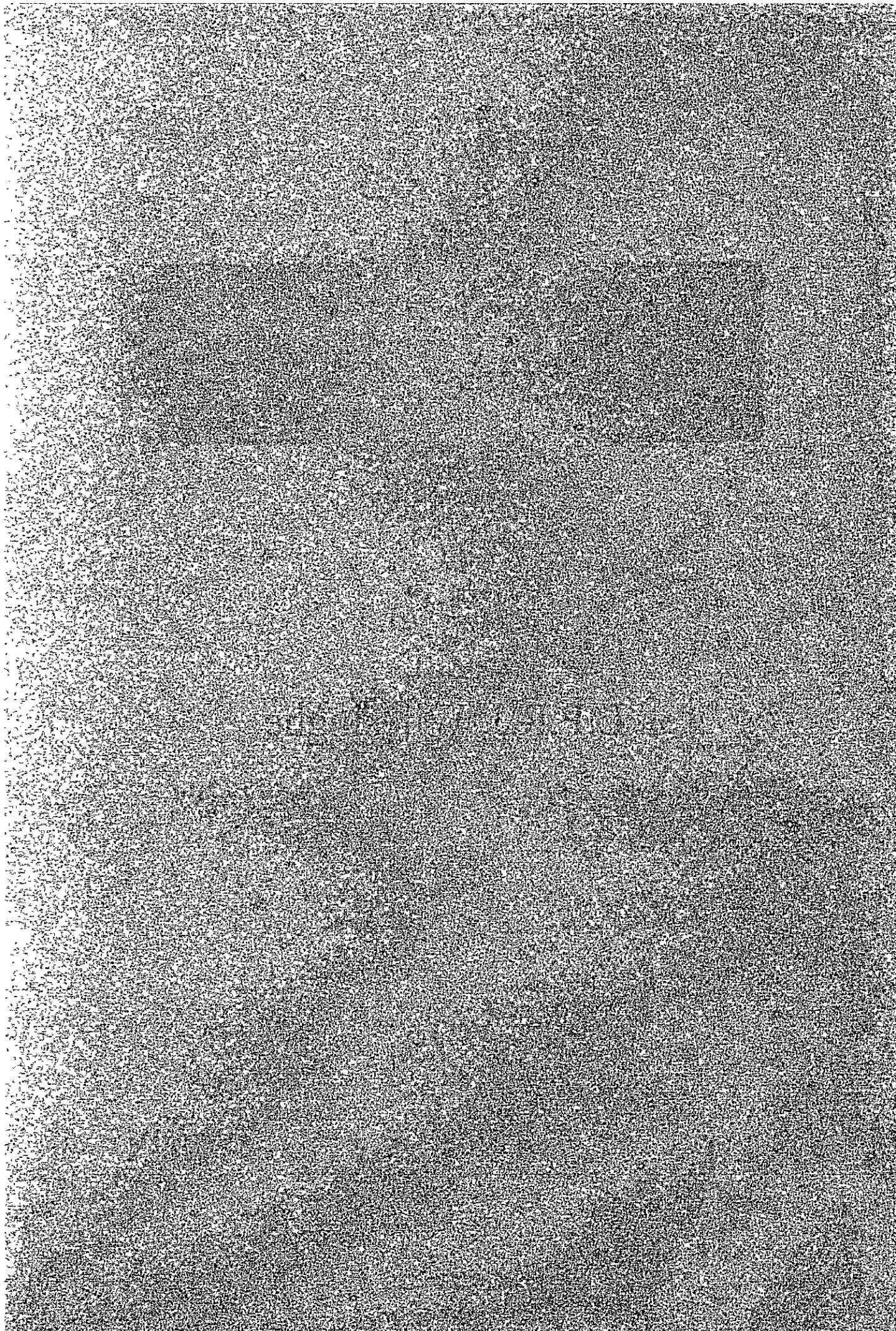


# Sri Lanka

L.P.R.J. Wijesinghe



# LAKE WATER QUALITY MANAGEMENT FOR SRI LANKA

*L.P.R.J. Wijesinghe*  
*Sri Lanka*

## INTRODUCTION

Lakes and reservoirs are the most precious environments for fresh water resources on earth. Fresh water occupies almost 3% of the earth surface area which calls for an effective and efficient management plan. Most of the living creatures biological resources, Human being, in the lake surrounding depends upon the available water resources. Sri Lanka is an island situated in the Indian ocean with approximate total area of 5,280 square miles and a population of 1.7 billion about one third of the population is living in urban areas.

The deterioration of lake water quality progresses slowly and steadily taking a long period of time. It becomes extremely difficult to predict its sudden acceleration and a dramatic deterioration of the ecological system. Once the degradation state reaches beyond the threshold level. Its almost impossible to recover back to its original state in terms of quality and ecological integrity.

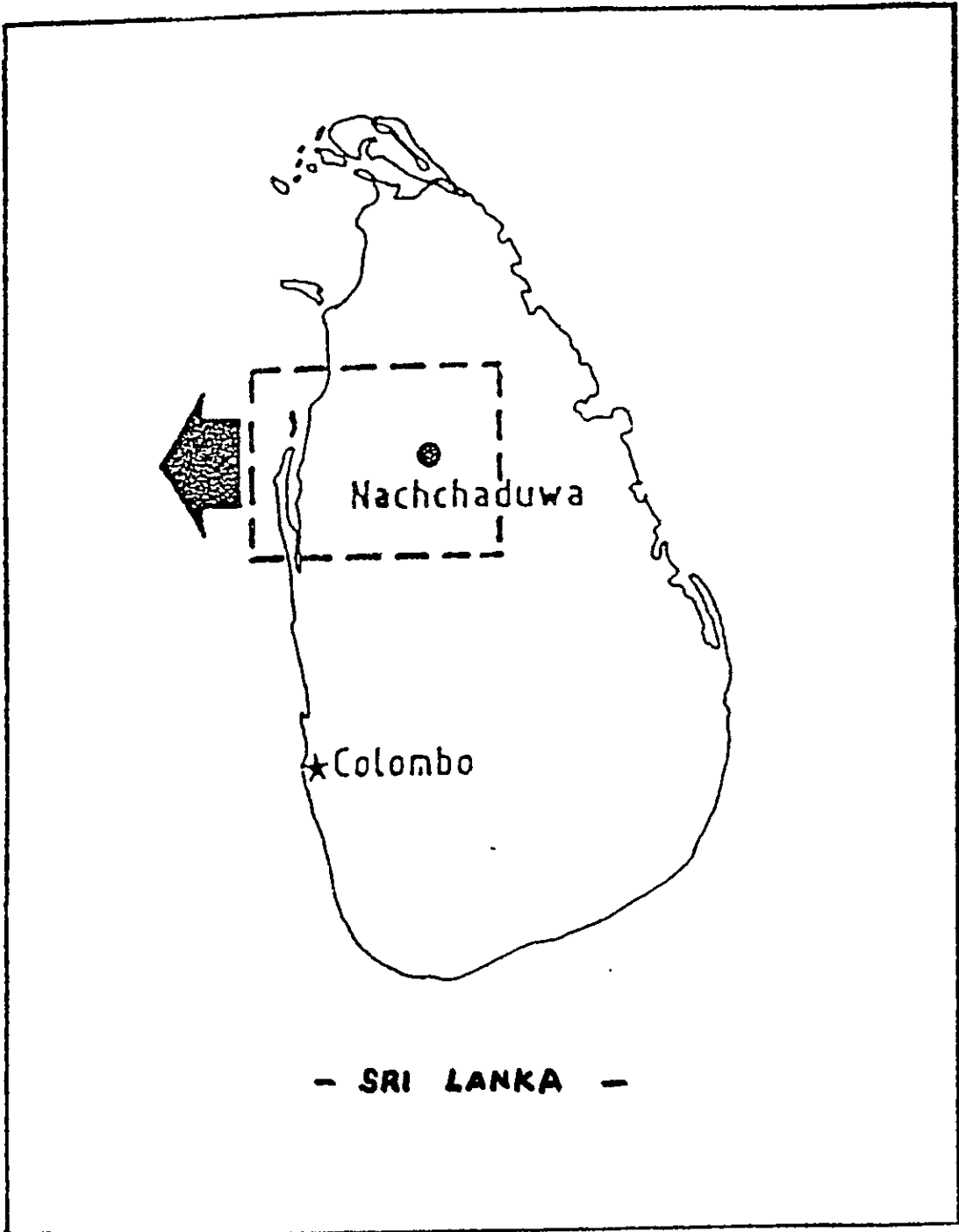
People in Sri Lanka use lake and reservoirs for wide range uses such as drinking, agriculture, fisheries, industries, recreational activities and power generation.

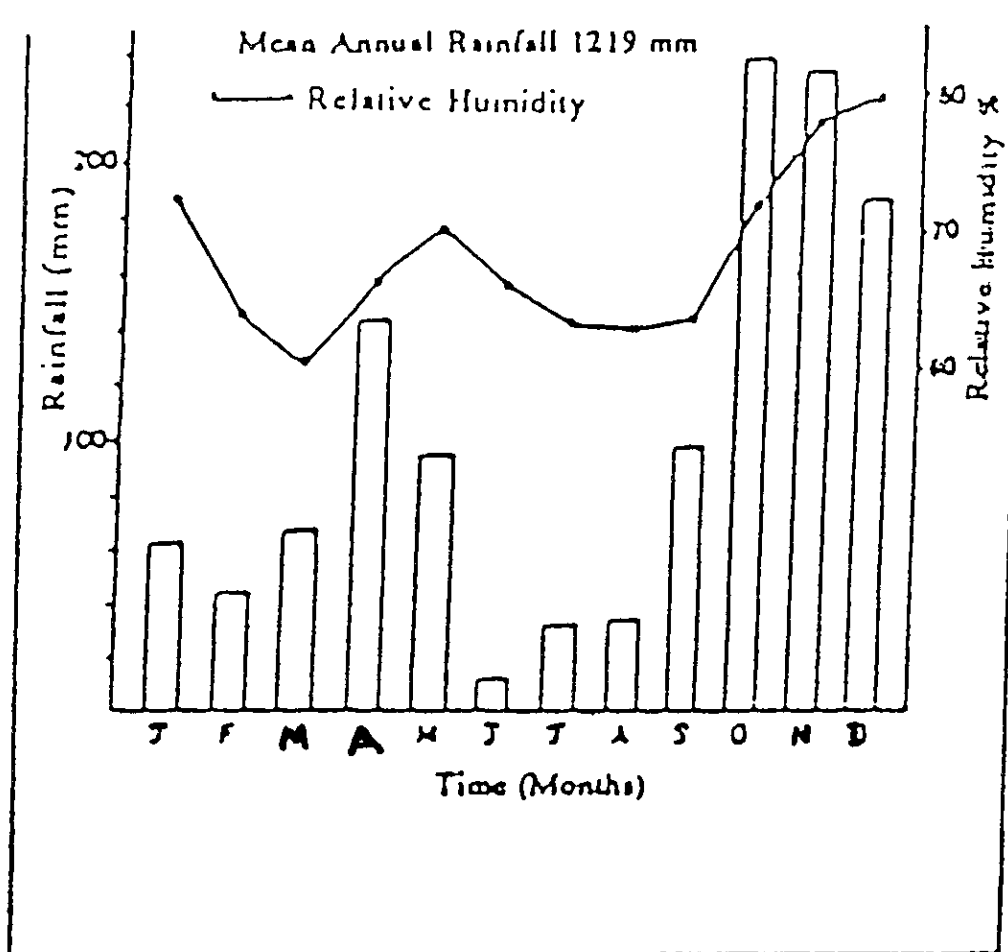
The main problem in lakes and reservoirs in dry zone is increasing of nitrate and phosphate level in water which enhance the eutrophication and on the other hand it has been noted that some types of Trihalomethane (THM) contained in city water sterilized by the addition of chlorine may cause cancer. It is reported that THMs are formed in the reaction of free chlorine with organic compounds such as Humic acids contains in the water.

The National Water Supply and Drainage Board (N.W.S.D.B.) in Sri Lanka is responsible for providing safe drinking water to urban and rural population in my country, being the Regional Chemist in North Central Province (N.C.P.) my responsibility is monitoring water quality. The N.C.P. consists of two administrative districts and containing 24 water supply schemes.

1. Anuradhapura District
2. Polonnaruwa District

In the area I serve main sources utilized are lakes and reservoirs to produce drinking water but in some water supply schemes taking ground water. When compared





*Mean monthly rainfall and relative humidity of Anuradhapura*

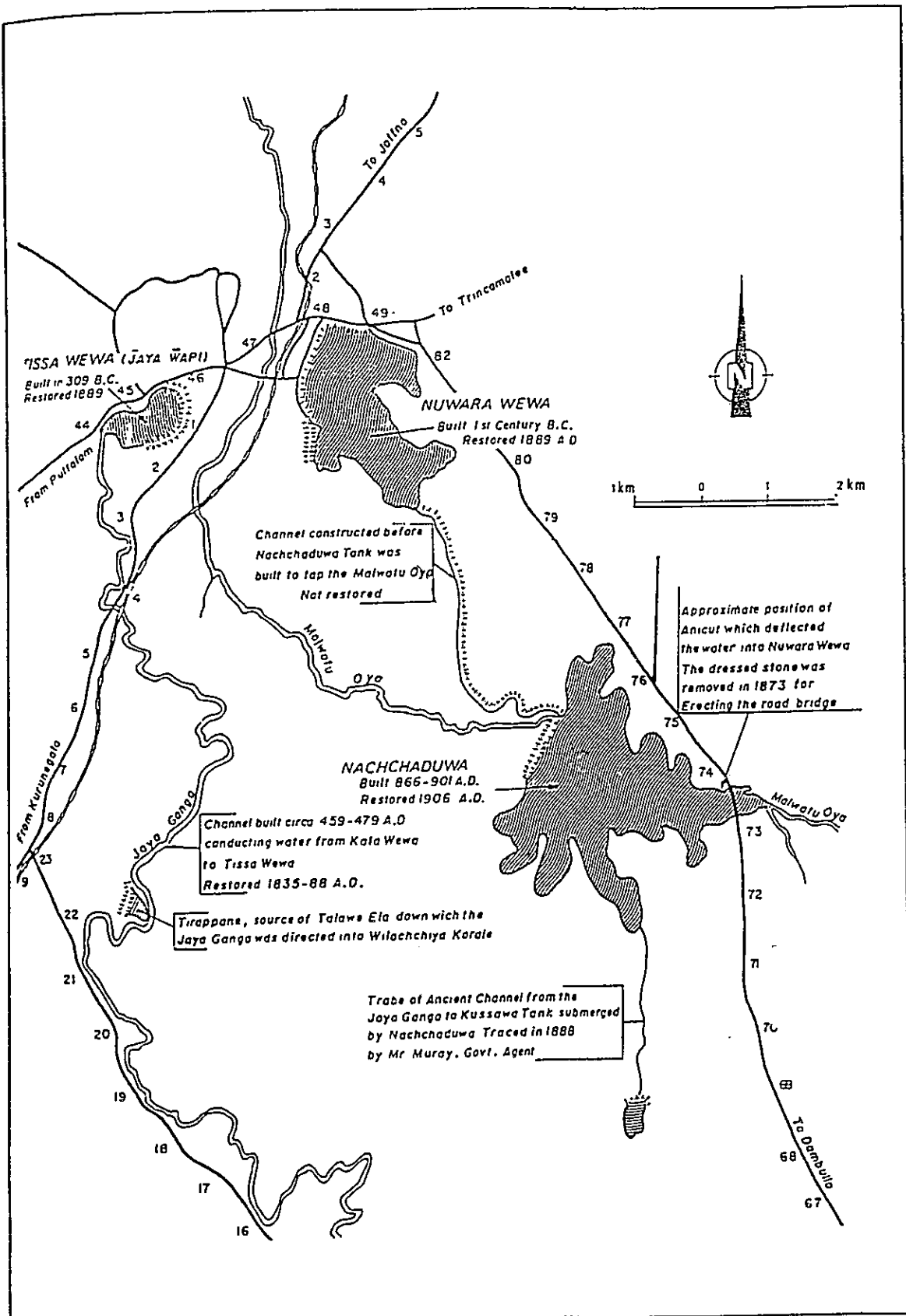
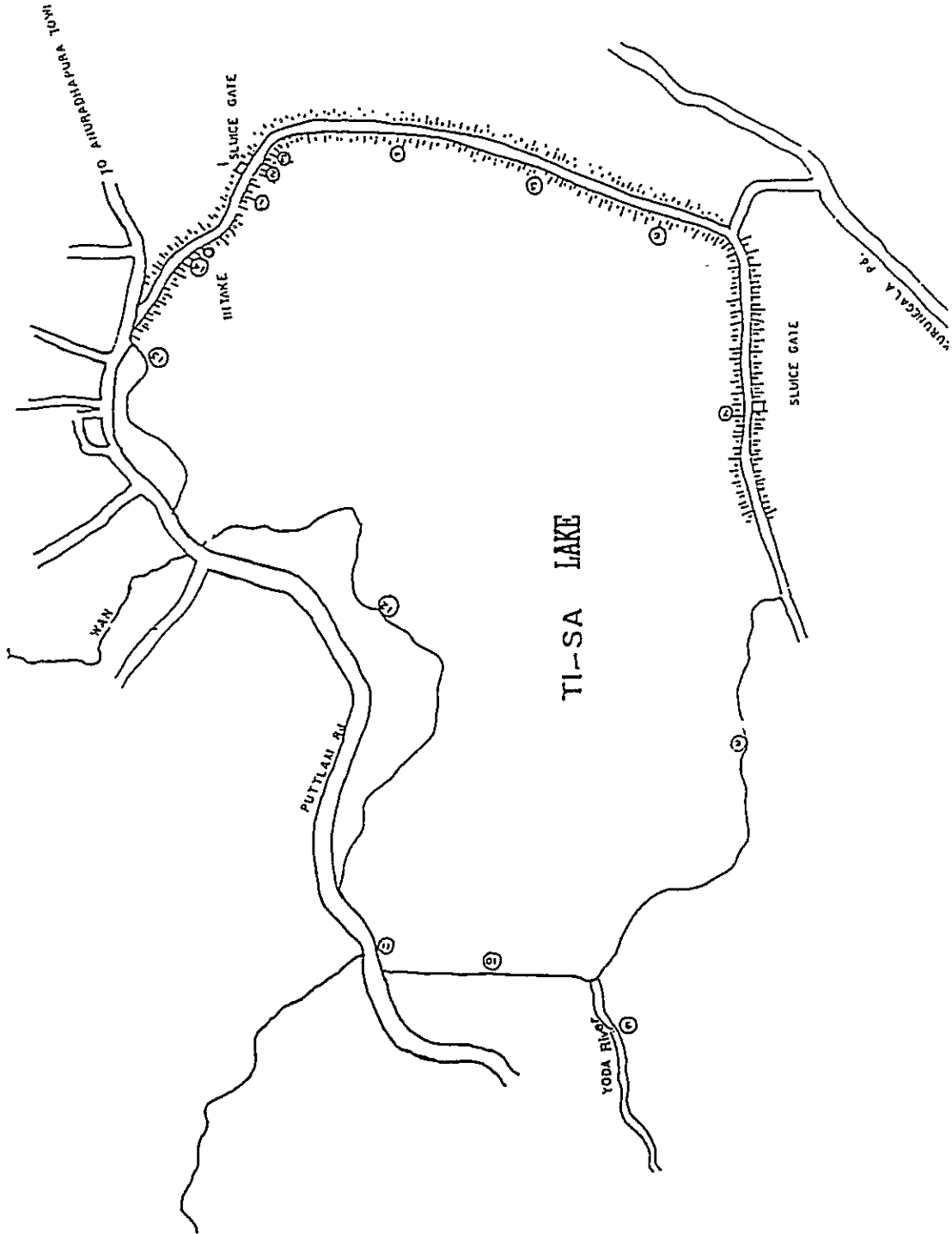
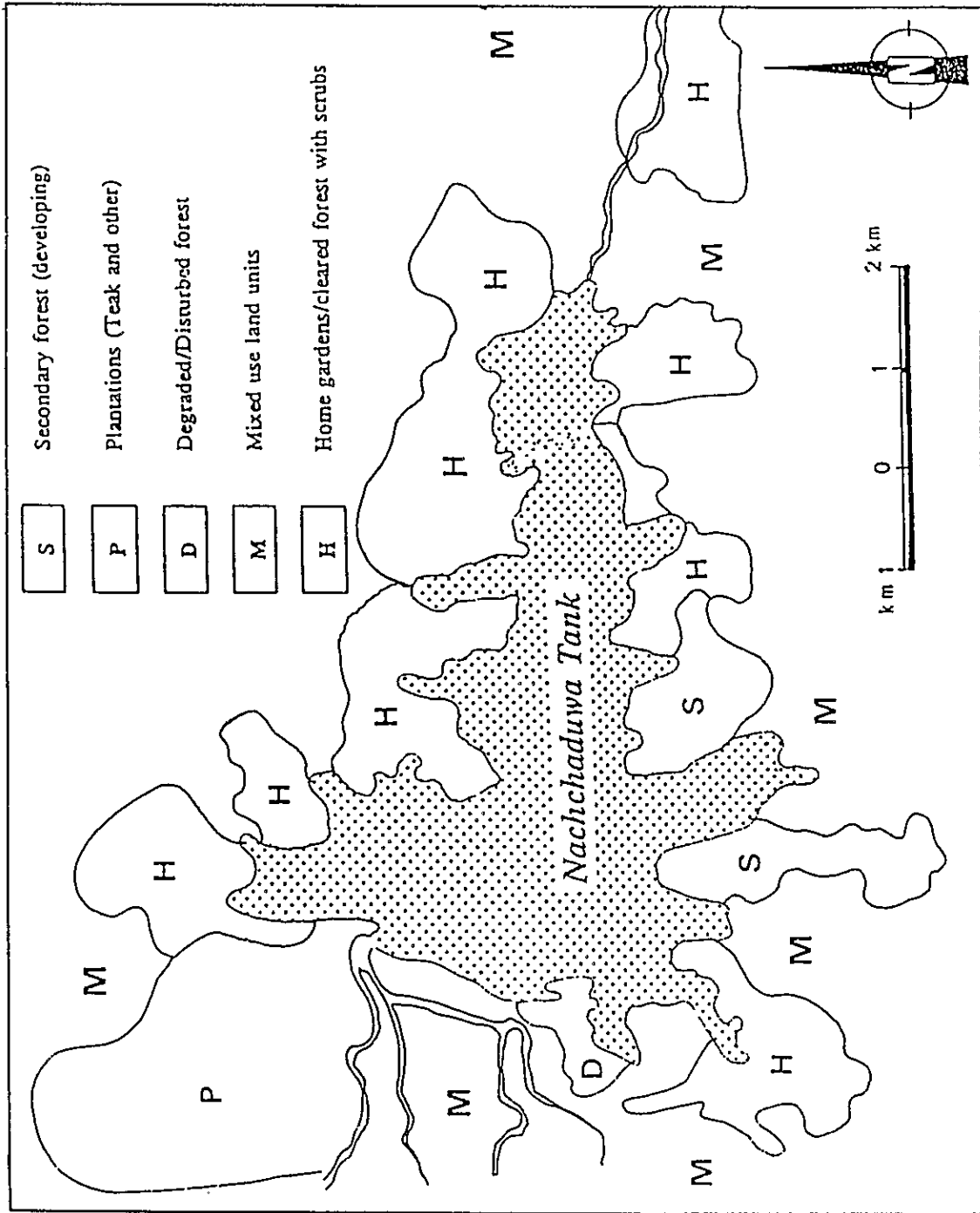


Figure 3

Figure







ground water with surface water the chemical and physical quality of ground water is not good but bacteriological quality is safety than surface water. Especially in dry zone (N.C.P.) ground water contain more minerals like fluorides, chlorides, nitrates etc. and also high conductivity is reported. Therefore we have to give more attention about conservation of our lakes and reservoirs.

#### **CHARACTERISTICS OF NUWARAWEWA**

1. Location :- 1.6 km East of Anurndhapura.
2. Original construction :- King Pandukabhaya (430 BC)
3. Source of supply :- Own catchment and occasional issues from Nachchaduwa
4. Capacity :- 36050 Ac.ft
5. Length of Bound :- 4 miles 1100 ft

#### **CHARACTERISTIC OF THE TIS-SA LAKE**

1. Location :- Along side Anuradhapura Puttalama road
2. Original construction :- King Devanampiyatissa 300 BC
3. Surface area :- 0.105 sq.km
4. Max. depth :- 40 m
5. Mean depth :- 15 m
6. Length :- 20 km
7. Max. with :- 4.0 km

#### **CHARACTERISTICS OF THE NACHCHADUWA LAKE**

1. Location :- Anuradhapura District
2. Original construction :- King Sena II
3. Source of supply :- Malwathu Oya, Maminiya Oya and Kala-Wewa
4. Surface Area :- 17.8 sq.km
5. Length :- 8.5 km
6. Max: Width :- 07 km
7. Volume :-  $5568 \times 10^6$  cu.m.
8. Max: Depth :- 10.67 m
9. Mean Depth :- 7.62
10. Length of :- 32 km  
shore line

f.3.2 Water Quality - NUWARA WEWA.

Parameter	Units	Range of Parameter		SLS - 1983	
		Min	Max	Max. desirable level	Max permissible level
Turbidity	FTU	10	95	10	20
Colour	pt	42	502	5	30
PH	-	7.4	8.6	7.0 - 8.5	6.5-9.0
Electrical conductivity	$\mu$ s/cm	255	470	750	3500
Total Hardness	ppm	104	120	250	600
Total alkalinity	"	78	110	200	350
Total Iron	"	0.06	0.51	0.3	1.0
Ammonium	"	0.3	0.94	-	0.06
Nitrate	"	0	4.84	-	0.03
Phosphate	"	0.16	0.22	-	2.0
Chloride	"	46	63	200	1200
Sulphate	"	0	9.0	200	400

f.1.2 Water Quality - Tisa Lake

Parameter	Units	Range of Parameter		SLS - 1983	
		Min	Max	Max. desirable level	Max permissible level
Turbidity	FTU	8	50	10	20
Colour	pt	42	275	5	30
pH	-	7.4	8.2	7.0 - 8.5	6.5-9.0
Electrical conductivity	µs/cm	260	360	750	3500
Total Hardness	ppm	84	115	250	600
Total alkalinity	"	80	130	200	400
Total Iron	"	0.05	0.15	0.3	1.0
Ammonium	"	0.2	0.6	-	0.06
Nitrate	"	0.9	7.5	-	10
Phosphate	"	0.07	0.26	-	2.0
Chloride	"	24	96	200	1200
Sulphate	"	0	9.0	200	400

(c) Water Quality - NACHCHADUWA LAKE

Parameter	Units	Range of Parameter		SLS - 1983	
		Min	Max	Max. desirable level	Max permissible level
Turbidity	FTU	6	35	10	20
Colour	pt	42	270	5	30
PH	-	6.83	8.11	7.0 - 8.5	6.5-9.0
Electrical conductivity	s/cm	207	623	750	3500
Total Hardness	ppm	60	198	250	600
Total alkalinity	"	24	130	200	400
Total Iron	"	0.08	1.98	0.3	1.0
Ammonium	"	0.01	0.93	-	0.06
Nitrate	"	0.04	2.32	-	10
Phosphate	"	0	0.03	-	2.0
Chloride	"	25	85	200	1200

## **PRESENT PROBLEMS IN LAKES AND RESERVOIRS IN NORTH CENTRAL PROVINCE OF SRI LANKA**

1. Eutrophication of the lakes and development of odour and colour due to growth of Algae in water, which cause the inefficient filtration process.
2. Eutrophication cause Humic acid formation in water, because of this during chlorinating process THM formation suspected in our water supply schemes.
3. Contamination by Agrochemicals.
4. Contamination by Heavy metals. this is not a big problem for lakes and reservoirs in North Central Province, but in some other lakes in Sri Lanka is much effected by heavy metals.
5. Domestic sewage contamination and contamination of faecal coliforms.
6. Extraction of ground water through agro-wells and hand pump wells may deplete surface water level.

## **PROPOSED WATER QUALITY MANAGEMENT PLAN**

### **1. Water Quality Monitoring In Lake**

1.1 Selection of the sampling points in TIS-SA lake and NUWARA WEWA and carry out sampling for once a month for following analysis.

Total Nitrogen  
Total phosphate  
Colour  
Turbidity  
PH  
Total Hardness  
Total Alkalinity  
Electrical Conductivity  
BOD, COD and DO  
Suspended solids

1.2 Daily monitoring is important for the following parameters because these lakes are specially use for drinking purposes.

Transparency	Turbidity
Colour	Temperature
Electrical conductivity	Total solids

1.3 Eutrophication cause mainly due to increase of Nitrates and Phosphates in water therefore much concern about these two parameters and data should be analyse through the year.

1.4 Carry out investigation about contamination by agrochemicals, specially Cl and P contain chemicals.

1.5 Carry out investigation about effluents come from Rest Houses, Hotels and factories.

## **2. Research Activities**

2.1 Eutrophication causes humic acid formation in lakes and this humic acid enhance carcinogenic chemicals like THM formation during disinfection process therefore carry out research about this THM in our water purification plants.

1. Anuradhapura New Town Water Supply Scheme.

2. Anuradhapura Sacred City Water Supply Scheme.

2.2 THM concentration is increase during boiling of water therefore carry out research to find out this phenomenon in our water purification plants.

2.3 Free chlorination process enhance specially THM formation therefore avoid free chlorination as far as possible and find out possibility of avoiding free chlorination in our water purification plants.

2.4 Identification of various kinds of Zooplanktons and Phytoplaktons in lakes and carry out algae counting in specific sampling points of the lakes.

2.4 Identification of fish species and Amphibians in the lake.

## **3. Water Quality Monitoring In Drinking Purposes**

3.1 After purification ,carry out residual chlorine (RCI) checking once an hour in our water purification plant and two times per day in distribution system.

3.2 Carry out monitoring of following parameters in two times per day in our purification

plant.

Turbidity  
Colour  
Electrical conductivity  
Total solids  
Temperature

3.3 Carry out bacteriological analysis according to the Sri Lanka standards

1. Total Coliform test
2. E.coli test

3.4 For a special conditions following analysis should be recommended:

Cyanide	Arsenic
Lead	Chromium(Hexavalen)
Mercury	Fluorid
Cadmium	Pesticides

3.5 Minamata and Itai-Itai diseases occurred in Japan during the 1940s and 1960s at the time of the country was witnessing rapid industrialization simultaneously .basic cause of these disease was identified to the water pollution caused by industrial effluent containing mercury and Cadmium. therefore with considering Japanese experience we have to give more attention about cadmium and mercury pollution.

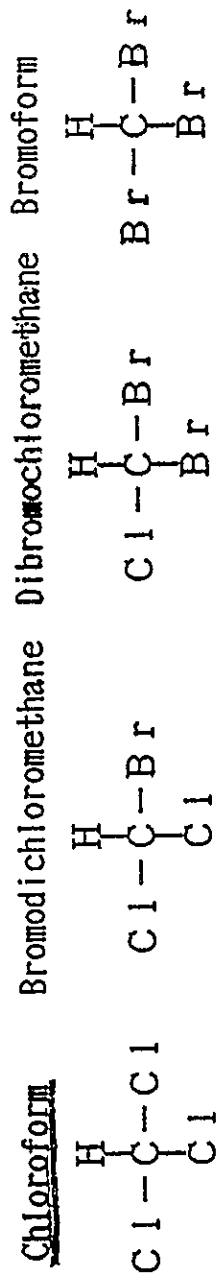
#### **4. Institutional Co-Operation**

4.1 Institutional co-operation is very important for preservation of water quality in lakes. therefore following institutes should be co-operated as far as possible,

1. National Water Supply and Drainage Board (N.W.S.D.B)
2. Irrigation Department (I.D.)
3. Central Environment Authority (C.E.A)
4. Urban Councils (U.C.)
5. Sri Lanka Standards Institution (S.L.S.I.)

4.2 Lake water quality standards should be set up by the co-operation of above mention institutions.

## T r i h a l o m e t h a n e

Chlorination of humic acid

Trihalomethane

$$[\text{THM}] = 8.2 \times 10^{-4} (\text{pH} - 2.8) [\text{TOC}] [\text{Cl}_2]^{0.23} t^{0.36}$$

TOC : Total Organic Carbon (mg/l)Cl<sub>2</sub> : Chlorine (mg/l)

t : reaction time(hours)

(K.Urano et al., Water Res., 17, 1797-1802 (1983))



## Why is Trihalomethane Detected in Drinking Water?

Lakes and Rivers (THM concentration should be zero.)

### Eutrophication



Increase of phytoplankton

Increase of humic acid

Treatment by chlorine for decomposition of organic substances and sterilization of drinking water

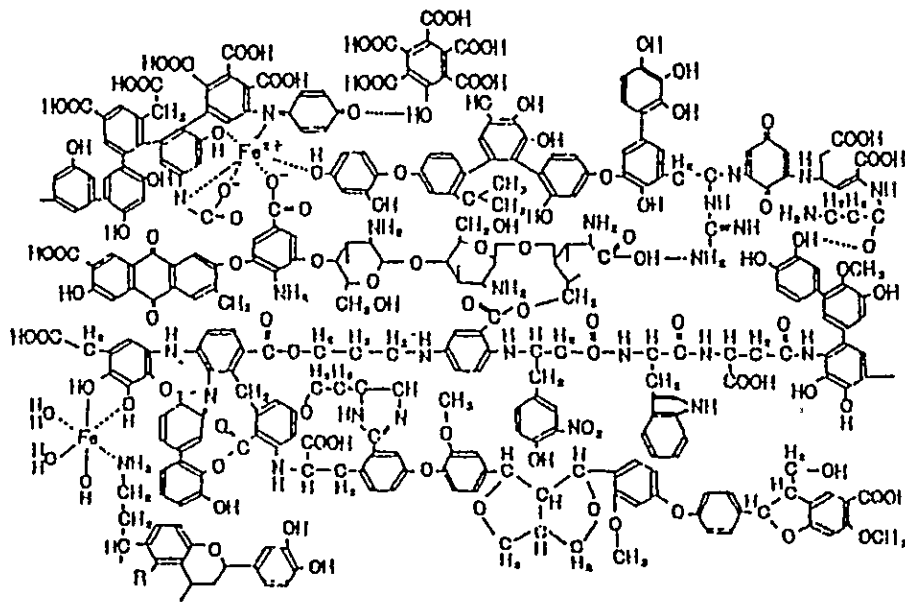
### THM and TOX

THM (100 $\mu$ g/l)  $\rightarrow$  Possibility of cancer  
(4 person/100,000 person)

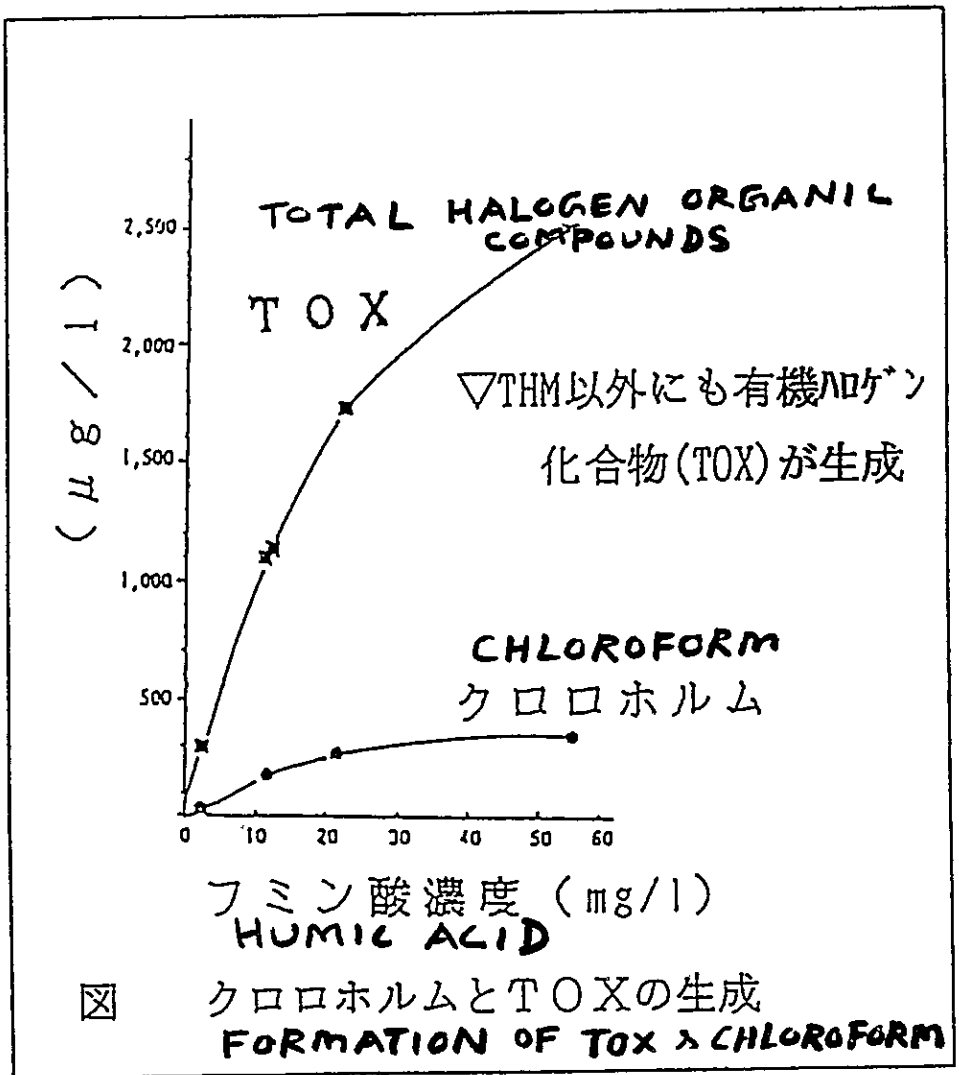
Phytoplankton

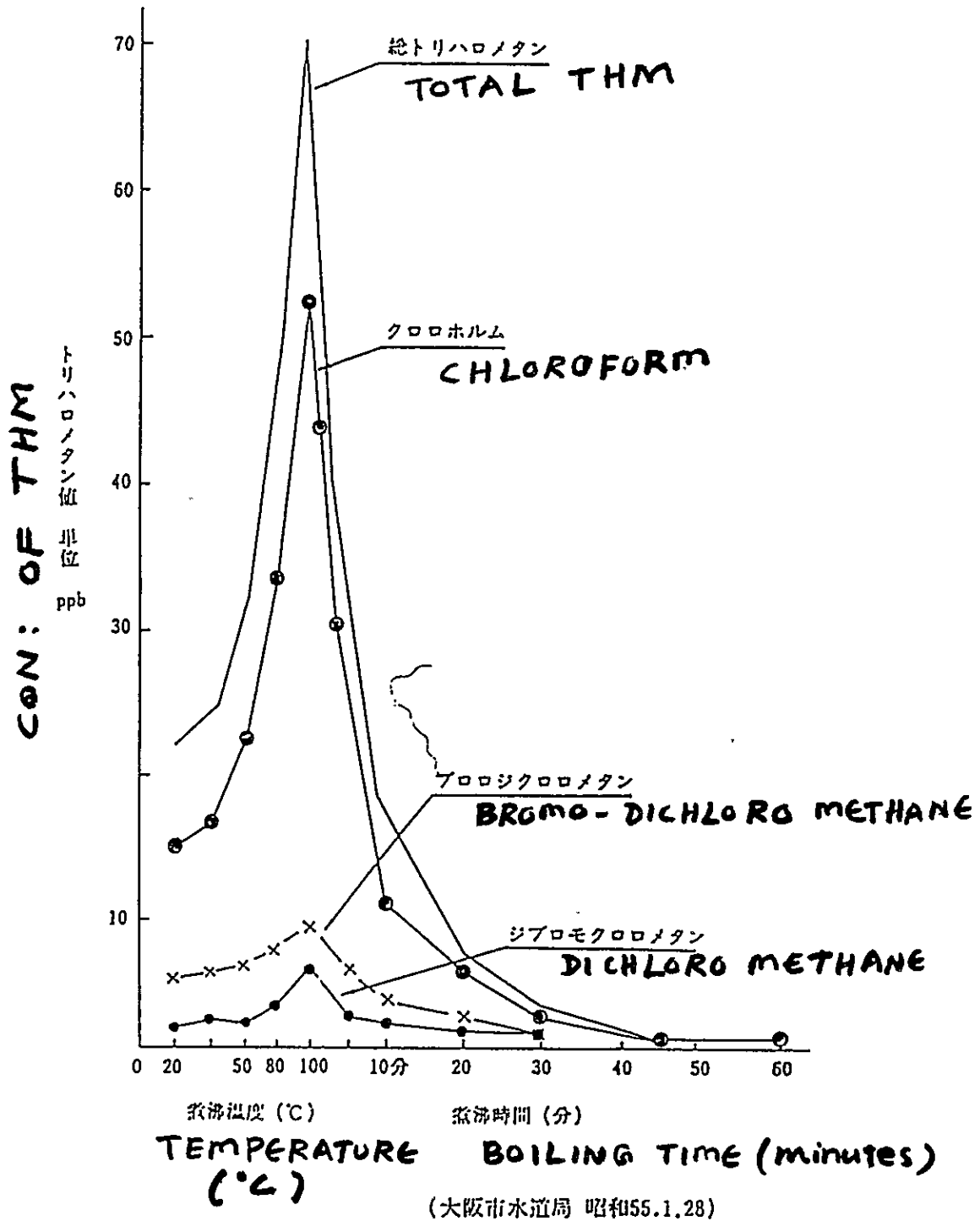
↓  
Decomposition

↓  
Humic Substances



↓  
Inorganic Substances





4.3 Revision of drinking water quality standards according to regional requirements.

4.4 Water pollution laws should be strictly implemented.

4.5 Laboratory facilities, qualified staff and other necessary facilities should be provided towards the water quality monitoring section of the relevant organization.

4.6 Public awareness and environment education is very important not only for children but also adults.

#### **REFERENCES**

1. Chemistry in Sri Lanka volume 12 No 1
2. Wetland Site report for Nachchaduwa.
3. Sri Lanka Standards 614:1983 specification for potable water part-1
4. Hand book for Monitoring of Lake Water Quality.
5. The future of LAKE BIWA
6. Guidelines of Lake Management, volume-4

#### **ACKNOWLEDGEMENT**

I would like to express my thanks and appreciation to the government of Japan through JICA for giving me an opportunity to attend this training course and the government of Sri Lanka and National Water Supply And Drainage Board which supported and allowed me to participate in this training course.

My special thanks to all Lectures who gave me useful knowledge and to the ILEC members who organized this successful program.

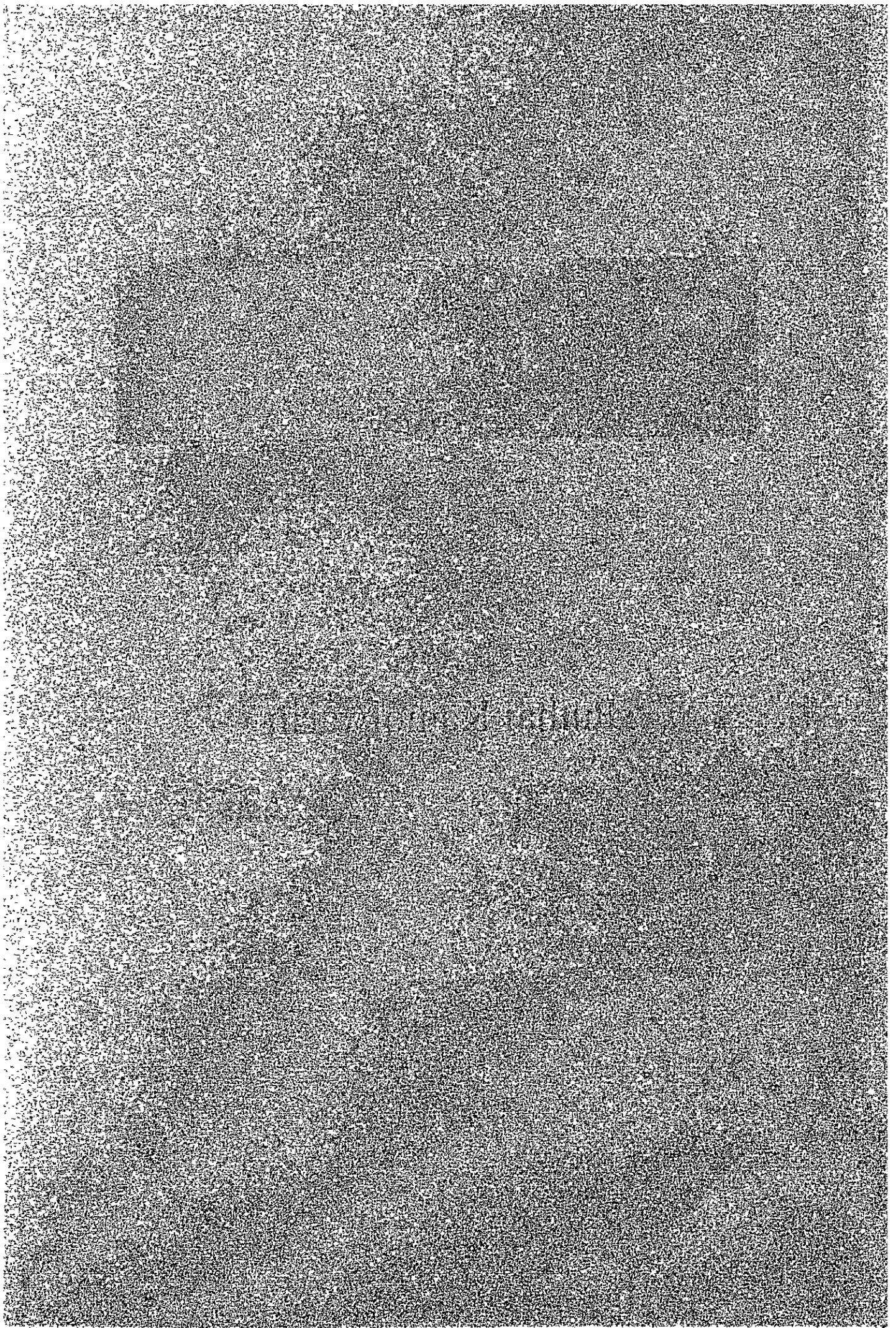
I wish to express my sincere gratitude to our co-ordinator, Mr. Hideki Kanematsu and Mr. Kinjiro Toda and Training officer Miss. Mikiko Oba and ILEC/OSIC all staff members.

And last but not the least, I would like to express my sincere thanks to our Japanese language teachers and all new friends for the unforgettable and enjoyable time I had with them.



# Thailand

Puthai Kamolwarin





# **CHO-PHARYA RIVER WATER QUALITY MANAGEMENT**

*Puthai Kamolwarin  
Thailand*

## **INTRODUCTION**

Thailand has traditionally been an agricultural country and major food exporter. It experienced rapid industrialization and double-digit economic growth through the 1980s. While economic growth has tapered off in the 1990s to about 8 per cent, industry's share of the Gross Domestic Product continues to rise today is more than twice that of agriculture's. Thus Thailand is well on its way toward becoming a newly industrialized country. With the rapid growth of the population and industries, more water is required for their needs. River, lake or reservoir are therefore under direct pressure in terms of their ability and use for domestic consumption and for agricultural, industrial and navigation purpose.

Chao-phraya is the most important river in the central part of Thailand because it flows through nine provinces and capital. The water in river decreases during hot season and thus causing more pollution and also scarcity of water. The rapid rate of socio-economic development in river basins has come to be recognized increasingly as a major threat to the quality of the river environment.

Its agricultural growth, demands for more irrigation and drainage systems, use of fertilizers and pesticides, building of factories, released of un-treated domestic and industrial wastes into the river is causing serious environmental damage.

## **SOURCES OF WATER POLLUTION**

Water use in this area include domestic consumption, industrial, irrigation, fisheries, tourism and for livestock. The industrial activities is fast growing. Some industries are located near Chao-phraya river and waste water from some industries directly discharged into river without treatment, thus resulting in water pollution.

When the population and human activities around the river are expected increase, the discharge loads generated in the river would increase and some activities caused high nitrogen and phosphorus in water, resulting in eutrophication and deterioration in water quality. The sewage and kitchen waste from the home is directly discharged into the river without un-treatment.

Today, farmers in Thailand who lived near Chao-phraya river used many

chemicals. Agricultural chemicals to increase production of grains. The farmers use lot of fertilizers and pesticides and this waste water contains lot of harmful substances from agriculture field and finds its way to river thus causing pollution to water.

Water hyacinths in the river are proliferate at tremendous rates in tropical. When the entire surface of a river is covered by water hyacinths, navigation becomes impossible. In addition, since the surface cover prevents light from entering, photosynthesis by plankton does not take place, causing the river to become anoxic, and tap water to become malodorous.

### **WATER QUALITY MANAGEMENT**

Before I came to Japan for lake water quality management training course, I wished to get something, that I could apply to my work in rivers, lake or reservoirs in my country. Case study of lake Biwa and observation around the lake me understood.

River, Lake or reservoirs are utilized by man for :

- Production of drinking water
- Production of electricity
- Agriculture
- Industry
- Fishery
- Discharge of waste water

Water quality for drinking water needs more stringent water quality standards than for the other purpose, In the cause of health risk, 80% of all diseases affecting man are due to inadequate water or sanitation which include the effect of drinking contaminated water.

All activities are affected by the quality of water. It is essential that information collected from monitoring reach the relevant decision-makers quickly so that rational decisions can be made on time. Accordingly, for a rational management system, monitored information should be channelled in a timely fashion so that it can be converted into decision and action.

Monitoring of river, lake or reservoir are complex process since a large number of regular and specific tasks have to be performed, both concurrently and sequentially, in a coordinated manner, by variety of professions, within available expertise, time and resources.

The water quality monitoring may include:

- monitoring of exposure of human beings and living environment to pollutants

- monitoring of effluent of pollutants from the sources
- monitoring survey of river environmental quality standard
- monitoring survey of factory effluent
- monitoring by automatic measurement of water quality which serves as a primary warning system for water supply management.
- evaluation of improvements resulted from implemented measures

The pollution loads should be reduced by the measures:

- sewage construction for treatment of waste water
- construction of a raw sewage treatment plant by the introduction of tertiary treatment
- Control of effluent from agriculture and livestock industry through control of water and effluent and use of appropriate fertilizers
- removal of water hyacinths

### **ENVIRONMENTAL EDUCATION AND ACTIVITIES**

I learnt from lake Biwa case study, the management of one river or lake in good condition comprised many factors, and the most important factor was people. Environmental education is becoming an increasingly important part of education in schools and lifelong learning, because solving of environmental cannot be attained by legal, administrative measures and technology alone. The people who judges the state of the environment should not just of scientists or administrators but citizens. That is, citizens should be central to overcoming environmental crisis.

Therefore, it should be essential the citizens have ability to:

- Understand environmental problems with scientific eyes
- Make decisions about technology and society
- Act on the basis of their own decisions

The national government or local government be promote environmental education and activities are as following:

- Promotion of non-phosphorus detergents
- Citizen's participation in rivershore cleanup
- Rivershore municipalities designate each a village to watch water quality and illegal garbage dumping into the river
- Training on simple monitoring techniques is given to volunteer in the villages near river

- Promoted environmental education to farmers, house-wives, students in primary and high school
- A long-distance swimming or boat-race meet is held every year in the river to encourage people to experience the real river water quality

### **COOPERATION AMONG ORGANIZATION**

Chao-phraya river is a very important in the central part of Thailand and the way to keep or prevent water pollution in the river is not quite easy because of river flows through nine province and capital.

Organizations must be cooperated together:

1. Ministry of Public Health
  - Department of Health
2. Ministry of Industries
  - Department of Industries
3. Ministry of Interior
  - Department Public Works
4. Ministry of Agriculture
5. Local government

### **ENVIRONMENT LEGISLATION**

Component shall involve the formulation and recommendation of appropriate policies to the national and local governments that will support all the conservation activities for river, lake or reservoir.

### **CONCLUSION**

However, I think the plans can not succeed and finish without understanding and cooperation among many organizations and people. The ideas learnt from this training course has broadened my knowledge in water quality management.

Water quality was protected successfully in Japan, Lake Biwa is exactly typical case, a lot of experience can be use for reference for implementation of comprehensive water quality in my country.

## REFERENCES

1. Guidelines of lake Management Volume 1 Principle of Lake Management
2. Guidelines of lake Management Volume 2 Socio-Economics Aspects of lake Reservation Management
3. Directory of Water Related International Cooperation 1995
4. International Conference on the conservation and Management of lake-Ksumigaura '95
5. Appropriate Technology and Measures for lake Environment Conservation Chap 8-Monitoring for lake Biwa Quality Preservation
6. UNCRD Newsletter No. 40, Autumn 1995

## ACKNOWLEDGEMENTS

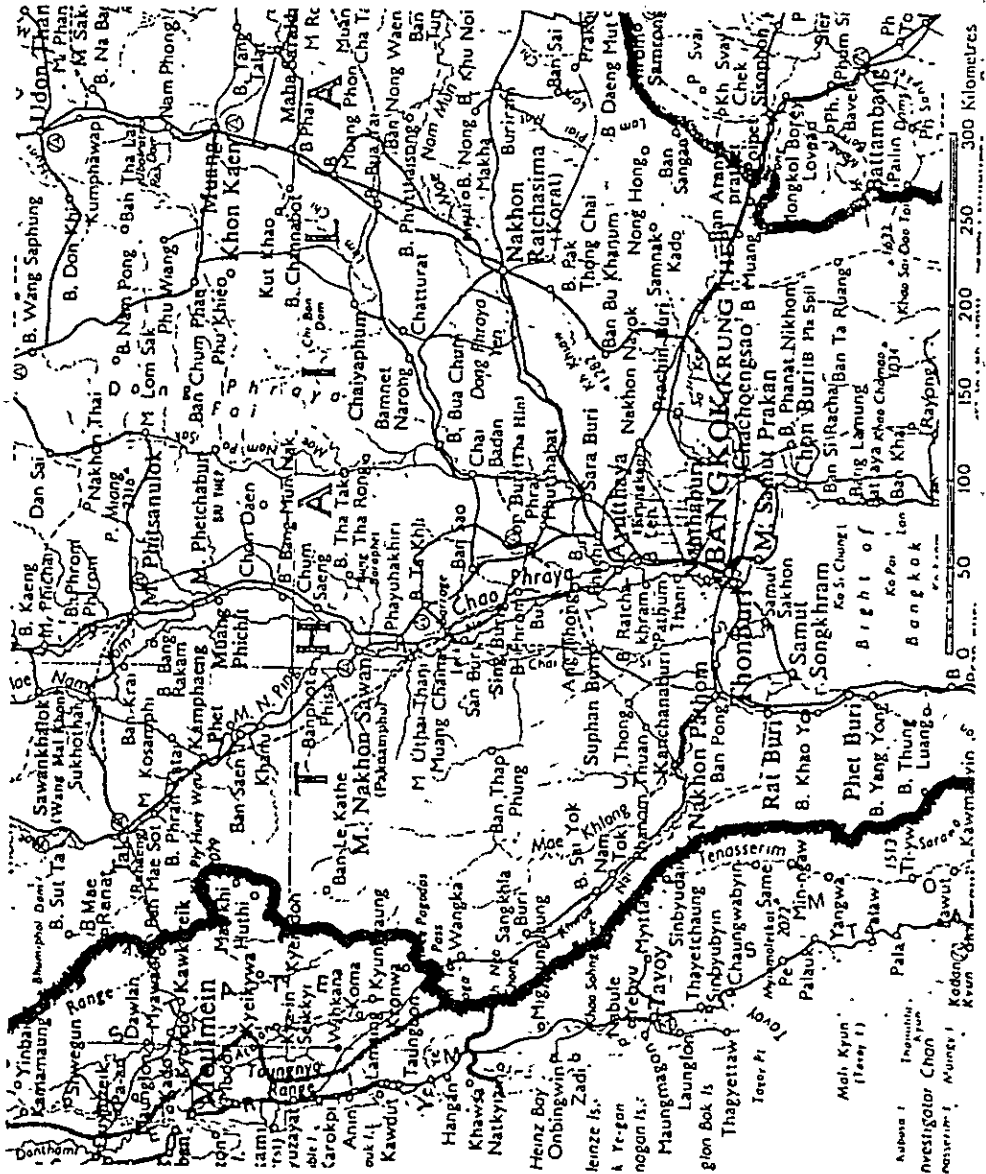
First of all, I would like to express my sincerest gratitude to the Japan International Cooperation Agency for giving me the opportunity to attend this training and experience the environmental management in Japan. Thank you all lectures, ILEC and ILEC staffs for helps and the facilities through the course and my coordinator for his patience and efficiency.

And for all of my participants from different country who brought me joy during the almost three months like brothers and sisters. I will keep a good memory in my life.

The last, my special thanks to my sister in Japan Ms. Sachiko Mizutani and her family.

*Sayonara, La kon, Sawaddee Krab.*

さよなら ラ コン スワディ カブ



# Photo Plates





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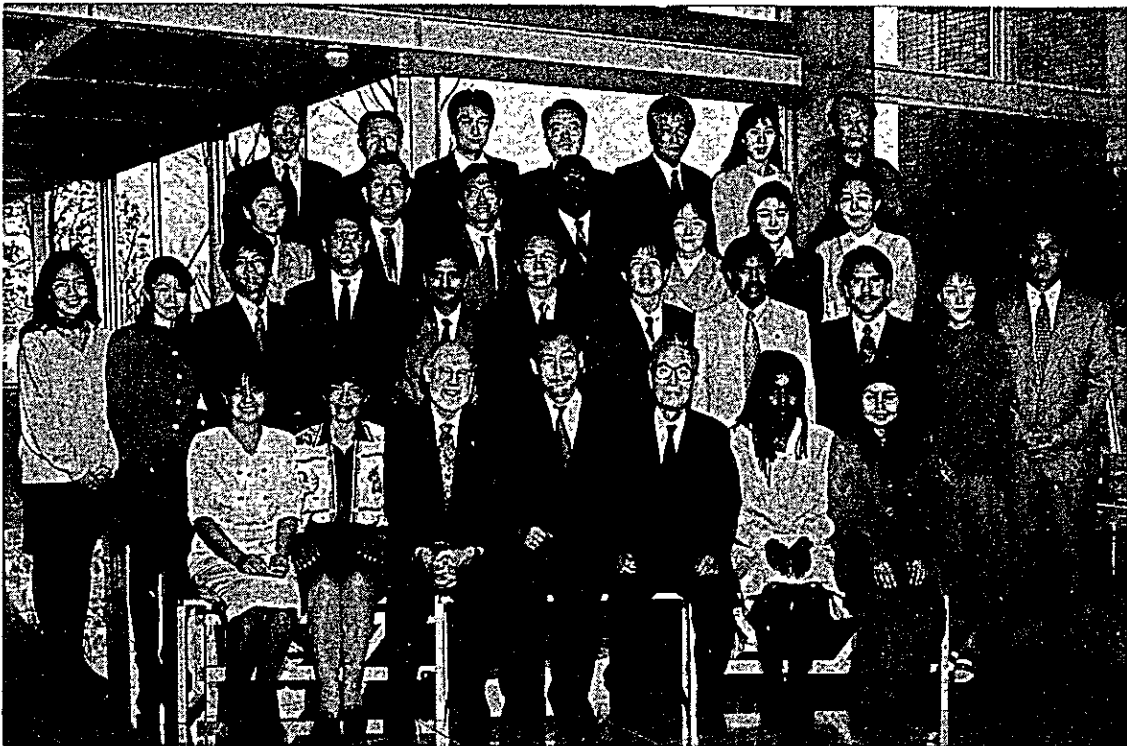
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*PHOTO ALBUM*

研 修 写 真

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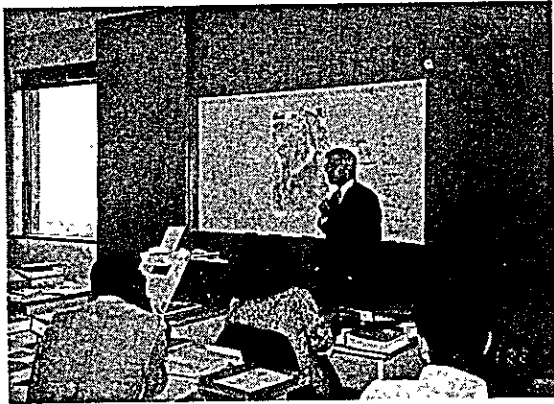


**Closing Ceremony of Lake Water Quality Management Course  
(January 22 to March 22, 1996) Sponsored by ILEC/JICA**

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**LECTURE**

講 義

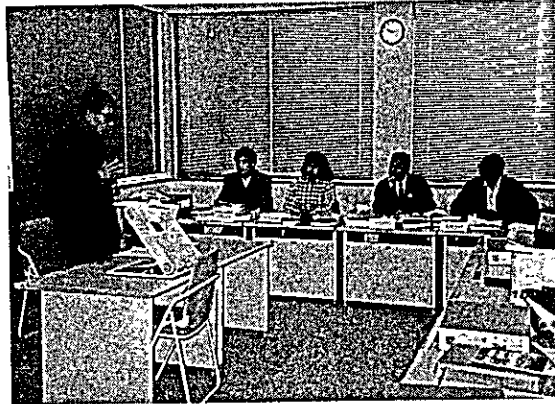


January 22

Lecture by Dr. Nakamura,  
Introduction to Lake Biwa.

1月22日

琵琶湖概要に関する講義  
中村正久(琵琶湖研究所所長)



January 24

Lecture by Prof. Kira, Principle of  
Lake/Reservoir Management.

1月24日

湖沼管理の基本概念  
吉良龍夫(国際湖沼環境委員会副理事長)



February 21

Lecture by Mr. Sugatani, Japanese  
Environmental Administration.

2月21日

環境行政と地球環境に関する講義  
菅谷 晋(環境庁課長補佐)



February 5

Lecture by Dr. Ide, Basic Knowledge of  
Water Quality data Processing.

2月5日

水質データの活用法に関する講義  
井手慎司(滋賀県立大学助教授)



**March 6**

**Practice on Water Quality Analysis.  
(Ryukoku University)**

**3月6日**

**水質分析実習（龍谷大学）**



**March 6**

**Practice on Water Quality Analysis.  
(Kyoto University)**

**3月6日**

**水質分析実習（京都大学）**

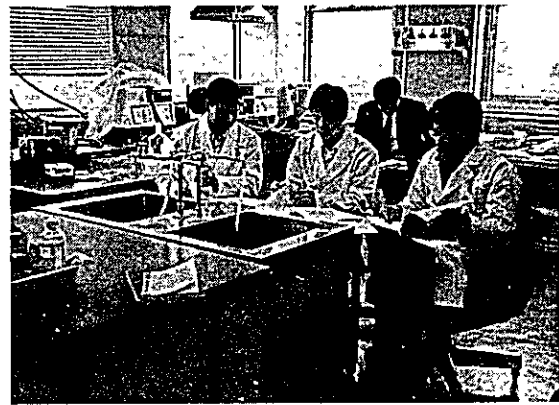


**March 6**

**Practice on Water Quality Analysis.  
(Shiga University)**

**3月6日**

**水質分析実習（滋賀大学）**



**March 6**

**Sampling on Water Quality.  
(Institute of Public Health and  
Environmental Science)**

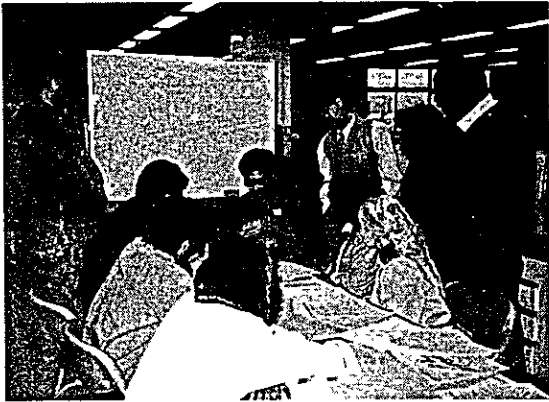
**3月6日**

**サンプリング実習（滋賀県衛生環境センター）**

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## OBSERVATION

### 見学

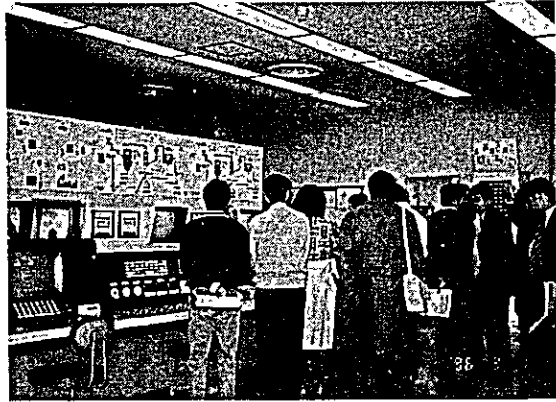


February 27

In the Studies of Basic Knowledge of  
Laboratory Facilities & Gas  
Chromatography. (Shimadzu Corporation)

2月27日

分析機器の基礎知識 (島津製作所)



March 1

Field study on a Refuse Burning Plant.

3月1日

大津市ゴミ焼却場見学



February 2

Field study on a Waste Water  
Treatment Plant.

2月2日

湖南中部流域下水道見学



February 22

Field study trip to National Institute for  
Environmental Studies.

2月22日

国立環境研究所訪問

## ANNEX

### Number and Nationality of the Participants (1991- 1996)

	Jan-Mar 1991	Jan-Mar 1992	Jan-Mar 1993	Jan-Mar 1994	Jan-Mar 1995	Jan-Mar 1996	Total
Argentina	1	1					2
Bolivia			1	1	1	1	4
Brazil		1	1	1	1	1	5
Cambodia				1		1	2
Chile					1		1
China	1	2	1	1		1	6
Egypt				1	1		2
Ghana	1		1			1	3
Guatemala					1		1
India			1		1	1	3
Indonesia	1	1	1	1	1		5
Kenya	1	1		1		1	4
Macedonia					1		1
Malaysia	1					1	2
Nicaragua		1					1
Paraguay	1						1
Pakistan					1		1
Peru						1	1
Philippines		1	1	1	1	1	5
Poland					1		1
Singapore				1			1
Sri Lanka					1	1	2
Syria			1				1
Thailand	1	1	1	2		1	6
Turkey			1				1
Venezuela		1	1	1	1		4
Zimbabwe	1	1					2
Total	9	11	11	12	13	12	68

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**Final Report**  
**6th GROUP TRAINING COURSE**  
**IN**  
**LAKE WATER QUALITY MANAGEMENT**  
平成8年4月

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