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THE 11TH CONFERENCE ON PUBLIC WORKS RESEARCH AND DEVELOPMENT IN ASIA

Proceedings

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National Institute for Land and Infrastructure Management
Ministry of Land, Infrastructure and Transport
Government of Japan

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The 11th Conference on Public Works Research and Development in Asia

Proceedings

December 2002

Synopsis

This report summarizes the country reports from each participating country, documents provided for discussion, records of the lectures, schedule, symposium, on-site tour report, list of participants and outlines of the debates on the 11th Conference on Public Works Research and Development in Asia held from Oct. 15, 2002 to Oct. 24, 2002 at the National Institute for Land and Infrastructure Management (NILIM) in Tsukuba and the Bankoku Shinryokan in Okinawa.

Keywords : Sustainable development, Water management,
Water resources, Country report, NILIM,
Conference on Public Works Research and Development in Asia,
National Institute for Land and Infrastructure Management

FOREWORD

The 11th Conference on Public Works Research and Development in Asia (The Fifth Executives' Seminar on Public Works and Management) was held by the National Institute for Land and Infrastructure Management (NILIM) with the support of the Japan International Cooperation Agency (JICA) at NILIM in Tsukuba City and at the Bankoku Shinryokan in Okinawa Prefecture from Tuesday, October 15 to Thursday, October 24, 2002.

The Conference has been held every year since 1992 to permit officials in charge of civil engineering technology development in the countries of Asia to gather at one location to exchange views and to create a research exchange network.
(up to 2000, held by the Public Works Research Institute of the former Ministry of Construction)

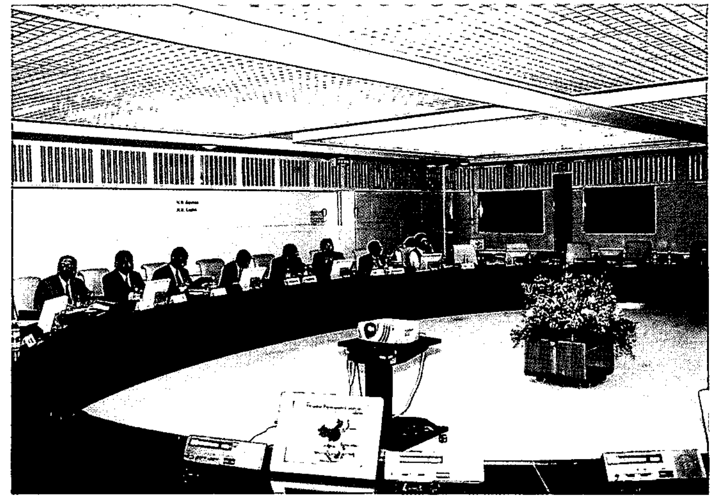
Representatives of ten countries, India, Indonesia, Korea, Laos, Malaysia, Pakistan, Philippines, Sri Lanka, Thailand, and Japan, attended the 11th Conference. In line with the theme, Water Resources and River Management for Sustainable Development, the delegates debated the present status of, need for, and problems facing research and development of public works technology to lower environmental loads in the participating countries. The Conference was a great success.

This report summarizes the country reports from each participating country, documents provided for discussion, records of the lectures, and outlines of the debates. We hope that all of you will make good use of its contents. In conclusion, we would like to express our deep gratitude to everyone for their cooperation that made this event possible.

Secretariat of the Conference

The 11th Conference on Public Works Research and Development in Asia

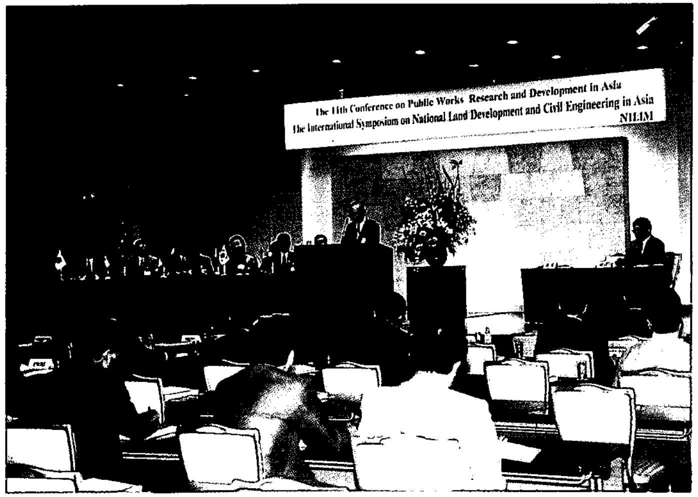
Courtesy call on Director General of NILIM
(Oct. 15, 2002)



Discussion (Oct. 17, 2002)

Courtesy call on State Secretary for Land,
Infrastructure and Transport (Oct. 18, 2002)

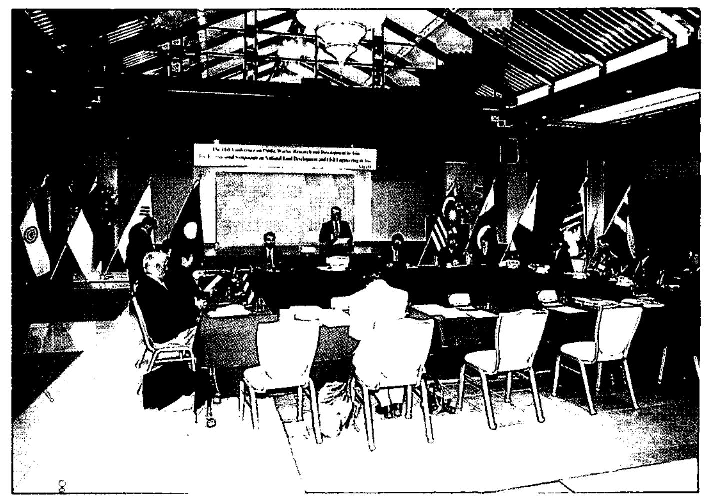
Study Tour (Ohtsu Auxiliary Conduit; Oct. 19, 2002)



Opening Ceremony (Oct. 22, 2002)

The 11th International Symposium on National Land Development and Civil Engineering in Asia (Oct. 22, 2002)

Study Tour (Taiho Dam; Oct. 23, 2002)



General Discussion (Oct. 24, 2002)

CONTENTS

A. PROGRAM

I. Program 1

II. Objectives and Details 13

B. MINUTES

I. Minutes 61

II. Conclusion 81

C. LECTURES

Hydrology and Water Resources in Monsoon Asia 85
Dr. Katsumi MUSIAKE
President, Japan Society of Hydrology and Water Resources
Department of Human and Society, Institute of Industrial Science, University of Tokyo

Flood and Sediment-related Disasters in Japan 123
Mr. Yasuo NAKANO
Director, Research Center for Disaster Risk Management, NILIM

D. COUNTRY REPORTS

JAPAN 141

INDIA 167

INDONESIA 187

LAOS 197

MALAYSIA 217

PAKISTAN 231

PHILIPPINES 243

SRI LANKA 263

THAILAND 287

A. PROGRAM

Ⅰ. Program

E. SYMPOSIUM

Program ··· 314

Lecture 1 —Case of Japan Ⅰ— ··· 315

Lecture 2 —Case of Japan Ⅱ— ··· 349

Lecture 3 —Case of Korea— ··· 369

Lecture 4 —Case of India— ··· 393

Lecture 5 —Case of Philippines— ··· 413

Lecture 6 —Case of Pakistan— ··· 445

Lecture 7 —Case of Okinawa in Japan— ··· 473

F. ON-SITE TOUR REPORT

On-Site Tour Report ··· 487

1. Schedule of the Conference

Oct. 14 (Mon)	:	Arrive in Japan	(Tsukuba)
15 (Tue)	:	JICA Orientation Courtesy Call on Director-General of NILIM Tour of Research Laboratories of NILIM	(Tsukuba)
16 (Wed)	:	The 5th Executives' Seminar on Public Works and Management Lectures Session on Specific Subjects	(Tsukuba)
17 (Thu)	:	Session on Subject of Common Interest	(Tsukuba)
18 (Fri)	:	Session on Specific Subjects Courtesy call on State Secretary for Land, Infrastructure and Transport Study Tour	(Tokyo)
19 (Sat)	:	Move (Tokyo → Kyoto) Study Tour	(Kyoto)
20 (Sun)	:	Study Tour	(Kyoto)
21 (Mon)	:	Study Tour Move (Kyoto → Okinawa)	(Okinawa)
22 (Tue)	:	The 11th Conference on Public Works Research and Development in Asia Opening Ceremony The 11th International Symposium on National Land Development and Civil Engineering in Asia Welcome Reception	(Okinawa)
23 (Wed)	:	Study Tour	(Okinawa)
24 (Thu)	:	Concluding Session General Discussion JICA Evaluation Preparation for Leaving	(Okinawa)
25 (Fri)	:	Leave Japan	

2. Session Program of the Conference

October 14 (Mon.) **Arrive in Japan**

Stay at Okura Frontier Hotel Tsukuba
TEL. 0298-52-1112 FAX 0298-52-5623

October 15 (Tue.) **Place : NILIM**

In the morning	JICA Orientation
13:30 ~ 14:00	Pre-Conference Meeting
14:00 ~ 15:00	Courtesy Call on Director-General of NILIM
15:00 ~ 17:00	Tour of Research Laboratories of NILIM
	① River hydraulics laboratory
	② Coastal hydraulics laboratory
	③ Sabo model(Exhibition hall)
	④ Road environmental field(Test track)
	⑤ Test track
17:00	Lv. NILIM for Hotel
18:00 ~	Welcome Party hosted by Director-General of NILIM (at the Subaru Room, Okura Frontier Hotel Tsukuba) Director-General of GSI, Executives of PWRI, Managing Director of TBIC, etc.

Stay at Okura Frontier Hotel Tsukuba
TEL. 0298-52-1112 FAX 0298-52-5623

October 16 (Wed.) **Place : 8F International Conference Room, NILIM**

9:30 ~ 11:00	Lecture "Hydrology and Water Resources in Monsoon Asia" Lecturer : Dr. Katumi MUSIAKE President, Japan Society of Hydrology and Water Resources Dapartment of Human and Society, Institute of Industrial Science, University of Tokyo
11:00 ~ 12:00	Lecture "Flood and Sediment-related Disasters in Japan" Lecturer : Mr. Yasuo NAKANO Director Research Center for Disaster Risk Management, NILIM
12:00 ~ 13:00	Lunch
13:00 ~ 13:30	"First International Conference on Hydrology and Water Resources in the Asia Pacific Region" Speaker : Mr. Satoru KONDO Director of the River Department, NILIM
13:30 ~ 16:30	Discussion on Specific Subjects I ① Flood Control and Water Resources Management (R 524)

(India, Indonesia, Laos, Philippines, Thailand)
River Div., Water Management and Dam Div.
Erosion and Sediment Control Div.
Flood Disaster Prevention Div.
Dam Hydraulic Engineering Research Team

② Water Quality (Malaysia, Sri Lanka) (R 532)
River Environment Div.
Wastewater System Div.
Water Quality Research Team

③ Groundwater (Pakistan) (R 730)
Hydrologic Engineering Research Team

16:30 ~ 17:00 Adjustment of the Minutes of Specific Subjects I

Stay at Okura Frontier Hotel Tsukuba
TEL. 0298-52-1112 FAX 0298-52-5623

October 17 (Thu.) : Place : 8F International Conference Room, NILIM

9:30 ~ 9:45 Report of the Previous Conferences
by Mr. Takeo NAKAJIMA,
Director of Planning and Research Administration Dept., NILIM

9:45 ~ 16:30 Session on Subject of Common Interest
"Water Resources and River Management for Sustainabale Development"
[Chairman: Mr. Satoru Kondo, Director of the River Department, NILIM]

9:45 ~ 10:30	JAPAN	Mr. Haruhiko OKUNO
10:30 ~ 10:45	Break	
10:45 ~ 11:15	INDIA	Mr. Kaushal Narayan AGRAWAL
11:15 ~ 11:45	INDONESIA	Mr. Djoko MURJANTO
11:45 ~ 13:15	Lunch	
13:15 ~ 13:45	LAOS	Mr. Viengsavath SIPHANDONE
13:45 ~ 14:15	MALAYSIA	Mr. MOBARAK Bin Hussein
14:15 ~ 14:45	PAKISTAN	Mr. Zubair Emran KHAWAJA

14:45 ~ 15:00 Break

15:00 ~ 15:30 PHILIPPINES Ms. Sofia Torio SANTIAGO

15:30 ~ 16:00 SRI LANKA Mr. Piyankarage DAYANANDA

16:00 ~ 16:30 THAILAND Mr. Jirachai SUTHASSANAJINDA

16:30 ~ 17:00 Pre-Conference Meeting for the Symposium on October 22

Stay at Okura Frontier Hotel Tsukuba
TEL. 0298-52-1112 FAX 0298-52-5623

October 18 (Fri.) Place : NILIM

9:30 ~ 12:00 Discussion on Specific Subjects II

① Roads, Pavement, Traffic Management and Safety, (R PWRI)
(India, Indonesia, Laos, Pakistan, Sri Lanka)
Road Environment Div.,NILIM
Road Department, NILIM
Road Technology Research Group, PWRI

② Volcanic Disaster, Erosion Control & Debris Flow (R 730)
(Philippines, Malaysia, Thailand)
Erosion and Sediment Control Div., NILIM
Volcano and Debris Flow Research Team, PWRI

12:00 ~ 12:50 Lunch
12:50 ~ 15:30 Move
16:00 ~ 16:30 Courtesy call on State Secretary for Land, Infrastructure and Transport
16:30 ~ 18:00 Visit to downtown Tokyo

Stay at Yaesu Fujiya Hotel (Tokyo)
TEL. 03-3273-2111 FAX 03-3273-2180

October 19 (Sat.) : Study Tour

9:00 Leave Hotel
9:37 Move to Kyoto: by Shinkansen Hikari 211
Visit to Biwako Construction Office
18:00 Arrive at Hotel

Stay at Hotel Brighton City Yamashina (Kyoto)
TEL. 075-502-1111 FAX 075-502-1090

October 20 (Sun.) : Study Tour

10:00 Leave Hotel
Lake Biwa Canal Museum of Kyoto, Incline, Kamo River, etc.

14:00	JTB Tour
18:00	Arrive at Hotel

Stay at Hotel Brighton City Yamashina (Kyoto)
TEL. 075-502-1111 FAX 075-502-1090

October 21 (Mon.) : Study Tour

8:20	Leave Hotel
10:30	Visit Sayama Pond(Constructed in early 7th century)
14:10	Leave Kansai Airport (ANA 495)
16:10	Arrive at Naha Airport
16:30	Visit Okinawa Urban Monorail
19:00	Arrive at Hotel

Stay at The Busena Terrace Beach Resort (Okinawa)
TEL. 0980-51-1333 FAX 0980-51-1331

■ Opening and Symposium

October 22 (Tue.) : Conference **Place: Bankoku Shinryokan**

TEL. 0980-53-3155 FAX. 0980-53-3163

13:30 ~ 14:00 Opening Ceremony

Address by Mr. Haruhiko OKUNO, Director General
National Institute for Land and Infrastructure Management
Ministry of Land, Infrastructure and Transport

Address by Mr. Hisakazu Ohishi , Vice Minister for Engineering Affairs
Ministry of Land, Infrastructure and Transport

Address by Mr. Keiichi INAMINE
Governor of Okinawa Prefecture

Address by Mr. Piyankarage DAYANANDA
Director Programming, Road Development Authority
Ministry of Transport & Highways, Sri Lanka

Introduction of Overseas Participants

Introduction of Cooperated Organizations

14:05 Group Photograph

14:20 ~ 18:00 The 11th International Symposium on National Land Development and Civil Engineering in Asia

— Water Resources and River Management for Sustainable Development —

14:20 ~ 14:50 Lecture 1 "Case of JAPAN Ⅰ"
- Comprehensive Water-Resource issues of Island Communities -
by Dr. Housei UEHARA, Honorary Professor,
University of the Ryukyus

14:50 ~ 15:20 Lecture 2 "Case of JAPAN Ⅱ"
— Tokyo Metropolitan Region and Tonegawa -
by Mr. Haruhiko OKUNO, Director General
National Institute for Land and Infrastructure Management
Ministry of Land, Infrastructure and Transport

15:20 ~ 15:30 Break

15:30 ~ 16:00 Lecture 3 "Case of KOREA"
by Dr. LEE Jang-Hwa,
Senior Research Fellow,
Structural Materials Research Group
Korea Institute of Construction Technology

16:00 ~ 16:30 Lecture 4 "Case of India"
by Mr. Kaushal N. AGRAWAL
Additional Director General, Central Public Works Department
Ministry of Urban Development

16:30 ~ 17:00 Lecture 5 "Case of Philippines"
by Ms. Sofia Torio SANTIAGO
Project Manager II ,and OIC,
Assistant Director, Bureau of Design Department of Public Works & Highways

17:00 ~ 17:30 Lecture 6 "Case of Pakistan "
by Mr. Zubair Emran KHAWAJA
Director
Road Research and Material Testing Institute
Private Sector Projects Investment Cell
Communication & Works Department
Government of the Punjab, Lahore

17:30 ~ 18:00 Lecture 7 "Case of OKINAWA"
– Integrated Dam Management and the Development of Okinawa's Water Resources –
by Mr. Tamio SHIMOGAMI
Deputy Director, Okinawa General Bureau

Address by Mr. Hirokazu MIYAO, Engineer General,
Okinawa Prefectural Government

18:00 ~ 19:30 Reception hosted by Vice Minister for Engineering Affairs
Ministry of Land, Infrastructure and Transport

Place : Bankoku Shinryokan

Address by Vice Minister for Engineering Affairs
Address by Vice Governor of Okinawa Prefecture
Introduction of Overseas Participants
Address by Mr. Jirachai SUTHASSANAJINDA, Thailand
Toast by Deputy Director General, Okinawa General Bureau
Closing by Director General, NILIM

Stay at The Busena Terrace Beach Resort (Okinawa))
TEL. 0980-51-1333 FAX 0980-51-1331

October 23 (Wed.) : Study Tour

8:00	Leave Hotel
	Visit to: IE-Village,
	Water recycling
	Lunch
	Visit to: Haneo Dam, Taiho Dam
18:10	Arrive at Hotel
18:10 ~ 18:30	Adjustment of the Minutes of Common Interest Session
	Adjustment of the Minutes of Specific Subjects I, II

Stay at The Busena Terrace Beach Resort (Okinawa)
TEL. 0980-51-1333 FAX 0980-51-1331

October 24 (Thu.) : Concluding Session **Place : Bankoku Shinryokan**

9:00 ~ 11:00 Discussion on Specific Subjects III

– Red Soil Erosion Countermeasures & Environmental Preservaton in Okinawa –

① Integrated operation of dams

② Road Construction

(Indonesia, Korea, Laos, Malaysia, Pakistan, Philippines,
Sri Lanka, Thailand)

Okinawa General Bureau
Okinawa Prefectural Government

11:00 ~ 12:00 General Discussion
[Chairman: Mr. Haruhiko OKUNO, Director General, NILIM]

12:00 ~ 12:30 Closing Ceremony
Address by Mr. Haruhiko OKUNO, Director General, NILIM

12:30 ~ 13:30 Lunch

13:30 ~ 14:30 JICA Evaluation

Afternoon Study Tour

17:40 ~ 18:00 Adjustment of the Minutes of specific Subjects III
18:00 ~ 20:00 Dinner

Stay at The Busena Terrace Beach Resort (Okinawa)
TEL. 0980-51-1333 FAX 0980-51-1331

October 25 (Fri.) : Leave Japan

■ List of Participants

FOREIGN COUNTRIES

India	Mr. Kaushal Narayan AGRAWAL Additional Director General Central Public Works Department Ministry of Urban Development
Indonesia	Mr. Djoko MURJANTO Secretary of Board Constructon and Investment Development Board Ministry of Settlement and Regional Infrastructure
Korea	Dr. LEE Jang-Hwa Senior Research Fellow, Civil Eng. Division Structural Materials Research Group Korea Institute of Construction Technology
Laos	Mr. Viengsavath SIPHANDONE Director General, Department of Roads Ministry of Communication, Transport Post and Construction
Malaysia	Mr. MOBARAK Bin Hussein Director Mechanical & Electrical Services Division Department of Irrigation and Drainage
Pakistan	Mr. Zubair Emran KHAWAJA Director Road Research and Material Testing Institute Private Sector Projects Investment Cell Communication & Works Department Government of the Punjab, Lahore
Philippines	Ms. Sofia Torio SANTIAGO Project Manager Ⅱ ,and OIC Assistant Director, Bureau of Design Department of Public Works & Highways
Sri Lanka	Mr. Piyankarage DAYANANDA Director Programming, Road Development Authority Ministry of Transport & Highways
Thailand	Mr. Jirachai SUTHASSANAJINDA Agricultural Engineer、Engineering Division Agricultural Land Reform Office(ALRO) Ministry of Agriculture and Cooperatives

JAPAN

Mr. Haruhiko OKUNO	Director-General, NILIM
Dr. Syuji TAKASU	Executive Director for Research Affairs, NILIM
Mr. Takeo NAKAJIMA	Director of the Planning and Research Administration Department, NILIM
Mr. Satoru KONDO	Director of the River Department, NILIM
Mr. Yasuo NAKANO	Director of the Research Center for Disaster Risk Management, NILIM
Mr. Kazuhiro NISHIKAWA	Research Coordinator for Evaluation, Planning and Research Administration Department, NILIM
Dr. Yoshinobu HIRANO	Research Coordinator for Codes and Standards, Planning and Research Administration Department, NILIM
Mr. Hitoshi YOSHIDA	Research Coordinator for Water Quality Control, River Department, NILIM
Ms. Junko SAISYU	Head of the Research Administration and International Cooperation Division, Planning and Research Administration Department, NILIM

(IAI) Public Works Research Institute
Okinawa General Bureau
Okinawa Prefectural Government
Japan International Cooperation Agency

II. Objectives and Details

■ Outline of "The 11th Conference on Public Works Research and Development in Asia"

1. Objectives : The participants of the Conference are officials from government agencies in Asian countries and responsible for infrastructure research and development and its promotion.

The objectives of the Conference are to find common problems on research and development in the field of civil engineering and to find seeds for possible joint research, through exchanging information and discussion on the present and future status of each country's infrastructure improvement.

Furthermore, they try to form a continuous networking among Asian countries, and properly contribute to implementation of public works.

2. History : The Conference has been held once per year in Japan since F.Y. 1992.

Also the Symposium has been organized by Regional Construction Bureau etc. with participation of experts from governmental and private organization as well as universities, as a part of the activities of the Conference.

The outline of Conference is shown in following pages.

The 1st Conference on Public Works Research and Development in Asia

Duration	From February 15, 1993 to February 26, 1993
Place	Public Works Research Institute, MOC
Program	Keynote Lecture 1) Infrastructure Policies for Economic and Social Development of Asian Countries by Prof. Fumio Nishino, University of Tokyo 2) Progress of Civil Engineering and Its Contribution to Economic and Social Development in Modern Japan — PWRI's 70 Years and Perspective — by Mr. Yukihiko Sumiyoshi, Director-General, Public Works Research Institute 3) The Role of Research and Technology Development in International Technical Cooperation by Mr. Hiroaki Tamamitsu, Vice President, Japan Construction Training Center
	Country Report ① Outline of Country ② Public Works System ③ Description of the Department/Institute in charge of R&D of Public Works ④ Major R&D projects in the Department/Institute ⑤ International Research Exchange Programmes in the Department/Institute ⑥ Activities concerning "Disaster and Disaster Prevention" ⑦ Activities concerning "Harmony between the Environment and Improvement of Infra."
	Subject of Common Interests on "Future Perspective for R&D of Disaster Prevention Techniques against Disaster caused by Rainfall" 1) River-Related Disaster 2) Sediment-Related Disaster
	Specific Subjects 1) Sedimentation of Dam Reservoir (China, Japan) 2) Water Pollution Control (Indonesia, Japan) 3) River Environment (Korea, Japan) 4) Soil Improvement (Thailand, Japan) 5) Tunnel (Singapore, Thailand, Japan) 6) Volcanic Disaster, Debris Flow and Road Disaster Prevention (Malaysia, Philippines, Japan) 7) River (China, Japan) 8) Water Quality (Korea, Japan) 9) Soil Mechanics and Foundation Engineering,Traffic Engineering (Malaysia, Thailand, Japan) 10) Pavement (Philippines, Singapore, Thailand, Japan) 11) Highway Bridges (Philippines, Japan)
	Study Tour Hokkaido (Shin-Chitose Airport, CERI, Muroran Hakucho-Bridge, Seikan-Tunnel etc.) Kanto (Trans-Tokyo Bay Highway、Miyagase-Dam)
Participants	Overseas: 8, Japan:37, Guests:35 (Overseas:5, Japan:30)

The 2nd Conference on Public Works Research and Development in Asia

Duration	From November 15, 1993 to November 26, 1993
Place	Public Works Research Institute, MOC
Program	Keynote Lecture 1) Role of Civil Engineers for Sustainable Development by Mr. Atsushi Hamamori, President, Japan Overseas Consultants Co. Ltd. 2) Socio-Economic Development and Construction Technology Transfer by Mr. Yukihiko Sumiyoshi, Director-General, Public Works Research Institute 3) Research in Japan -Focusing Civil Engineering- by Prof. Hiroyoshi Shi-igai, University of Tsukuba
	Country Report ① Outline of Country ② Public Works System ③ Description of the Department/Institute in charge of R&D of Public Works ④ Major R&D projects in the Department/Institute ⑤ International Research Exchange Programmes in the Department/Institute
	· Subject of Common Interests on "Disaster and Disaster Prevention" 1) Comprehensive Countermeasure against Floods 2) Countermeasure against Highway Slope Failure · Subject of Common Interests on "Harmony between the Environment and Improvement of Infrastructure" 1) Measures for Water Quality Control of Reservoirs and Rivers 2) Countermeasures against Air Pollution and Noise caused by Road Traffics in Urban Areas
	Specific Subjects 1) Debris Flow (China, Philippines, Japan) 2) Materials of the Highway Bridges -Concrete- (Indonesia, Japan) 3) Flood Control (Korea, Japan) 4) Care for the Rivers (Malaysia, Japan) 5) Utilization of the Underground Space (Singapore, Japan) 6) Air Pollution (Thailand, Japan) 7) Materials of the Pavement (Indonesia, Japan) 8) Environment Improvement -Water Quality Control- (Korea, Thailand, Japan) 9) Creation of the River Environment (Malaysia, Japan) 10) Traffic Management (Singapore, Japan)
	Study Tour Chugoku-Shikoku (Seto-Ohashi) Kyushu (Yoshinogari Historical Park, Rokkaku River, Mt.Unzen etc.) Kanto (Trans-Tokyo Bay Highway)
Participants	Overseas: 7, Japan:41, Guests:60 (Overseas:7, Japan:53)

The 3rd Conference on Public Works Research and Development in Asia

Duration	From October 17, 1994 to October 28, 1994
Place	Public Works Research Institute, MOC
Program	Keynote Lecture 1) Viewpoints on Panama Canal Alternative Study by Dr. Akira Ishido, Managing Director, Yachiyo Engineering Co. Ltd. 2) Vision of Construction Technical Research and Development to the 21st Century by Dr. Takashi Iijima, Director-General, Public Works Research Institute 3) Economic Growth, Infrastructure Development and International Cooperation in Asian Counties by Prof. Yuzo Akatsuka, Saitama University
	Trend of Public Works Research and Development ① Role and Outline of Research Organization in Public Works ② Activities and Topics of Research and Development in Research Organization ③ Research Management (Implementation of Research, Mid-term or Annual Research Plan, Research Budget, Improvement of Researcher)
	· Subject of Common Interests on "Environmental Policy of Rivers, Lakes and Marshes" (Improvement of Water Quality, Infrastructure Development with Considerations for the Environment) · Subject of Common Interests on "Infrastructure Development in the field of Roads" (Establishment of Road Network, Maintenance and Management of Roads such as Pavement and Bridge)
	Specific Subjects 1) Flood Control (Bangladesh, India Indonesia, Thiland, Japan) 2) Highway Planning, Traffic System (China, Korea, Japan) 3) Soil Improvement (Malaysia, Japan) 4) Water Pollution Control (Philippines, Thailand, Japan) 5) Volcanic Disaster, Debris Flow (Indonesia, Japan) 6) Geological Survey (Malaysia, Japan) 7) Water Quality for Drinking (Philippines, Japan)
	Study Tour Kinki (Akashi Kaikyo Ohashi, Osaka Bay Highway, Kansai International Airport, Asuka Historical Park, Otaki Dam)
Participants	Overseas: 9, Japan:36, Guests:65 (Overseas:7,Japan:58)

The 4th Conference on Public Works Research and Development in Asia

Duration	From September 25, 1995 to October 4, 1995
Place	Public Works Research Institute, MOC
Program	Trend of Public Works Research and Development ① Role and Outline of Research Organization in Public Works ② Activities and Topics of Research and Development in Research Organization ③ Research Management (Implementation of Research, Mid-term or Annual Research Plan, Research Budget, Improvement of Researcher)
	Subject of Common Interests on " Research and Development for Natural Disaster Reduction"
	Specific Subjects 1) Flood Control (Bangladesh, India, Indonesia, Thailand, Japan) 2) Highway Planning, Traffic System (China, Korea, Japan) 3) Soil Improvement (Malaysia, Japan) 4) Water Pollution Control (Philippines, Thailand, Japan) 5) Volcanic Disaster, Debris Flow (Indonesia, Japan) 6) Geological Survey (Malaysia, Japan) 7) Water Quality for Drinking (Philippines, Japan)
	Study Tour Kinki (Akashi Kaikyo Ohashi, Osaka Bay Highway, Kansai International Airport, Asuka Historical Park, Otaki Dam)
Participants	Overseas: 9, Japan: 36, Guests: 65 (Overseas: 7,Japan: 58)

The 5th Conference on Public Works Research and Development in Asia

Duration	From October 25, 1996 to October 22, 1996
Place	Public Works Research Institute, MOC
Program	Keynote Lecture 1) Case Study from my Overseas Work by Dr. Yorio MURAKAMI, Vice President, Kawasaki Geological Engineering Ltd. 2) Report on the Disaster Caused by 1995 Hyogoken Nanbu Earthquake by Mr. Tadahiko SAKAMOTO, Director-General, Public Works Research Institute 3) Development Cooperation and Public Works in Asia by Dr. Akira TAKAHASHI, Professor Emeritus, University of Tokyo
	Subject of Common Interests ① Harmony between Public Works and Environment ② Securement and Training of Civil Engineers
	Specific Subjects 1) Earthquake Disaster (India, Philippines, Japan) 2) River Management (Malaysia, Thailand, Japan) 3) Road Technology (China, Japan) 4) Soft Ground (Bangladesh, Korea, Japan) 5) Air Pollution (Indonesia, Nepal, Japan)
	Study Tour Tohoku (Ichinoseki Retarding Basin, Onikobe Road, Sen-en Road)
Participants	Overseas: 9, Japan: 36, Guests: 65 (Overseas: 7,Japan: 58)

The 6th Conference on Public Works Research and Development in Asia

<table>
<tr><td>Duration</td><td>From October 14, 1997 to October 21, 1997</td></tr>
<tr><td>Place</td><td>Harbor View Hotel, Okinawa</td></tr>
<tr><td rowspan="10">Program</td><td>Keynote Lecture</td></tr>
<tr><td>1) Regional Development and the Environment
Dr. Hosei Uehara, Professor, University of the Ryukyus</td></tr>
<tr><td>2) Intelligent Transport systems (ITS)
Mr. Seizo Tsuji, Director General, PWRI</td></tr>
<tr><td>3) Okinawa's Social Capital and Development Technologies
Mr. Tamio Shimogami, Engineering General, Okinawa Prefectural Government</td></tr>
<tr><td>Subject of Common Interests</td></tr>
<tr><td>"Research and Development of Public Infrastructure Suitable to Environmental and Climatic Condition"</td></tr>
<tr><td>Specific Subjects</td></tr>
<tr><td>1) Soil Mechanics and Foundation .... Bangladesh, India, Japan
2) Flood Control .... Thailand, Japan
3) Traffic Management .... China, Nepal, Japan
4) Water Quality Control .... Indonesia, Malaysia, Japan
5) Volcanic Disaster, Debris Flow .... Philippines, Japan</td></tr>
<tr><td>Study Tour</td></tr>
<tr><td>Kinjo Dam
Gushigawa Sewage Disposal Facility
Haneji Dam
Okinawa National Memorial Park</td></tr>
<tr><td>Participants</td><td>200</td></tr>
</table>

The 7th Conference on Public Works Research and Development in Asia

Duration	From October 12, 1998 to October 23, 1998
Place	Okinawa Convention Center, Okinawa
Program	Keynote Lectures
	1)Surveyal,Planning,Design and Implementation of Bridge Construction in Japan's Grant Aid Projects Mr. Satoshi Watabe, Pacific Consultants International
	2)Disaster Preventive Project under the Consideration of Nearby Environmental Condition – The Project for Flood Mitigation in Ormoc City, Phillippines Mr. Hitoshi Kin, CTI Engineering Co., Ltd.
	3)Infrastructure Development and Management Prof.Masahiko Kunishima, University of Tokyo
	4) Okinawa's Coastal Waves and Outflow of Red Soil to the Seashore Dr. Seikoh Tsukayama, Professor, University of Ryukyus
	5) New Direction for Sustainable Development in Asia Mr. Yasutake Inoue, Director General, PWRI
	6) Promotion and Development of Okinawa and Its Public Works Technology Mr. Masamichi Shirahase, Vice Director General, Okinawa General Bureau
	Subject of Common Interests
	"Research and development on the comprehesive disaster prevention measures considering ecological environment and social condition"
	Specific Subjects
	1) Water Pollution .... Bangladesh, India, Japan 2) Flood Control .... Bangladesh, Philippines, Korea, Japan 3) Soil Improvement and Slope Protection........India, Laos, Malaysia, Japan 4) Pavement .... Indonesia, India, Malaysia, Japan 5) Sedimentation of Dam Reservoir .... Malaysia, Korea, Japan 6) Earthquake Disasters .... Nepal, Japan 7) Coastal Erosion .... Thailand, Japan
	Study Tour
	Haneji Dam Okinawa National Memorial Park
Participants	Oveaseas: 11, Japan: 30, Guests: 60

The 8th Conference on Public Works Research and Development in Asia

Duration	From October 12, 1999 to October 21, 1999	
Place	Kariyushi Urban Resort Naha, Okinawa	
Program	Keynote Lectures	
	1)Present Situation and Tasks of Japan's ODA — Mainly on Infrastructures	Mr. Kenji Kiyomizu, Development Specialist on Civil Engineering of JICA
	2)Infrastructure Development and Management in Asia	Prof.Masahiko Kunishima, University of Tokyo
	3)Asian Concrete Model Code	Asso. Prof. Tamon Ueda, University of Hokkaido
	Subject of Common Interests	
	"Research and development on the construction technology which is applicable to the local natural environment and social condition"	
	Specific Subjects	
	1) National Disaster Prevention	India, Japan
	2) Soil Improvement	Bangladesh, Malaysia, Japan
	3) Sedimentation of Dam Reservoir	Nepal,Philippines, Japan
	4) Design Load of Bridges	Thailand, Japan
	5) Under Ground Use	Indonesia, Korea, Japan
	6) Pavement	Laos, Japan
	7) River Management	China, Japan
	Study Tour	
	Okinawa National Memorial Park Haneji Dam Seawater Desalination Plant	
Participants	200	

The 9th Conference on Public Works Research and Development in Asia

Duration	From October 10, 2000 to October 19, 2000
Place	National Institute for Land and Infrastructure Management, MLIT Bankoku Shinryokan, Okinawa
Program	Keynote Lectures
	Public Works Management Mr. Akira Fujimoto Research Coordinator for Public Works Management, Research Center for Public Works Management, PWRI Prof. Masahiko Kunishima, University of Tokyo Mr. Takenori Yamashita Head, Management Research Division Research Center for Public Works Management, PWRI Mr. Kenichi Matsui Head, System Development Division Research Center for Public Works Management, PWRI
	Subject of Common Interests
	"Research and development on Promoting Technology Transfer in the field of Construction Technology"
	Specific Subjects
	1) River Management....Laos, Japan 2) Water Quality Control.... China, Japan 3) Sedimentation of Dam Reservoir ....Malaysia, Japan 4) Traffic Management ....Nepal, Philippines, Japan 5) Soil Improvement....Thailand, Japan 6) Earthquake Disaster Prevention....India,Indonesia, Japan
	Study Tour
	ITS Information Center Haneji Dam Okinawa National Memorial Park Kanna Dam Historical Road
Participants	130

The 10th Conference on Public Works Research and Development in Asia

Duration	From October 16, 2001 to October 25, 2001
Place	Nantional Institute for Land and Infrastructure Management, MLIT Bankoku Shinryokan, Okinawa
Program	Lectures
	Public Works Management Mr. Kenichi Matsui Head, Construction Management Division Research Center for Land and Construction Management, NILIM
	Subject of Common Interests
	"Research and development on Public Works concerned with Reducing Environmental Impact for Sustainable Development"
	Specific Subjects
	1) Water Quality Management........India, Japan 2) River Management........Lao, Nepal, Japan 3) Coast Management........Malaysia, Japan 4) Traffic Management ....Thailand, Japan 5 Earthquake Disaster Prevention........Bangladesh, India, Japan
	Study Tour
	1)Arakawa River Channel 2)Kobe Akashi Kaikyo Bridge 3)Okinawa ITS Information Center Electric Power Plant Kanna Dam Plastic Bridge
Participants	100

The 11th Conference on Public Works Research and Development in Asia

Duration	From October 15, 2002 to October 24, 2002
Place	National Institute for Land and Infrastructure Management, MLIT Bankoku Shinryokan, Okinawa
Program	Keynote Lectures
	1) Hydrology and Water Resources in Monsoon Asia Dr. Katumi Musiake President, Japan Society of Hydrology and Water Resources Department of Human and Society, Institute of Industrial Science University of Tokyo 2) Flood and Sediment-related Disasters in Japan Mr. Yasuo Nakano, Director Research Center for Disaster Risk Management, NILIM 3) Comprehensive Water-Resource Issues of Island Communities Dr. Housei Uehara, Honorary Professor, University of the Ryukyus
	Subject of Common Interest
	"Water Resources and River Management for Sustainable Development"
	Specific Subjects
	1) Specific Subjects I ① Flood Control and Water Resources Management .... India, Indonesia ,Laos, Philippines, Thailand, Japan ② Water quality .... Malaysia, Sri Lanka, Japan ③ Groundwater .... Pakistan, Japan 2) Specific Subjects II ① Roads, Pavement, Traffic Management & Safety .... India, Indonesia, Laos, Pakistan, Sri Lanka, Japan ② Volcanic Disaster, Erosion Control & Debris Flow .... Philippines, Malaysia , Thailand, Japan 3) Specific Subjects III - Red Soil Erosion Countermeasures & Environmental Preservation in Okinawa - ① Integrated operation of dams ② Road Construction .... Indonesia, Korea, Laos, Malaysia, Pakistan, Philippines, Sri Lanka, Thailand, Japan
	③ Study Tour
	1)Kyoto: Ohtsu Auxiliary Conduit, Seta River Weir(Outlet Flow Control) Amagase Dam, Drainage of Lake Biwa and the Incline, 2)Osaka: Legacy of Sayama Pond 3)Okinawa: The Urban Monorail System, Ie Village, Haneo Dam, Taiho Dam
Participants	130

The 1st Symposium on Public Infrastructure and Civil Engineering in Asia

Date	February 22, 1993
Place	Sapporo Grand Hotel, Hokkaido
Host	Public Works Research Institute of MOC, Civil Engineer Research Institute of Hokkaido Development Bureau
Program	Keynote Lecture on "Development and Infrastructure of Hokkaido" by Prof. Hideo IGARASHI, Hokkaido University
	Panel Discussion on "Public Infrastructure Projects in Each Country and Their Technical Problems" Coordinator: Toshitaka OHTA, Director General, CERI, Hokkaido Development Bureau, JAPAN Panelists : Yukihiko SUMIYOSHI, Director-General, PWRI, MOC, JAPAN CHEN Bing Xin, Director, IWHR, CHINA BADRUDDIN Machbub, Director, RIWRD, ARD, MPW, INDONESIA LEE Sang Eun, Vice President, KICT, KOREA Abdul RAHMAN B. Abdullah, Deputy Director General, PWD, MALAYSIA Manuel M. BONOAN, Assistant Secretary for Planning, DPWH, PHILIPPINES TAN Siong Leng, Director, Building Control Div., PWD, SINGAPORE TEERACHARTI Ruenkrairergsa, Director, Road R&D Center, DOH, THAILAND
Participants	200

The 2nd Symposium on Public Infrastructure and Civil Engineering in Asia

Duration	November 22, 1993
Place	Soralia Nishi-Tetsu Hotel, Fukuoka
Host	Public Works Research Institute and Kyushu Regional Construction Bureau, MOC
Program	Keynote Lecture on "Regional Development and Civil Engineering Technology in Kyushu" by Prof. Takeshi CHISHAKI, Kyushu University
	Panel Discussion on "Striving for a Better Environment -Regional Development Projects, Disaster Prevention, Environmental Issue-" Coordinator: Yukihiko Sumiyoshi, Director-General, PWRI, MOC, JAPAN Panelist: Eiki ARAMAKI, Director General, Kyushu Regional Construction Bureau, MOC, JAPAN WU Ji Shan, Director, IMHE, CHINA SOEDARMANTO Darmonegoro, Secretary, ARD, MPW, INDONESIA KIM Keung Hwan, Director, Planning & Coordination Div., KICT, KOREA TEH Siew Keat, Director of River Engineering, DID, MALAYSIA Jose H. ESPIRITU, Director, BRS, DPWH, PHILIPPINES KHOR Poh Hwa, Chief Civil Engineer, PWD, SINGAPORE ANUSORNANT Mahavinichaimontri, Director, Materials and Research Div., PWD, THAILAND
Participants	200

The 3rd Symposium on Public Infrastructure and Civil Engineering in Asia

Duration	October 24, 1994
Place	Mainichi Oval Hall, Osaka
Host	Public Works Research Institute and Kinki Regional Construction Bureau, MOC
Program	Keynote Lecture on "Struggling to Develop the New Construction Technology" by Mr. Koutaro HASHIMOTO, Director General, Kinki Regional Construction Bureau, MOC Keynote Lecture on "Cultural Exchange in Global Age" by Prof. Nobuyuki HATA, National Museum of Ethnology
	Panel Discussion on "Public Infrastructure and Development of Construction Technology in Asia" Coordinator: Hiroji NAKAGAWA, Professor, Kyoto University, JAPAN Panelist : Takashi IIJIMA, Director-General, PWRI, MOC, JAPAN Abdul Wahed CHOWDURI, Joint Secretary, MHPW, BANGLADESH XIONG Qiu Shui, Senior Engineer, SPTD, Min. of Com., CHINA Kewal Krishan MADAN, Director General, CPWD, MUD, INDIA Mohamad Yusuf GAYO, Director of MIER, DGWRD, MPW, INDONESIA KIM Il-Joong, Director, Technology Promotion Div., MOC, KOREA Abdul KADIR bin Awang Hamat, Director, IKRAM, PWD, MOW, MALAYSIA Luis A. MAMITAG, Jr., Chief of R&D Div., BRS, DPWH, PHILIPPINES WIJARN Thunthithum, Senior Engineer, DWD Sub-Div., SED, PWD, THAILAND
Participants	300

The 4th Symposium on Public Infrastructure and Civil Engineering in Asia
(Session of Ministers' Forum on Infrastructure Development in the Asia-Pacific Region)

Duration	September 27, 1995
Place	Hotel New Otani Osaka, Osaka
Host	Public Works Research Institute and Kinki Regional Construction Bureau, MOC
Program	Panel Discussion on "Research and Development and International Research Cooperation for Great Natural Disaster Reduction" Coordinator: Takashi IIJIMA, Director-General, PWRI, MOC, JAPAN Panelist : Yasuyuki KOGA, Director, Earthquake Disaster Prevention Dept. ,PWRI, MOC, JAPAN Abdul MAJID Khan, Director General, RRI, BANGLADESH Guowei YANG, Senior Engineer, CWRC, CHINA Digvijai SINGH, Director General, CRRI, MST, INDIA PATANA Rantetoding, Director General, IRE, MPW, INDONESIA Antonio A. STA. ELENA, Regional Director, DPWH, Region IX, PHILIPPINES SURAPOL Pongthaipatana, Deputy Director General, TTI, PWD, MOI, THAILAND
Participants	200

The 5th Symposium on Public Infrastructure and Civil Engineering in Asia

Duration	October 21, 1996
Place	Sendai International Center, Miyagi
Host	Public Works Research Institute and Tohoku Regional Construction Bureau, MOC
Program	Panel Discussion on "Harmony between Regional Development Projects and Environment" Coordinator: Tadahiko SAKAMOTO, Director-General, PWRI, MOC, JAPAN Panelist : Toshiki AOYAMA, Director-General, Tohoku Regional Construction Bureau, MOC, JAPAN MD. Siddique Ullah, Chief Engineer, Public Works Department, Ministry of Housing and Public Works, BANGLADESH Zhang Yuan-fang, Deputy Director, Research Institute of Highway, Ministry of Communications, CHINA Surinder Kumar Chawla, Chief Engineer, Central Public Works Department, Ministry of Urban Affairs and Employment, INDIA Joelianto Hendro Moeljono, Director General, Agency for Research and Development, Ministry of Public Works, INDONESIA Hong Sung-Wan, Vice President, Korea Institute of Construction Technology, KOREA Keizrul Bin Abdullah, Deputy Director General I, Department of Irrigation and Drainage, Ministry of Agriculture, MALAYSIA Nestor V. Agustin, Assistant Regional Director, Region IV, Department of Public Highways ,Region IX, PHILIPPINES Siripong Hungspreug, Director, Project Planning Division, Royal Irrigation Department, THAILAND Mohan Bahadur Karki, Director General, Department of Roads, Ministry of Works and Transport, NEPAL
Participants	200

The 6th Symposium on Public Infrastructure and Civil Engineering in Asia

<table>
<tr><td>Duration</td><td colspan="2">October 17, 1997</td></tr>
<tr><td>Place</td><td colspan="2">The Busena Terrace Beach Resort, Okinawa</td></tr>
<tr><td>Host</td><td colspan="2">Public Works Research Institute
Okinawa General Bureau and Okinawa Prefectural Government</td></tr>
<tr><td rowspan="2">Program</td><td>Keynote Address</td><td>Prof. Kiyoshi UEMA
"Okinawa's Heritage and Social Infrastructure"</td></tr>
<tr><td>Panel Discussion</td><td>"Research and Development of Social Infrastructure Suitable to the Environment and Climatic Condition"</td></tr>
<tr><td rowspan="10">Panelist</td><td>Tamio Shimogami</td><td>Engineer General, Okinawa Prefectural Government, JAPAN</td></tr>
<tr><td>Azizul Haque</td><td>Additional Chief Engineer, Public Works Department Under Ministry of Works, Govt. of BANGLADESH</td></tr>
<tr><td>Qi Ji</td><td>Vice Director, China Building Technology Department Center, CHINA</td></tr>
<tr><td>Krishan Kumar</td><td>Chief Engineer & Project Manager, Parliament Library Project, Central Public Works Department, INDIA</td></tr>
<tr><td>Zulkarnaen Aksa</td><td>Executive Secretary Agency for Public Works' Research and Development, Ministry of Public Works, INDONESIA</td></tr>
<tr><td>Ahmad Fuad
Bin Embi</td><td>Director, Drainage Division, Department of Irrigation and Drainage, MALAYSIA</td></tr>
<tr><td>Devendra Prasad
Rimal</td><td>Joint Secretary, Ministry of Works and Transport, NEPAL</td></tr>
<tr><td>Salvador L. Manto</td><td>Division Chief, Portworks & Shore Protection Division Bureau of Construction, Department of Public Works and Highway's, PHILIPPINES</td></tr>
<tr><td>Vidhaya Samaharn</td><td>Director, Research and Laboratory Division, Royal Irrigation Department, THAILAND</td></tr>
<tr><td>Coordinator
Seizo Tsuji</td><td>Director - General, PWRI</td></tr>
<tr><td>Participants</td><td colspan="2">200</td></tr>
</table>

The 7th Symposium on Public Infrastructure and Civil Engineering in Asia

<table>
<tr><td>Duration</td><td colspan="2">October 18, 1999</td></tr>
<tr><td>Place</td><td colspan="2">Okinawa Convention Center, Okinawa</td></tr>
<tr><td>Host</td><td colspan="2">Okinawa General Bureau</td></tr>
<tr><td rowspan="4">Program</td><td>Theme</td><td>"R&D of Paving Technologies Suited to Environmental and Climatic Conditions"</td></tr>
<tr><td rowspan="2">Keynote Address</td><td>"Recent Development in Paving Technology"
Tamotsu Kobayashi,
Research Coordinator for Traffic Safety, PWRI</td></tr>
<tr><td>"R&D of Paving Technologies in Okinawa"
Kaoru Seto,
Sr. Officer, Planning & Coordination, Development Construction Department, Okinawa General Bureau</td></tr>
<tr><td>Site Visits</td><td>Test Site:
Semi-Flexible Pavement (Nakanishi Area, Urasoe City)</td></tr>
<tr><td rowspan="11">Paticipants</td><td>A. K. M. Mukitur Rahman</td><td>Additional Chief Engineer, Public Works Department, BANGLADESH</td></tr>
<tr><td>Indu Prakash</td><td>Chief Engineer, Ministry of Surface Transport (Road Wing), INDIA</td></tr>
<tr><td>Mohammad Sjahdanulirwan</td><td>Acting Director, Institute of Road Engineering,
Agency for Research and Development of Public Works,
Ministry of Public Works, INDONESIA</td></tr>
<tr><td>Chai Sung Gee</td><td>Research Fellow, Korea Institute of Construction Technology, KOREA</td></tr>
<tr><td>Laokham Sompheth</td><td>Project Manager, Ministry of Communication Transport, Post, and Construction, LAOS</td></tr>
<tr><td>Haji Ghazali Bin Omar</td><td>Director, Drainage Division,
Department of Irrigation & Drainage, MALAYSIA</td></tr>
<tr><td>Abdul Razak Bin Dahalan</td><td>Deputy Director, Department of Irrigation & Drainage, Perak, MALAYSIA</td></tr>
<tr><td>Lekh Raj Upadhyay</td><td>Director General, Department of Building,
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<tr><td>Manuel Agyao Y. Swegen</td><td>Regional Director, Cordillera Administrative Region,
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<tr><td>Thiraphan Thongpravati</td><td>Chief Engineer, Public Works Department, Ministry of Interior, THAILAND</td></tr>
<tr><td>Masamichi Shirahase</td><td>Vice Director-General, Okinawa General Bureau</td></tr>
<tr><td>Others</td><td colspan="2">70</td></tr>
</table>

The 8th International Symposium on National Land Development and Civil Engineering in Asia

Duration	October 18, 1999	
Place	Kariyushi Urban Resort Naha, Okinawa	
Host	Okinawa General Bureau and Okinawa Prefectural Government	
Program	Keynote Lecture	Prof. Takeshi OSHIRO "Corrosive Environment and Salt Induced Damage of RC Structures"
	Panel Discussion	"Research and Development on the construction technology which is applicable to the local natural environment and social condition"
Panelist	Ayumu Yasukawa	Engineer General, Okinawa Prefectural Government, JAPAN
	Morshed Uddin	Additional Chief Engineer, Public Works Department Under Ministry of Works, Govt. of BANGLADESH
	Qian, Min	Vice Director General, Huaihe River Commission, Ministry of Water Resources, CHINA
	Prabodh Gopal Dhar Chakrabarti r	Director, Ministry of Urban Development, INDIA
	Supardiyono Sobirin	Director,Research Institute for Human Settlements, INDONESIA
	Hong, Sung Wan	Senior Research Fellow,Korea Institute of Construction Technology, KOREA
	Math Sounmala	Director General, Cabinet Office, Ministry of Communication Transport Post and Construction, LAOS
	Wahid bin Omar	Deputy Director General II ,Public Works Department, MALAYSIA
	Kedar Prakash Rizal	Project Director,Water Induced Disaster PreventionTechnical Centre,Ministry of Water Resources, NEPAL
	Eleno Uttoh Colinares,Jr	Regional Director, Department of Public Works and Highways, Region V, PHILIPPINES
	Samart Yolpak	Chief Engineer,Public Works Department,Ministry of Interior, THAILAND
	Coordinator Tomomitsu Fujii	Director - General, PWRI
Participants	200	

The 9th International Symposium on National Land Development and Civil Engineering in Asia

Duration	October 17, 2000
Place	Bankoku Shinryokan, Okinawa
Host	Public Works Research Institute Okinawa General Bureau and Okinawa Prefectural Government
Program	Lecture Dr. Tetsuya YABUKI, Professor, University of the Ryukyus "Case of Japan Ⅰ" － New Developments in Bridges － Mr. Takeshi HASHIMOTO, Deputy Director General, Okinawa General Bureau, Okinawa Development Agency "Case of Japan Ⅱ" － Infrastructure Development in Okinawa- Mr. Subhash Chander VASUDEVA, Additional Director Genaral, Central Public Works Department, Ministry of Urban Development, India "Case of India" Ir. SAROSO Bambang Suksmono, Operation Management Director, The Research Institute for Road Infrastructure Technology, Ministry of Settlement & Regional Development, Republic of Indonesia "Case of Republic of Indonesia" Dr. Hyoseop WOO, Senior Research Fellow, Korea Institute of Construction Technology, Republic of Korea "Case of Korea" Mr. Jesus Pedro CAMMAYO, Assistant Secretary, Department of Public Works and Highways, Republic of the Philippines "Case of Philippines"
Participants	130

The 10th International Symposium on National Land Development and Civil Engineering in Asia

Duration	October 23, 2001
Place	Bankoku Shinryokan, Okinawa
Host	National Institute for Land and Infrastructure Management Okinawa General Bureau and Okinawa Prefectural Government
Program	Lecture Dr. Toshiya SHINJO, Professor, University of the Ryukyus "Case of Japan Ⅰ" − Foundation Work on the Limestone Ground Layer of the Southwest Islands − Mr. Tadayuki TAZAKI, Director-General, National Institute for Land and Infrastructure Management "Case of Japan Ⅱ" − Public Works Environmental Technology in Japan − Dr. Gyn-Jin Bae, Director, Civil Engineering Research Division, Korea Institute of Construction Technology, Republic of Korea "Case of Korea" Mr. Hin Seang SAW, Director, Coastal Engineering Division, Department of Irrigation and Drainage, Malaysia "Case of Republic of Malaysia" Mr. Amoda Nand MISHRA, Director-General, Department of Water Induced Disaster Prevention, Kingdom of Nepal "Case of Kingdom of Nepal" Mr. Oravit HEMACHUDHA, Chief, Public Works Planning Subdiv., Department of Public Works, Bangkok Metropolitan Administration, Kingdom of Thailand "Case of Kingdom of Thailand" Mr. Hirokazu MIYAO, Engineer General, Okinawa Prefecture Government "Case of Okinawa" − Okinawa Prefecture's Infrastructure Development for the 21^{st} Century −
Participants	100

The 11th International Symposium on National Land Development and Civil Engineering in Asia

Duration	October 22, 2002
Place	Bankoku Shinryokan, Okinawa
Host	National Institute for Land and Infrastructure Management Okinawa General Bureau and Okinawa Prefectural Government
Program	Lecture Dr. Housei UEHARA, Honorary Professor, University of the Ryukyus "Case of Japan Ⅰ" – Comprehensive Water-Resource Issues of Island Communities – Mr. Haruhiko OKUNO, Director-General, National Institute for Land and Infrastructure Management "Case of Japan Ⅱ" – Tokyo Metropolitan Region and Tonegawa – Dr. LEE Jang-Hwa, Senior Research Fellow Structural Materials Research Group Korea Institute of Construction Technology, Republic of Korea "Case of Korea" Mr. Kaushal N. AGRAWAL, Additional Director General, Central Public Works Department, Ministry of Urban Development, India "Case of India" Ms. Sofia Torio SANTIAGO, Project Manager, and OIC Assistant Director Bureau of Design Department of Public Works & Highways, Philippines "Case of Philippines" Mr. Zubair Emran KHAWAJA, Director Road Research and Material Testing Institute/ Private Sector Project Investment Cell Communication & Works Department Government of Punjab, Lahore, Pakistan "Case of Pakistan" Mr. Tamio SHIMOGAMI, Deputy Director General, Okinawa General Bureau, Okinawa Development Agency "Case of Okinawa" – Integrated Dam Management and the Development of Okinawa's Water Resources –
Participants	130

List of Participants of the Conference

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Dr. I. F. POERNOMOSIDHI
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B. MINUTES

I. Minutes

The 11th Conference on Public Works Research and Development in Asia
Discussion on Subjects of Common Interest
– Water Resources and River Management for Sustainable Development –

Minutes

1. Date and Venue: October 17, 2002 09:30 – 16:30

2. Participants

India	Mr. Kaushal Narayan AGRAWAL
Indonesia	Mr. Djoko MURJANTO
Laos	Mr. Viengsavath SIPHANDONE
Malaysia	Mr. MOBARAK Bin Hussein
Pakistan	Mr. Zubair Emran KHAWAJA
Philippines	Ms. Sofia Torio SANTIAGO
Sri Lanka	Mr. Piyankarage DAYANANDA
Thailand	Mr. Jirachai SUTHASSANAJINDA
Japan	Mr. Haruhiko OKUNO (Director-General, NILIM)
	Mr. Jun-ichi MURAKAMI (Deputy Director-General, NILIM)
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	Mr. Kazuhiro NISHIKAWA (Research Coordinator for Evaluation, Planning and Research Administration Department, NILIM)
	Mr. Hitoshi YOSHIDA (Research Coordinator for Water Quality Control, River Department, NILIM)
	Ms. Junko SAISHU (Head of the Research Administration and International Cooperation Division, Planning and Research Administration Department, NILIM)
	Mr. Shigeo MURATA (Deputy Head of Research Administration and International Cooperation Division, Planning and Research Administration Department, NILIM)

In the Conference, presentation and discussion was made on subject of common interest, **"Water Resources and River Management for Sustainable Development"**, from 9:30 a.m. to 4:30 p.m. on Thursday, October 17. Representatives from nine nations – India, Indonesia, Laos, Malaysia, Pakistan, Philippines, Sri Lanka, Thailand and Japan – participated.

Mr. Satoru Kondo, Director of River Department at National Institute for Land and

Infrastructure Management (NILIM) chaired the conference. To start, Mr. Takeo Nakajima, Director of Planning and Research Administration Department at NILIM, summarized the first to tenth conferences and had a report on the results of the research exchanges through these conferences. Then, the country reports were presented on the subject of common interest, by the representatives of the participating nations in the sequence of Japan, India, Indonesia, Laos, Malaysia, Pakistan, Philippines, Sri Lanka and Thailand.

The summary of the presentations and the discussions are as follows.

Introduction 1: Mr. Takeo NAKAJIMA

Mr. NAKAJIMA outlined the history and goals of the Conference.

The Conference has been started in 1993. Thanks to JICA, 98 representatives from 13 countries without Japan have discussed the issues of common concerns in the Conference. We welcomed new countries, Pakistan and Sri Lanka this year.

The Conference met three objectives:

(1) To facilitate the exchange of information on existing and future public works programs, and ideas between and among countries,

(2) To facilitate engineering discussions which stimulate thinking on solutions to issues common to the countries of SE Asia; and,

(3) To help build a network of practicing professional partnerships in Asian public works programs.

The Conferences bears bi-lateral and multi-lateral cooperative programs. And also, NILIM has accepted some 940 researchers and trainees from participating countries.

The Conference sets up the selected "Common Interest Subject" to help achieve its goals. The 2002 subject, "Water Resources and River Management for Sustainable Development," reflects concerns recently highlighted in major international conferences, such as the Johannesburg Summit 2002. And it is also one of the main topics of the 3rd World Water Forum to be held in Kyoto in March, 2003.

Country Report 1: Mr. Haruhiko OKUNO (Japan)

Mr. OKUNO's presentation on the Tonegawa riverworks showed the evolution of Japan's river management over four centuries. The Tonegawa Basin holds the so called Greater Tokyo metropolitan area.

Japan has four major islands with a total of 3,900 islands. With climate ranging from temperate to sub-tropical, rainfall throughout Japan ranges on the average from 1,000 to 2,500 mm per annum.

The Tonegawa Basin is the largest one in the five river basins draining the

Greater Tokyo area. Although the five river basins occupy just 6% of Japan's land, they have a population of 28 million (21%). In the Greater Tokyo, the property is evaluated at US$ 3.2 trillion (39%).

Sabo and riverworks programs on the Tonegawa actually began in 1594, over 400 years ago. In constructing the new capital of Edo (old Tokyo), the Tonegawa was redirected to east for four main reasons: (a) to prevent floods in Edo, (b) to develop new rice paddies, (c) to allow navigation of ships, and (d) to provide for the strategic defense of the new capital. The success of this early civil engineering brought tremendous prosperity to Edo as well as a rapid population increase.

Modern riverworks measures came in the Meiji era (early 1900's) as railways and automobile roads decimated the importance of river navigation. Civil engineering in this era focused on dredging and providing flood control embankments. The volume of dredged soil between 1900 and 1930 exceeded 30 million m^3. In 1947, the death toll and losses caused by the collapse of the levee by Typhoon Kathleen led to new, stronger measures for riverworks. Japan began building sabo erosion control facilities and dams. The Tonegawa was widened to increase river drainage capacity.

The Tonegawa basin has particularly been affected by population growth and changing land use. The Tsurumi-gawa, barely urbanized 10% in 1958, however, it shows 80% urbanization today. Urbanization and asphalt/concrete surfaces consequence less water absorption during rains. While improvement of riverworks has reduced the total inundated area, the concentration of properties and population in the flood plains has made floods greater disasters than ever before.

River management in Japan is now focused on comprehensive basin management, which includes the use of retarding basins and regulating reservoir on site storage, etc.

Additionally, the examples of recent river improvement projects like super levees, underground flow diversion pipes or channels to help drainage of smaller rivers, the use of multi-purpose dams were presented.

Country Report 2: Mr. Kaushal Narayan AGRAWAL (India)

Modern water resource management must maximize advantages of development while holding down adverse impacts, as well as deal with new demands arising from the linkage of freshwater resources and ecosystems. India reviewed its National Water Policy in 2002. Rainfall throughout India varies from 100 mm/annum in the west to 11,000 mm/annum in the NE. Also, India measures gross runoff from melted snows as 4,000 BCM (billion cubic meters) per year. The 877 key stations of the Central Water Commission gather data throughout the nation, and have marked significant advances in the remote sensing of snowmelt.

Flooding brings silt accumulation to the river beds that in turn, leads to future higher flood levels. Nearly 12% of India's area is subject to floods, which claim an average annual 1,500 lives and 94,000 head of cattle. Along with flood plains, India has broad water logged areas where flat land suffers from inadequate capacity to drain. Nearly all of India's modern reservoirs are multi-purpose facilities, serving irrigation, power generation and flood control.

As a non-structural measure, Flood Plain Zones have been clearly set to define areas prone to flooding risks. Indiscriminate development is restricted to minimize losses from floods. Another non-structural measure is flood forecasting.

A major concern is sedimentation disasters. These are variously caused by deforestation, improper tillage methods, and other various other human activities. Sedimentation is a major problem for irrigation, navigation, and hydropower engineering projects.

Water demand forecasts predict shortages and there is immediate need to augment reservoir capacities.

A final urgent issue is potable water quality and the discharge of untreated wastes: pollution. Urban centers have overloaded the carrying capacity of water bodies to assimilate waste. Contaminated water may account for 80% of all disease and possibly 1/3 of all deaths. Treatment programs must be further considered.

Country Report 3: Mr. Djoko MURJANTO (Indonesia)

Some 6,000 of the 17,506 islands comprising Indonesia are inhabited. As island communities, the issues of water involve both floods from torrential rains and water shortages. The islands are undergoing rapid population growth and urbanization, particularly Java which accounts for only 6% of the land surface.

Three primary factors affect Indonesia's floods: (a) geological conditions and geographical position, (b) changing natural phenomena, and (c) socio-economic factors ranging from deforestation to urban concentrations. There are both structural and non-structural countermeasures. Structural measures include dikes or embankment upgrades, dredging of river channels, the use of reservoirs and lowlands for flood water retention, and pumps to drain excess water from low lying areas. Non-structural measures include evacuation and resident warning systems, and disaster relief.

Indonesia recently launched a comprehensive flood management program which includes (a) studies on balancing use and conservation of natural resources, (b) using a "one river, one plan, one management" approach to cover whole river basins, and (c) providing low cost housing to relocate squatters on levees and slum areas.

Population growth and rapid urbanization in Java have led to degradation of catchments and watersheds. In Java and in outer islands, sedimentation has stopped up the lower reaches of the rivers, threatening harbors and inland water navigation. This constrains transportation of food and other goods to upstream areas.

Most sustainable development issues are related to the management of land. In Indonesia, land use issues of efficiency, sustainability, and equity are important focuses. On Java, for example, the conversion of higher elevation forests and coastal wetlands to agricultural use has led to soil erosion, watershed degradation, and loss of valuable marine resources. Unrestricted urban expansion gives rise to lower efficiency in providing for infrastructure.

Country Report 4: Mr. Viengsavath SIPHANDONE (Laos)

Landlocked LAO PDR is one of the world's poorer countries. It has a per capital GDP of only US$329/annum; however, over the last decade, it has had a growth rate of 5.7%.

90% of the nation is part of the Mekong River Basin; indeed Lao PDR has the greatest length of the Mekong of the Mekong River Commission states. The most serious problem of the Mekong is riverbank erosion.

According to the season, the water level of the Mekong changes over 10 meters. The river banks collapse both from fast current during high water and from the low water levels during dry season. This erosion has threatened National Road 13, the nation's most important trunk, as well as urban areas, housing, public utility systems, etc.

Most riverbank protection work uses gabions. However, even gabions are considered expensive in the Lao PDR because the iron mesh baskets must be imported. The annual budget for riverbank protection is about US$100,000 per annum.

Japan has helped introduce embankment protection methods that use natural materials. JICA has also arranged for a Development Survey for Riverbank Protection around Vientiane. This provides for pilot projects testing different uses of the Japan SODA mattress material to protect riverbanks from erosions.

Country Report 5: Mr. MOBARAK Bin Hussein (Malaysia)

PART I: Remote Monitoring and Control of Water Resources

Malaysia has a population of 23 million growing at 2.6% each year. Today, agriculture which contributes to about 20% of the GDP, is the major water consumer. Malaysia's Vision 2020 expects that as industries and household consumption rises, their water consumption will expand several fold.

Current water issues for irrigation in Malaysia include (a) low irrigation efficiencies, now at about 40% but expected to rise to 60%; (b) inefficient field water management due to various causes, and (c) lack of beneficiary participation.

To improve water resource management, Malaysia needs real time, accurate data via telemetry along with automation technology for effective control. A JICA proposed program for modernization of irrigation schemes in granary areas include the Kerian Irrigation project to (a) convert manually operated gates into motorized systems, (b) install remote control systems, and (c) provide for a Control Centre at Bagan Serai. Also needed are video monitoring, remote sensing, and software development.

PART II: Urban Stormwater Management in Malaysia

Along with greater flood frequency, urban centers are suffering from deterioration of water quality. The Malaysian agency, DID, has widened and diverted rivers, and provided other measures which however, cannot control all flooding. It was decided that there was a limit to conventional methods which emphasize rapid drainage, and the use of larger drains and rivers. However, as urban center runoff increases as a result of greater use of asphalt and cement, it becomes impossible to always build greater drainage systems. We must re-allow infiltration or absorption into the ground. Changing surfaces to gravel or grass are accompanied by greater use of retarding basins and temporary holding areas.

Rain tanks are placed on private properties to permit containment of precipitation, Similar holding facilities in public areas can include ponds and other reservoirs, while wetlands can be preserved to provide for retention of water resources.

Storm water management is governed by a manual provided to concerned developers and local state governments by DID; this manual includes "best practices" from throughout the world. Originally there was some concern that such management practices would add to development costs but the manual has proven to its worth by cutting losses in case of disasters. Malaysia's manual means that ideas and practices are not an issue so much as the major obstacle of convincing local authorities and developers to follow the plans.

Country Report 6: Mr. Zubair Emran KHAWAJA (Pakistan)

Pakistan's economy is primarily agricultural, with the sector accounting for more than 60% of foreign exchange earnings and employing 46% of the labor force. Crop cultivation accounts for 52% of the sector while livestock accounts for 44%.

The Indus, Makran and Kharan Basins are major water resources for irrigation and power generation but groundwater too is a significant source of water.

Silt erosion has reduced storage capabilities in the Mangla and Tarbela some 20%. Decentralization of authority has also given rise to a lack of consensus and slowed action on developing effective additional water storage facilities. Developing additional storage will require strong national commitment and leadership.

With water resources so crucial to the national economy, the Water & Power Development Authority has developed "Vision 2025," which outlines development of about 26 BCM in additional storage capacity.

Population growth and accompanying demand growth is the single most important factor driving water policies. Pakistan's population of 141 million will reach 221 million by 2025.

Future water resources must come from a combination of conservation and storage. There is an urgent requirement for more capacity and a public awareness program to help control scarce resources.

Country Report 7: Ms. Sofia Torio SANTIAGO (Philippines)

The Philippine Archipelago includes some 7,100 islands, covering an aggregate 300,000 square kilometers. With a tropical, oceanic climate, the Philippines has two distinct seasons: rainy and dry.

The Philippines has a wide gamut of rainfall levels, but an average annual precipitation of 2,360 mm. Directly in the Typhoon Corridor, the country experiences an average of twenty typhoons a year. 20 of the nation's 421 principal river basins are classified as major basins with catchment areas larger than 1,000 square kilometers. Rivers are generally short and flow down very steep gradients. However, the 20major basins have river deltas ranging between 50 to 280 kilometers. One aspect common to all the major river systems is the inadequate discharge or carrying capacity, equal to the worst flood conditions that occur every two years.

Urban sprawl affects river discharge, as riverbeds suffer sediments, i.e., are heightened at specific bottlenecks. Population has rapidly concentrated in the lower reaches and deltas, meaning that flood management practices struggle to keep up with demographics.

As a volcanic region, eruptions and earthquakes result in serious sediment disasters. Sediment problems have shifted or heightened river beds. Human intervention, such as illegal logging and consequent deforestation, has also contributed to sediment disasters. Needed measures are hampered by limited budget and the low priority given to flood controls. As such, many programs are ODA-dependent.

The demand for potable water far exceeds the capacity of the utilities to deliver.

Under the Philippines' Master Plan, policies and strategies were formulated using structural and non-structural approaches to key problems, including mitigating flooding in Metro Manila, coordinating flood control projects with irrigation programs, and providing flood forecasting and warning systems in all river basins.

Country Report 8: Mr. Piyankarage DAYANANDA (Sri Lanka)

As an island nation, Sri Lanka depends on rainfall during the monsoon season for the bulk of its water resources. However, rainfall comes mostly to what we call the wet zone, and precious little falls in the nation's dry zone. Little affected by earthquakes or typhoons, floods and sediment flows are among Sri Lanka's most serious concerns.

A significant portion of the land, 80%, is owned by the Government. This means that Land Policy is a crucial factor. Significant portions of Government owned cultivated land is leased to private companies. The implementation of systems improvements is affected by several problem areas, including (a) problems with existing, inappropriate legislation, (b) lack of institutional capacity, (c) limited budgets, (d) misuse of resources, etc. For example, irrigation now takes about 85% of our water.

Pollution is an emerging problem and is due to the lack of land use policies as well as direct disposal of wastes into water bodies by industry, small businesses, animal husbandry, etc. However Central Environmental Authority of Sri Lanka has passed legislation and is the maintaining organization too of the water bodies.

Colombo City had a large water retention area for torrential rains, which mitigated serious flooding. Today this area is taken up by urbanization, and floods are growing more common. Sri Lanka suffers too, from lack of enforcement of its laws.

Another aspect of civil engineering in Sri Lanka is that national agencies use the metric system while many of the local agencies use feet and miles. However distribution of water for irrigation at local level is encouraged to be given to farmer communities at present on an experimental basis.

Country Report 9: Mr. Jirachai SUTHASSANAJINDA (Thailand)

Management of limited water resources is a core issue in Thailand, where farms are generally small, depend on rainfall and have poor soil. Thus, Thailand has turned to an initiative called the Micro Irrigation Program managed by the Agricultural Land Reform Office (ALRO).

ALRO has allocated plots to small farmers, and taken responsibility to develop water resources for these small farming communities. Micro irrigation enhances the efficient use of water resources by providing water directly to the root of base of plants. This water use program also includes storing rainwater for use in dry seasons. Irrigation is done through micro sprinklers or dripping. Farmers must meet pre-set criteria, undergo education programs, and monitoring throughout the Micro Irrigation Program. They must also pay about 50% the cost of very simplified, basic pumps. The total per farm government subsidy of between 30 – 40,000 baht is balanced against expected annual farm revenues of 28 – 40,000 baht per year. Much of the labor is performed by farmers cooperating with each other. Being able to secure adequate labor resources is a criteria for program participation by farmers.

Under the program, ALRO provides equipment to 7,500 small farms, ownership of which is transferred to the farmers themselves. These plots cannot be more than 20 meters from some reliable water source.

Micro Irrigation is a Government project for Thai FY '03 (Oct 2002- September 2003). The 7,500 individual farm plots are scattered throughout 39 provinces. Each farmer must decide to grow either vegetables, flowers or fruit trees.

The success of micro irrigation methods is expected to help alleviate farm poverty, stabilized farm families and reduce migration to the urban centers.

The 11th Conference on Public Works Research and Development in Asia
Discussion on Specific Subjects I – Flood Control and Water Resources Management –

Minutes

1. Date and Venue: October 16, 2002 13:30-17:00 Discussion

2. Participants

India:	Mr. Kaushal Narayan AGRAWAL
Indonesia:	Mr. Djoko MURJANTO
Laos:	Mr. Viengsavath SIPHANDONE
Philippines:	Ms. Sofia Torio SANTIAGO
Thailand:	Mr. Jirachai SUTHASSANAJINDA
Japan:	Mr. Satoru KONDO (Director, River Department, NILIM)
	Mr. Tadashi SUETSUGI (Head, River Division, River Department, NILIM)
	Mr. Junji MIWA (Senior Researcher, Flood Disaster Prevention Division, Research Center for Disaster Risk Management, NILIM)

3. The discussion is summarized as follows:

(1) India suffers is an average annual loss of 1,500 lives due to floods. Accordingly, India implements both structural measures such as embankments as well as non-structural methods such as Flood Plain Zoning. India's National Water policy 2002 recognizes the need for preparation of a master plan for flood control and management.

(2) Indonesia's water resources management suffers from the negative aspects of population growth, urbanization and industrialization. However, the existing legal and regulatory framework is still inadequate, making organized countermeasures difficult.

(3) The issue in Laos in riverbank erosion of the Mekong River. With Japan's assistance since 1996, the Government has been introducing riverbank protection measures, to include SODA mattress and the use of local materials.

(4) Philippines flood countermeasures are designed to meet the worst flood conditions that might occur every ten year. The existing river system could only accommodate floods equivalent to two year return period. Over the last 20 years, floods have accounted for 27,000 fatalities. Compared to other infrastructure sectors, flood control sectors are given a much lower priority, resulting in less allocations than necessary.

(5) Flood control measures in Japan have reduced the numbers of fatalities and missing persons, but have not led to a corresponding reduction in flood damage costs. The primary cause of 74% of dike breaks is overtopping. This has led to studies of high graded levees, which are now in use at the Nakagawa and Ara Rivers. The 2001 revision of the Flood Fighting Law, led to forecasting of inundation area, the use of flood hazard map from 1995, and real-time river information services via the Internet and mobile phone.

The 11th Conference on Public Works Research and Development in Asia
Discussion on Specific Subjects I – Water Quality

Minutes

1. Date and Venue: October 16, 2002 13:30-16:30 Discussion

2. Participants
   Malaysia: Mr. MOBARAK Bin Hussein
   Sri Lanka: Mr. Piyankarage DAYANANDA
   Japan: Mr. Yoshiya YASUDA
   (Head, River Environment Division, Environment Department, NILIM)
   Mr. Minoru SASAKI
   (Senior Researcher, Water Quality Research Team, Water Environment Research Group, PWRI)
   Mr. Hiroki TSUJIKURA
   (Research fellow, River Environment Division, Environment Department, NILIM)

3. The discussion is summarized as follows:

(1) Mr. YASUDA:

Explained the problems and measures taken regarding water quality in Japan's lakes and reservoirs.

(2) Mr. SASAKI:

Discussed the causes of water pollution and quality degradation in Japan, along with an overview of the countermeasures. He also explained Japan's Environmental Standards.

(3) Mr. TSUJIKURA:

Explained the progress of research using a simulation model on water and water pollutant cycle.

(4) Mr. MOBARAK:

Explained the issues of water quality management in Malaysia. Also, he outlined the essential measure that must be taken by the Malaysia Government. Among these is a promising program to be implemented, called IRBM (Integrated River Basin Management).

(5) Mr. DAYANANDA

Explained climate in Sri Lanka, and outlined how water supply, reservoir systems, and water quality management is provided for the urban and mountainous areas.

(6) Conclusion:

The issues of water supply, usage and environmental problems for rivers and river basins cannot be completely resolved by "hard" or structural means, but requires "soft" operations such as nature restoration, and civic participation.

The 11th Conference on Public Works Research and Development in Asia
Discussion on Specific Subjects I – Groundwater

Minutes

1. Date and Venue: October 16, 2002 13:30-16:30 Discussion

2. Participants

Pakistan: Mr. Zubair Emran KHAWAJA

Japan: Mr. Kazuhiko FUKAMI
(Senior Research Engineer, Hydrologic Engineering Research Team, Hydraulic Engineering Research Group, PWRI)
Dr. Yangwen JIA
(Special Researcher, Hydrologic Engineering Research Team, Hydraulic Engineering Research Group, PWRI)

3. The discussion is summarized as follows:

(1) Introduction of PWRI hydrologic research activities:

Following Mr. Fukami's opening remarks, he continued on to explain the outline of the Independent Administrative Institute Public Works Research Institute (PWRI) using its FY2002 pamphlet. He next explained to Mr. Khawaja about major, recent research topics of the PWRI Hydrologic Engineering Research Team.

(2) Pakistan's major hydrological problems:

Mr. Khawaja explained the two major hydrologic problems in Pakistan. First is surface water quality. The majority of Pakistan's water resources derive from four rivers with headwaters in Himalayas. The water quality is quite good in the upper reaches but as the rivers flow through the urbanized Pakistan-India boundary region, the water is heavily polluted by industrial and municipal waste. Another major problem is quality of groundwater. Major areas far from rivers suffer saline water intrusion into the groundwater. Another issue of groundwater quality is, in certain areas, the presences of fluoride above medically acceptable limits.

(3) Discussion

Mr. Khawaja asked about conditions of flood retarding ponds in urbanized areas of Japan. Mr. JIA explained some examples of flood retarding ponds in the Ebigawa River of the Chiba Prefecture. The regulations and standards of water quality for river and groundwater were also discussed. Mr. Fukami presented some examples of basin wide groundwater management and the water quality standards in Japan.

The 11th Conference on Public Works Research and Development in Asia
Discussion on Specific Subjects II – Roads, Pavement, Traffic Management & Safety

Minutes

1. Date and Venue: October 18, 2002 09:30 - 12:00 Discussion

2. Participants

India:	Mr. Kaushal Narayan AGRAWAL
Indonesia:	Mr. Djoko MURJANTO
Laos:	Mr. Viengsavath SIPHANDONE
Pakistan:	Mr. Zubair Emran KHAWAJA
Sri Lanka:	Mr. Piyankarage DAYANANDA
Japan:	Mr. Toshiyuki NAKAMURA (Director, Road Department, NILIM)
	Mr. Kunio YASUI (Director, Road Technology Research Group, PWRI)
	Mr. Kinji HASEGAWA (Head, Road Engineering Division, Road Department, NILIM)
	Mr. Nozomu MORI (Head, Advanced Road Design and Safety Division, Road Department, NILIM)
	Mr. Nodoka OSHIRO (Researcher, Road Environment Division, Environment Department, NILIM)

3. The discussion is summarized as follows:

(1) Pavement in Pakistan

Mr. KHAWAJA talked about Evaluation Studies for Determining Premature Pavement Cracking. The types, positions and depth/width of pavement cracks in Pakistan were analyzed. It was thought that the major causes of cracks were premature oxidation and inadequate film coating on the particles despite the fact that it met the specified requirements.

(2) Traffic Management in India

Mr. K. N. AGRAWAL discussed how increased road traffic throughout India has resulted in severe congestion, and what measures are being taken. In terms of traffic management, signage that includes not only letters but also colors and images is more easily understood by drivers.

(3) Traffic Management in Indonesia

Mr. D. MURJANTO discussed the spatial planning of and commuting congestion in Jakarta, as well as the measures that are being undertaken. He indicated the need for ring roads surrounding the city center, improvement of public transportation systems, and passenger restrictions on vehicles use in the heart of the city.

(4) Traffic Management in Sri Lanka

Mr. P. DAYANANDA explained Sri Lanka's traffic conditions from the point of safety. There is heavy congestion from increased moped use, and a rising social cost due to accident fatalities. He also emphasized the importance of enhanced training of drivers and traffic enforcement. Further he explained that there is a 5 year Road Safety Program commenced to mitigate these issues. Mr. Nakamura discussed the importance of providing for the elderly in Japan's traffic safety management.

(5) Roadway Traffic Conditions in Laos

Mr. V. SIPHANDONE described roadway traffic conditions in Laos. Much of the roadways are unpaved. He explained the importance of quality control in roadway construction.

(6) Pavement Management System in Japan

Mr. YASUI explained current conditions and efficiency of the pavement management systems used in Japan.

The 11th Conference on Public Works Research and Development in Asia
Discussion on Specific Subjects II – Volcanic Disaster, Erosion Control & Debris Flow

Minutes

1. Date and Venue: October 18, 2002   09:30 - 12:00 Discussion

2. Participants

Philippines:	Ms. Sofia Torio SANTIAGO
Malaysia:	Mr. MOBARAK Bin Hussein
Thailand:	Mr. Jirachai SUTHASSANAJINDA
Japan:	Mr. Masaaki WATARI (Leader, Volcano and Debris Flow Research Team, Erosion and Sediment Control Research Group, PWRI) Mr. Takao YAMAKOSHI (Researcher, Volcano and Debris Flow Research Team, Erosion and Sediment Control Research Group, PWRI) Mr. Masaru KUNITOMO (Senior Researcher, Erosion and Sediment Control Division, Research Center for Disaster Risk Management, NILIM)

3. The discussion is summarized as follows:

(1) Japan: The conditions of sediment-related disasters, e.g. debris flows, land slides and steep slope failures in Japan were introduced with videos prior to the discussion.

(2) Japan: Actual examples were introduced of the measures to prepare for, response to sediment-related disasters in volcanic areas. These include nonstructural measures such as providing hazard maps to the populace, and structural measures that use unmanned monitoring facilities and sabo dikes.

(3) Philippines: The report covered sediment related flow disasters, and the importance of countermeasures, notably for the flows generated by the Mt. Pinatubo eruption.

(4) Japan: The discussion covered how standards are set for precipitation levels that require evacuation and warning procedures used in sediment related flows and disasters.

(5) Malaysia: Mud slides are becoming an affair due to heavy rain and hill sides development (uncontrollable).

(6) Discussion
Efforts to reduce the costs of countermeasures against sediment related disasters, requires the adoption of nonstructural measures. Also, in implementing these countermeasures, it is at times not just challenging to promulgate hazard maps but even more difficult to garner public understanding and cooperation for efforts to relocate residents away from areas susceptible to disasters. These important issues require future resolution.

The 11th Conference on Public Works Research and Development in Asia
Discussion on Specific Subjects III
−Red Soil Erosion Countermeasures & Environmental Preservation in Okinawa: Integrated Operation of Dams−
−Red Soil Erosion Countermeasures & Environmental Preservation in Okinawa: Road Construction

Minutes

1. Date and Venue: October 24, 2002 9:00-11:00 Discussion

2. Participants

Indonesia	Mr. Djoko MURJANTO
Korea	Dr. Lee Jang-Hwa
Laos	Mr. Viengsavath SIPHANDONE
Malaysia	Mr. MOBARAK Bin Hussein
Pakistan	Mr. Zubair Emran KHAWAJA
Philippines	Ms. Sofia Torio SANTIAGO
Sri Lanka	Mr. Piyankarage DAYANANDA
Thailand	Mr. Jirachai SUTHASSANAJINDA
Japan	
Okinawa General Bureau	Mr. Masaaki MANTOKU
	Mr. Takaaki OJIMA
	Mr. Sumio NAKAZATO
	Mr. Tsutomu ANIYA
	Mr. Seiichiro UCHIZATO
	Mr. Hiroshi MAEMURA
	Mr. Takeshi NAMASU
	Mr. Toshiro TOKUNAGA
	Mr. Toshiyuki MATSUURA
	Mr. Yasuhide TAKARA
	Mr. Takenori YAMASHITA
	Mr. Yoshikatsu MINAMI
	Mr. Hironori ISHIGAKI
	Mr. Isyou KOUCHI
	Mr. Chikara SANESHIMA
Okinawa Prefectural Government	Mr. Morio CHINEN
	Mr. Katsunobu UEHARA

Introduction 1 Red Soil Erosion Countermeasures & Environmental Preservation in Okinawa: Integrated Operation of Dams, Toshiro Tokunaga
Introduction 2 Red Soil Erosion Countermeasures & Environmental Preservation in Okinawa: Road Construction, Toshiyuki Matsuura

Question & Answer
Ms. SANTIAGO (PHI): Environmental Impact Assessments in the design stage?
Mr. TOKUNAGA (OGB): Basically, these are done.
Ms. SANTIAGO (PHI): Is there an agency that certifies for environmental compliance of facilities?
Mr. TOKUNAGA (OGB): No such agency. Guidelines used include the recently promulgated ISO 14000 Environment series.

Ms. SANTIAGO (PHI): How is the red soil buildup in dam reservoirs handled?
Mr. TOKUNAGA (OGB): Dam capacity is set at need over 100 years; there is no need for excavation until that standard is reached.
Mr. KHAWAJA (PKS): (1) What is done with red soil collected in sedimentation ponds? (2) Which is your emphasis: reef preservation or slope protection?
Mr. TOKUNAGA (OGB): (1) Red soil from sedimentation ponds is returned to the construction site. (2) Neither response is valid.
Mr. KHAWAJA (PKS): Isn't red soil eroded further by wind than by rain?
Mr. TOKUNAGA (OGB): Okinawa has no large, bare spaces so wind is less a factor than rain.
Mr. KHAWAJA (PKS): Problems in Pakistan include landslides during road construction and other issues. Is erosion from landslides a problem? Do you have other problems?
Mr. MATSUURA (OGB): Red soil erosion countermeasures are in place during the construction process. Much coordination with stakeholders and local residents is done. And, while not a problem in Okinawa, I've heard of problems with groundwater while boring tunnels.
Ms. SANTIAGO (PHI): What about opposition to construction? Do you require full consent or majority consent?
Mr. MATSUURA (OGB): There is no numerical standard for level of consent. If general consensus is not obtainable, we implement under the enforced use allowed by the land procurement and usage act.
Ms. SANTIAGO (PHI): (1) To clear areas for roads, do you compensate for both land and structures? (2) Do you assume responsibility for resettlement?
Mr. MATSUURA (OGB): (1) Monetary settlements cover both land and structures (2) Government is not responsible for resettlement or relocation.
Mr. MOBARAK (MLA): What are the standards for permitting the costs for environmental protection?
Mr. MATSUURA (OGB): It is difficult to say what parts of CE work are for environmental protection so there is no percentage of total project value set.

Introduction 3 Integrated Operation of Dams, Masaaki MANTOKU
Mr. KHAWAJA (PKS): (1) How do you handle prior claims on flows that have been redirected to reservoirs? (2) How do you mitigate the impact on the lower reaches of drawing water from the upper?
Mr. OJIMA (OGB): (1) There are no issues with prior claims. Water is provided to those who drew from the rivers before dam construction. (2) River levels remain much as they were before dam construction. Therefore, there is no excessive environmental impact.
Mr. MOBARAK (MAL): (1) Please explain the role of safety in Integrated Dam Management. (2) Please give more details on the rain measuring radar system.
Mr. OJIMA (OGB): (1) Japan's safety standards are even stricter than England's or the United States'. No safety imperfections have been identified yet. (2) Radar is used to warn construction sites of impending torrential rains.
Mr. MURJANTO (IDN): (1) Does an independent agency certify dams for operation safety? (2) Are there economic feasibility studies or social impact assessments?
Mr. YAMASHITA (OGB): (1) No independent certification system. (2) Benefit/Cost analysis are done. We also have 5-year periodic reviews.
Mr. MURJANTO (IDN): Why does construction take so long in Japan?
Mr. YAMASHITA (OGB): Winning public consensus is a time-consuming process.

II. Conclusion

CONCLUSIONS

The 11th Conference on Public Works Research and Development in Asia

The 11th Conference on Public Works Research and Development in Asia convened with the support of the Japan International Cooperation Agency (JICA) from October 15 to 24, 2002. It opened in Tsukuba at the National Institute for Land and Infrastructure Management, closing in Okinawa Prefecture.

Attendees included officials from government agencies responsible for implementing public works research and development policies. Participating countries included India, Indonesia, Korea, Laos, Malaysia, Pakistan, the Philippines, Sri Lanka, Thailand and Japan.

The Subject of Common Interest for this conference was "Water Resources and River Management for Sustainable Development."

Presentations and discussions based on country reports on the subject of common interest prepared by the participants of each country, achieved the common purpose of creating better understanding of the problems faced by each country and promoting mutual learning from the experiences of other countries.

The conclusions reached in the conference include:

1. Water problems such as shortage of water resources, floods and sediment flows are serious concerns for Asian countries. Water Resources and River Management are core policy issues which should be considered by each and every country in Asia.
2. Environmental issues are recognized to be at times, not simply those of a single country but of neighboring countries and the world.

3. Urban planning programs and infrastructure enhancements are needed for the economic growth of developing countries in particular. It is crucial to apply both structural and non-structural approaches to mitigate environmental impacts of development. These should not be accompanied by excessive fiscal burdens for broad and follow-on applications.

4. The participating countries will increase activities in research and development of those technologies in the field of public works, and actively promote technology transfer and mutual cooperation among themselves. The topography, natural environment and socio-economic conditions of each country should be duly considered in these undertakings.

The participants recognized the importance of the conference in furthering understanding of the role of research in public works, and the need for further improvement.

To further enhance and support the infrastructure development of each and every country, each country must seek to learn from the insights and experiences of all participating countries. The participants showed a shared recognition for the need to continue the conference series.

C. LECTURE

Hydrology and Water Resources in Monsoon Asia

Dr. Katumi MUSIAKE
President, Japan Society of
Hydrology and Water Resources
Department of Human and Society
Institute of Industrial Science
University of Tokyo

Hydrology and Water Resources in Monsoon Asia

- A Consideration of Necessity to Establish a Standing Research Community of Hydrology and Water Resources in Asia Pacific Region -

Katumi Musiake

President, Japan Society of Hydrology and Water Resources

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Abstract

Hydrological and water resources issues appear very differently, region by region, strongly affected by geographical conditions, and hydrological knowledge and methodologies which are obtained in a specific region can not be necessarily adopted to other regions. The purpose of this paper is to clarify the way to address adequately regional characteristics of hydrology and water resources in monsoon Asia, especially in "too much water" problems in the region. For the purpose, geomorphological factor, climatic factor and human intervention to the natural environment are taken into consideration as three major factors governing regional characteristics of the hydrology-water resources system. To identify geomorphological features macroscopically between the Asia Pacific region and other continental regions, "tectonic zone" and "stable region", which are two major subdivisions of continental masses in the world, are introduced. Also, a new climatic sub-division "warm-humid" is proposed to express the abundant precipitation due to the Asian monsoon. Then, hydrological characteristics common or similar in "warm-humid tectonic zones" in the Asia Pacific region, contrasted to those in stable regions, are enumerated together with the human intervention corresponding to the characteristics, and research targets peculiar to warm-humid tectonic zones are discussed. Finally, the establishment of a standing research community called "Asia Pacific Association of Hydrology and Water Resources" is proposed to promote the exchange of operational knowledge and experience in water resources management, cooperative research activities and professional education in the Asia Pacific region.

KEY WORDS comparative hydrology, hydrology - water resources system, hydrological region, climatic region, geomorphology, monsoon Asia, Asia monsoon, tectonic zone, floodplain management

INTRODUCTION

"The basic concepts of investigating hydrological processes were developed in Europe and refined and further improved in North America. It is quite natural, therefore, that the methods usually applied to describe the continental branch of the hydrological cycle are fitted to the geographic and climatic conditions prevailing in those areas. Both Europe and North America - at least their greater parts - belong to the temperate zone, large areas having humid or semi-humid climates and undulating topography. Therefore the conventional hydrology in those

continents is based on the determination of catchment-response to precipitation. ------- When the development of hydrological sciences became linked to a large international program, the limitations to the application of conventional methods in areas with different characteristics were immediately recognized -------. "

This is referred from a paper entitled "Proposal to construct a coordinating matrix for comparative hydrology" written by G. Kovac (Kovac, 1984) who served the President of IASH at that time. The above description expresses very well the background of the development of hydrological sciences and their limitations. The purpose of his paper was to provide a framework for comparative hydrology by defining " specific regions" in which common hydrological conditions take place. By combining morphological and climatic conditions, he proposed a new systematic categorization of specific hydrological regions. In this categorization, morphological conditions are classified into three sub-divisions such as flat lands, sloping terrains and mountainous regions according to the gradient of the land slope. The categorization proposed by Kovac is systematic and overall, and might be useful for huge continental river basins. It is partly used as sub-topics for "hydrological problems of specific regions" in the IHP research projects. However, it is too detailed to be applied for relatively small-scale river basins like those in Asia Pacific region.

Usually we consider hydrological characteristics for a start in a river-basin scale in which a series of mountainous areas, sloping terrains and flat lands are included. The purpose of this paper is to propose more macroscopic hydrological regions that enable to express hydrological characteristics common in a river-basin scale especially for the monsoon-Asian region.

THREE MAJOR FACTORS GOVERNING HYDROLOGY – WATER RESOURCES SYSTEM

Generally in the past study on the classification of hydrological regions including Kovac's one, the morphology of terrain and the climate are considered as decisive factors characterizing regional hydrology. We adopt two similar factors, geomorphology in place of morphology and climate, in this paper. These factors represent natural conditions for hydrology. However, the hydrological features in the river basin are different not only by natural conditions, but also considerably modified by human activities such as land use, water utilization, flood control measures etc.. Especially, more than 60% of the earth's population live in the humid climate region influenced by Asian monsoon, different from arid, semi-arid and semi-humid regions, and an appreciate number of human beings live even in mountainous areas in the region. Therefore, we have to take various effects of human activities into account as an important decisive factor modifying the hydrological features. Then, we introduce this decisive factor as "human intervention to the natural environment".

In other words, the human intervention to the natural environment is closely related to water resources management components in a wide sense (including water utilization, flood disaster mitigation, environmental conservation and protection, etc..), while the former two factors represent hydrological components. Therefore, we define the interdependency of these components as "hydrology – water resources system" as shown in Fig. 1. Regional characteristics of hydrology and water resources issues should be considered in a dynamic interaction among these three factors.

Geomorphological factor

The term "geomorphology" means the form and structure of terrain, or both topography and geology. The geomorphological factor, associated with land cover conditions, has predominant effects on every hydrological processes on the ground such as surface runoff and stream flow, infiltration and percolation, groundwater storage and runoff, sediment yield and transport, etc.. In addition, the factor is a decisive factor for human beings to determine the land use.

What can we adopt to express the geomorphological factor characterizing the Asian region?

From a global point of view, the continent masses consist of two basic subdivisions: one is an active belt of mountain making and another is an inactive region of old rocks (Strahler et al, 1992). The mountain-making activity on the earth is caused by plate tectonic motion and the belts are called "tectonic zones". The inactive region is called "stable region" hereafter in this paper.

There are two principal tectonic zones: one is Alpine-Himalayan zone and another is circum-Pacific zone (Fig.2). The Alpine-Himalayan zone runs from Alps and Mediterranean coast, through Middle and Near East, to Himalayas and then to Malay peninsula, Sumatra and Java islands. The circum-Pacific zone runs from New Zealand, through New Guinea, Philippines, Taiwan, Japan and Aleutian islands, and also along eastern fringe of Asian continent like Vietnam, southern and eastern China, Korea and northeastern Russia, then to west coasts of both north and south American continents. Land (topographical and geological) conditions in these tectonic zones are remarkably different from stable regions, and consequently characteristics of river basins from the hydrological point of view are distinctly distinguished between tectonic zones and stable regions.

Hydrological characteristics in river basins along tectonic zones are summarized below:

- Most of all high mountains in the world are located in tectonic zones.
- The land is structurally unstable as a result of tectonic plate motion over the past 200,000,000 years, and the motion is still taking place.
- The tectonic zones are characterized by seismic and volcanic activities, and have similar geological components such as igneous rocks, volcanic products, Tertiary formations, fractured zones, etc.
  - Basin geology greatly affects the hydrological regime, the river configuration and the feature of alluvial plains.
- The steep slope and fragile geology bring about high sediment yield, slope failure, landslide and debris/mud flow in mountainous areas.
- The scale of plains is relatively small in tectonic zones. Large plains in the world face mainly Atlantic and Arctic Coasts.
- Plains in tectonic zones are mainly alluvial plain, formed up by flooding of rivers, while those in stable regions are mainly structural plain, of which the surface is composed of residual soils.
- In general, the alluvial plain in tectonic zones is composed of three topographical units; alluvial fan, natural levee area and delta. On the other hand, most portions of the river course in stable regions are erosive valley, and the alluvial plain is usually limited in the delta area near the river mouth.

As a conclusion of the above discussion, it can be said that two basic categories based on geological structure, namely tectonic zones and stable regions (inactive regions of old geology), are quite suitable to express primary characteristics of geomorphology on the earth. The tectonic zones cover large parts of Asia and have great influences on hydrological processes in almost of all river basins in Asia.

Climatic factor

Most common approach to the classification of the climate from the hydrological point of view is a combination of two parameters, namely aridity and latitude. The aridity index (α) is defined as the ratio of potential evapotranspiration (ETP) to precipitation (P) given by

$$\alpha = ETP / P$$

Here, ETP and P both represent annual average values. If α less than unity, the region is classified as humid, whereas if it is greater than unity, the region is classified as arid. If α greater than 1 on annual basis but become less than 1 during some part of year, the region is classified as semi-arid, whereas the regions for opposite case where α is less than 1 for annual average but becomes greater than 1 during some part of year are termed as semi-humid.

Usually five zones are distinguished according to latitude: arctic, sub arctic, temperate, subtropical and tropical. Their borders can be defined basically by given values of latitude, although may be modified due to oceanic effects as well as orographic conditions.

The combination of two climatic parameters makes twenty possible categories, but twelve categories out of twenties exist actually on the earth as follows; humid arctic, humid sub arctic, humid temperate, humid tropic, semi-humid sub arctic, semi-humid temperate, semi-humid tropic, semi-arid temperate, semi-arid sub tropic, semi-arid tropic, arid temperate and arid sub tropic (Kovac, 1984).

Then, what climatic regions are East, Southeast and South Asian regions classified into ?

Let us take the Chao Phraya river basin in Thailand as an example. The basin is classified into semi-arid according to the conventional definition of aridity index, since the annual precipitation is about 1,200mm and the potential evapotranspiration about 2,000mm. However almost of all annual precipitation appears during the rainy season from May to October when it is quite humid and everywhere of flat lands are inundated with heavy rainfall. It is not fitted for our feeling that Thailand is defined as semi-arid. In a large part of monsoon Asia, there is plenty of rainfall during the rainy season. In such a case, we should consider not only the ratio of ETP to P, but also the absolute value of P. Tentatively, if the annual precipitation is greater than 1,000mm, then the region is defined as humid. Thus almost of all East and Southeast Asian regions are involved in humid climate (Fig. 3).

As for the latitudinal categorization, the summer in East Asian countries like Japan, Korea and part of China located in temperate zone has high temperature similar to Southeast and South Asia located in the tropical zone. Therefore, from a macroscopic point of view, we put temperate and tropic together in the same category, which is defined here as "warm" zone.

The combination of "warm" and "humid" both defined here makes a new climatic region named "warm-humid". The wan-humid climates cover a large part of Asian regions.

Proposal of a new hydrological region "warm-humid tectonic zone"

By combining geomorphological and climatic factors discussed above, "warm-humid tectonic zone" is proposed as a new macroscopic hydrological region. The warm-humid tectonic zone covers widely island countries in the Pacific Ocean and the south-eastern fringe of Asian continent. Similarly, we will be able to define "warm-semi-humid tectonic zone", "warm-semi-arid or arid tectonic zone", etc., taking "tectonic zone" as a primary geomorphorogical factor. The definition of these hydrological regions should be examined and discussed in the future.

We can observe many types of human activities particular to the warm-humid tectonic zone, such as paddy cultivation, slope agriculture, location of urban areas in alluvial flood-plains, protection of alluvial plain from inundation, etc.. The interrelationship between human activities and natural conditions in the zone are discussed in the following section.

HYDROLOGY AND WATER RESOURCES CHARACTERISTICS COMMON IN WARM-HUMID TECTONIC ZONE

Hydrological characteristics in the tectonic zone, contrasted to those in stable regions, are enumerated together with the human intervention corresponding to the characteristics below:

- The hydropower potential is high in mountain areas associated with the abundant precipitation.
- The mountain slope cultivation can be carried out on slopes composed of the fragile geology such as volcanoes, fractured zones, Tertiary formation and weathered granite areas. Therefore, an appreciate number of people live even in mountainous areas. On the other hand, the fragile geology, associated with the steep slope, bring about high sediment yield, slope failure, landslide and debris/mud flow in mountainous areas. It is necessary to apply Sabo engineering works (debris control, landslide and slope failure prevention works) in order to prevent or mitigate damages caused by them.
- Catchment areas of rivers in the tectonic zone are generally smaller than those in stable regions, because of relatively short distance from the mountain to the seashore.
    - The size of river basins in the zone is suitable for the integrated river basin management.
- The alluvial plain is the most important place for people's lives and industrial activities in the tectonic zone, while the major human activities in stable regions are placed on relatively high lands located in the structural plain with gentle and undulating topography.
- Since the alluvial plain is low-lying and wet land, it is used for paddy cultivation if the high temperature and sufficient water can be obtained. The paddy cultivation has special water management technologies different from other field crop cultivation in stable regions.
- It is the most densely populated area in the tectonic zone; big cities, towns and villages are located in the low-lying alluvial plain, while, in stable regions, they are located generally in the undulating high structural plain.
- Alluvial plains, formed up by flooding, have a nature vulnerable to be flooded.
    - Therefore, flood control and flood disaster mitigation measures are much more important in the tectonic zone than in stable regions.

- The concept of flood plain management is remarkably different between tectonic zone and stable regions;
  - In case of flood plains along the erosive valley in stable regions, they apply mainly non-structural measures such as land use restriction without the construction of flood control facilities like embankment.

Regional characteristics of hydrology – water resources system in the warm-humid tectonic zone are summarized and illustrated in Fig. 4.

DIFFERENCES IN RESEARCH SUBJECTS OF HYDROLOGY AND WATER RESOURCES BETWEEN TECTONIC ZONE AND STABLE REGIONS

Physical, chemical and biological principles governing the hydrological phenomena are general and common in the world. However, the phenomena themselves appear very differently, region by region, strongly affected by geographical conditions. Usually, researchers and practitioners in the field of hydrology and water resources deal with subjects surrounding them. It is difficult even for an excellent researcher to develop the study on hydrological phenomena which does not exist surrounding him. In this sense, hydrological studies tend to be site-specific. Therefore, scientific concepts and/or methods developed in a specific region are not necessarily applicable to other regions. Also, targets of research in a specific region may differ from those in another region. Some examples representing those differences between warm-humid tectonic zone and stable regions are listed up below:

- The original version of SHE (Systéme Hydrologique Européenne) Model, one of the most sophisticated distributed hydrological models, does not have a component of lateral sub-surface flow, since it was developed in gently undulating terrains. Therefore it is very difficult to simulate the stream runoff in river basins with steep gradient and thick surface soil of mountain slope (Jha et al, 1995).
- SiB2 (Simple Biosphere Model 2), one of the latest Land Surface Models, does not have the scheme for paddy fields. The scheme was developed in the research related to the GEWEX Asian Monsoon Experiment (GAME), and using it, the results of simulation were much improved (Kim et al, 2001).
- The source of sediment yield in stable regions is mainly soil erosion, and the soil erosion process is formulated as Universal Soil Loss Equation (Wischmier and Smith, 1965), Revised Soil Loss Equation (Weltz et al., 1987), etc.. We have other major sources of sediment yield particular to tectonic zones, such as landslide, mountain-slope collapse, debris/mud flow and volcanic eruption. Although the estimation and prediction of sediment yields from these sources are very difficult due to their discontinuous nature, systematical studies on them should be organized in our region.
- In Europe, "karst hydrology" becomes a specific field of hydrology, since limestone areas which have special hydrological conditions are widely distributed. Volcanic areas located in tectonic zones also have special conditions, but we do not establish yet a specific research field of "volcanic hydrology".
- The awareness of flood plains seems to be considerably different between warm-humid tectonic zone and stable regions. Generally in stable regions, most of river reaches are erosive and in those reaches the bottom of valley is flood plain, which is relatively only limited areas. Most of population lives on undulating terrains above the valley. On the other hand, in the tectonic zones we have large alluvial flood plains along the middle and down reaches of river, where a lot of people live and human activities are most active. Therefore the idea of flood-plain management is basically different between two regions.
- The awareness of river basin is somewhat different between arid/semi-arid and humid regions. In the arid/semi-arid region where the water resources depend mainly on the ground water, the awareness of river basin is very weak. On the other hand, in the humid region where the water resources depend mainly on the river water and the flood inundation often takes place in the alluvial plain, we have much concern to the

river basin.

These are only limited examples relating to the author's research subjects. We can find out a lot of other specific research topics particular to the Asia Pacific region. Some examples are as follows:

- Precipitation mechanism in Asian monsoon, influences of ENSO/El Nino on monsoon rainfall, etc.
- Irrigation and drainage technologies and water management peculiar to the paddy cultivation
- Flood disaster mitigation measures for urbanizing areas located in the low-lying alluvial plain
- Integrated water resources management for river basins where there are "too much water" and "too little water" issues at the same time.

SUMMARY – TOWARD THE ESTABLISHMENT OF ASIA PACIFIC ASSOCIATION OF HYDROLOGY AND WATER RESOURCES

In this paper, the main focus is placed on how to recognize the "too much water" problems in monsoon Asia, which are not adequetely addressed in the world–wide international societies led by western people. For this purpose, the author introduced a new macroscopic hydrological region defined as "warm-humid tectonic zone", indicating that geomorphological conditions peculiar to the tectonic zone should be considered together with abundant precipitation due to Asian monsoon, and discussed water resources issues and research subjects particular to the zone. Using the macroscopic classification of tectonic zone and stable region, differences in "too much water" problem between two regions may be more clearly recognized.

On the other hand, there are also arid, semi-arid and semi-humid areas in monsoon Asia. Although the "too little water" problems were not discussed in this paper for the above-mentioned reason, we have many research and practical subjects to be solved for the water scarcity due to the imbalance between supply and demand in a geographical region of monsoon Asia.

In order to encourage and promote the exchange of operational knowledge and experience in water resources management and cooperative research activities in monsoon Asia, Japan Society of Hydrology and Water Resources (JSHWR) proposed to establish a standing research community at " International Symposium on Innovative Approaches for Hydrology and Water Resources Management in Monsoon Asia" (JSHWR, 2001) held in 13-14 December 2001, Tokyo, Japan. At a consultation meeting during the Symposium, the Preparatory Committee for Asia Pacific Association of Hydrology and Water Resources was organized to discuss and decide the terms of reference describing the framework of the Association's activities. After finalizing the terms of reference, the Association will launch on 1 September 2002, and will hold the "First International Conference on Hydrology and Water Resources in Asia Pacific Region" in 13-15 March 2003 (just before the Third World Water Forum), Kyoto, Japan (the conference web site: http://www.wrrc.dpri.kyoto-u.ac.jp/~aphw/APHW2003/WWW/index.html).

Although the Association deals mainly with water issues particular in the Asia Pacific region, the membership is open for individuals and institutes of every country in the world. We expect that the Association will be grown up by the active participation of many researchers and practitioners.

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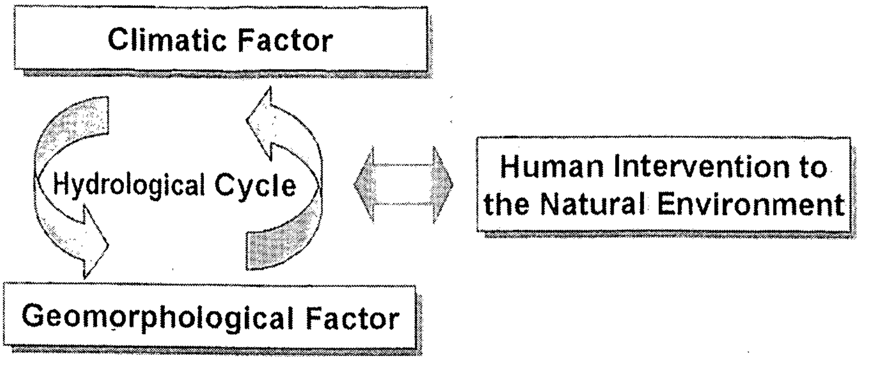


Fig.1 Three major factors governing hydrology–water resources system

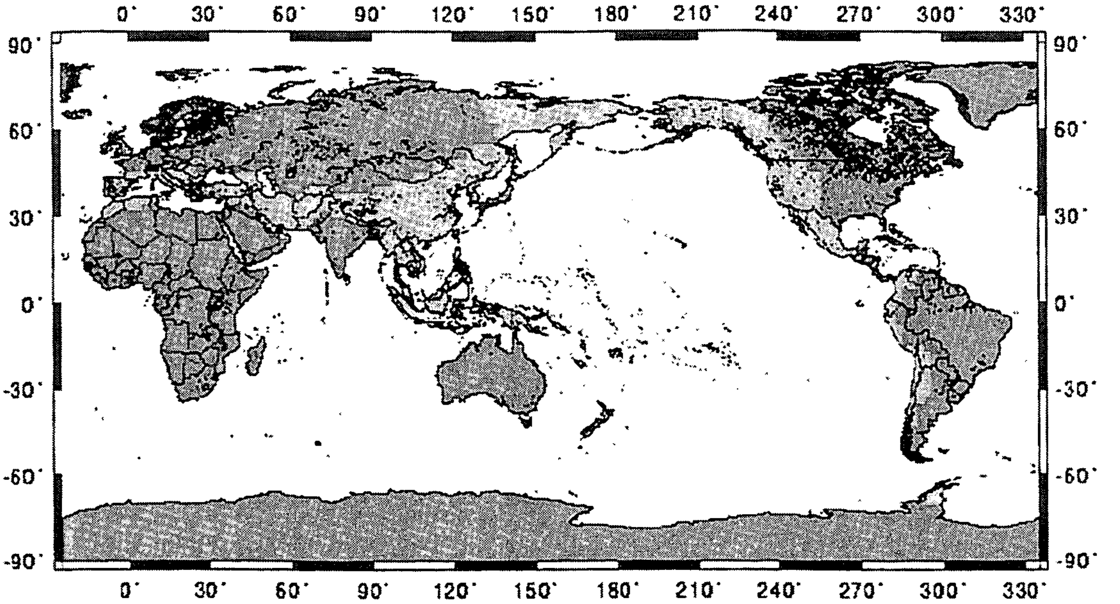
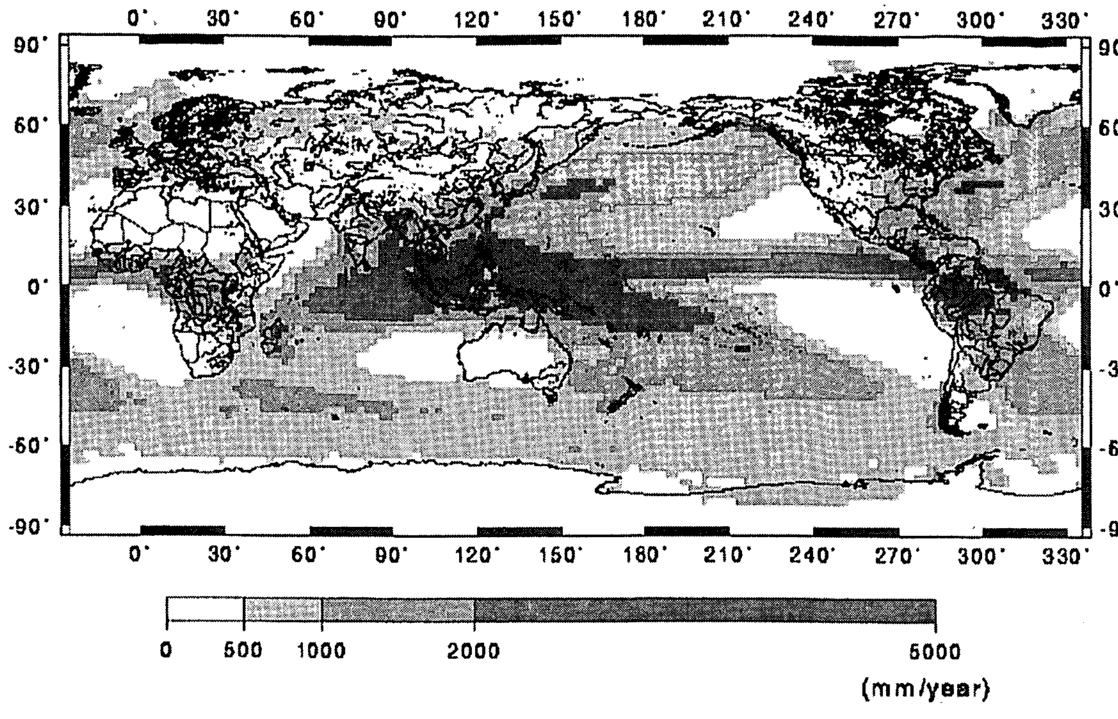


Fig. 2 World distribution of tectonic zones



Mean Annual Precipitation (Average of 1979-1999)

Fig. 3 World distribution of annual precipitation

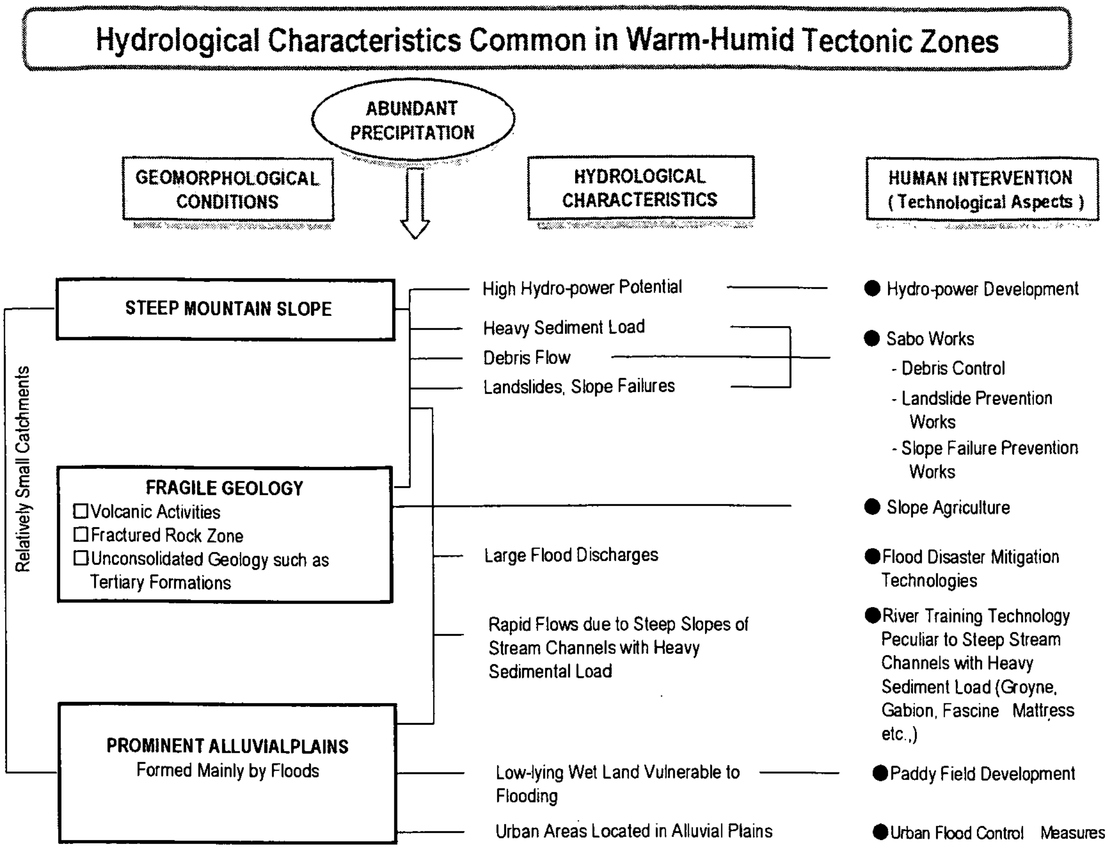


Fig. 4 Hydrological and water resources characteristics common in warm-humid tectonic zones

Hydrology and Water Resources In Monsoon Asia

A Consideration of Necessity to Establish a Standing Research Community of Hydrology and Water Resources in Asia Pacific Region

Katumi Musiake
Former President, Japan Society of Hydrology and Water Resources
IIS, University of Tokyo

Purpose of My Talk

- " Asia Pacific Association of Hydrology and Water Resources (APHW)" just launched on 1 Sept. 2002 after discussions in the international Preparatory Committee since Dec. 2001.
  The First International Conference on Hydrology and Water Resources will be held in 13-15 March 2003 (just before the Third Water Forum), Kyoto, Japan.
- Why do we need to establish the APHW ?
  – That is the purpose of my talk

Contents

- Motivation for proposing to establish a standing research community in Asian region
- Regionality of hydrological phenomena and their studies
- How to categorize regional features of hydrology and water resources in monsoon Asia, from a macroscopic or global point of view
- Proposal of a hydrological region, "warm-humid tectonic zones", to represent hydrological characteristics in East, Southeast and South Asian Regions
- Research subjects particular to the Asian Region
- Introduction of newly established "Asia Pacific Association of Hydrology and Water Resources"

Motivation

Ideas from Asia region are rarely reflected to world-wide international societies related to hydrology and water resources

- **A Typical Case : "World Water Vision" presented by World Water Council in 2000**

- Its major focus is placed on water issues appearing in arid and semi-arid regions such as north and west Africa, Middle East etc., which are of interest mainly to Western countries

- Almost no description about "too much water" issues (flood problems) from which most of Asian countries suffer seriously

- Why western people show little concern about "too much water" issues ? ⇨ The weight of them is comparatively very low.

- We should appeal water issues particular to Asian region more systematically and more effectively to the world

For this, we have to recognize regional characteristics of hydrology and water resources in our region

Major Disasters around the World, 1963-1992
- Those which cause 100 or more of deaths -

Region / Type	Asia			America			Europe	Mid.East／Africa			Caribbean	Pacific
	EAS	SAA	SAS	NOA	CAM	SAM		MEA	CAF	SAF		
Floods		130			35		10		19		2	6
	42	10	78	5	3	27		9	1	9		
Tropical Storms		84			13		0		5		11	40
	41	1	42	8	4	1		1	0	4		
Storms, Other		27			10		1		4		0	4
	8	0	19	9	0	1		3	1	0		
Landslides		26			20		3		3		1	1
	9	5	12	1	1	18		0	0	3		
Drought		6			0		0		15		0	0
	2	4	0	0	0	0		0	11	4		
Food Short -ages/ Famine		1			0		0		3		0	4
	0	1	0	0	0	0		0	1	2		
Earthquakes		34			20		22		22		0	4
	10	10	13	4	5	11		19	2	1		
Epidemics		41			16		1		74		0	0
	4	3	34	0	2	14		3	49	22		
Other		31			21		7		5		1	7
	6	5	20	14	2	5		2	2	1		

(Source: Disaster around the World – A Global and Regional View, World Conf. on IDNDR, Yokohama, Japan, May 1994)

- The number of disasters which caused 100 or more of deaths in one event
- Aggregated country-base statistics for 30 years from 1963 to 1992

Disasters related to "too much water" such as floods, storms and landslides are much more serious in Asia than in North America/Europe or in Mid. East/Africa.

Roughly speaking, the frequency of serious flood disasters in North America/ Europe or in Mid. East/Africa is one order less compared to that in Asia.

Regional classification for the above table

EAS(Eastern Asia): Japan, Democratic Republic of Korea, Republic of Korea, People's Republic of China, Republic of China, Mongolia, Hong Kong Macao, Vietnam, Laos, Kampuchea, Thailand, Myanmar

SAA(Southeastern Asia/Australia): New Zealand, Australia, Papua New Guinea, Indonesia, Malaysia

SAS(Southern Asia): Bangladesh, Nepal, India, Sri Lanka, Maldives, Pakistan, Afghanistan

NOA(North America): Canada, United States, Mexico

CNA(Central America): Belize, Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica, Panama

SAM(South America): Venezuela, Guyana, Suriname, Colombia, Ecuador, Brazil, Peru, Bolivia, Paraguay, Uruguay, Argentina

MEA(Middle East/North Africa): Iran, Iraq, Syria, Lebanon, Israel, Jordan, Bahrain, Saudi Arabia, United Arab Emirates, Oman, Yemen, Egypt, Libya, Tunisia, Algeria, Morocco

CAF(Central Africa): Somalia, Djibouti, Ethiopia, Sudan, Chad, Central Africa, Cameroon, Niger, Nigeria, Benin, Togo, Burkina Faso, Ghana, Mali, Cote d'Ivoire, Liberia, Sierra Leone, Guinea, Guinea Bissau, Senegal, Gambia, Mauritania, Cape Verde

SAF(Southern Africa): Mauritius, Madagascar, Comoros, Kenya, Uganda, Rwanda, Burundi, Tanzania, Mozambique, Malawi, Zimbabwe, Swaziland, Lesotho, Congo, Zambia, Botswana, South Africa, Namibia, Angola, Gabon, Equatorial Guinea, Sao Tome & Principe

How to Express Regionality of Hydrology

- **There are some proposals of hydrological regions in the context of comparative hydrology such as arid/semi-arid regions, humid tropics, marsh-ridden areas, fractured rock areas, etc.**
- **A systematic approach to classify hydrological regions : "*Proposal to construct a coordinating matrix for comparative hydrology*" by G. Kovac (1984) who served the President of IAHS**
- **The purpose of his paper is to provide the framework of comparative hydrology for IHP Phase 4, and some of his proposal have reflected for setting research themes in "hydrological problems of specific regions" of IHP**

Hydrological Sciences – Journal – des Sciences Hydrologiques, 29, 4, 12/1984

比較水文学のためのコーディネーティング マトリックス 構成案

Proposal to construct a coordinating matrix for comparative hydrology

G. KOVÁCS
President IAHS, Research Centre for Water Resources Development, VITUKI, Pf 27, H-1453 Budapest, Hungary

INTRODUCTION

The basic concepts of investigating hydrological processes were developed in Europe and refined and further improved in North America. It is quite natural, therefore, that the methods usually applied to describe the continental branch of the hydrological cycle are fitted to the geographic and climatic conditions prevailing in those areas. Both Europe and North America – at least their greater parts – belong to the temperate zone, large areas having humid or semi-humid climates and undulating topography. Therefore the conventional hydrology in those continents is based on the determination of catchment-response to precipitation.

ヨーロッパで開発
北アメリカで改良
温帯 湿潤
半湿潤
なだらかな地形

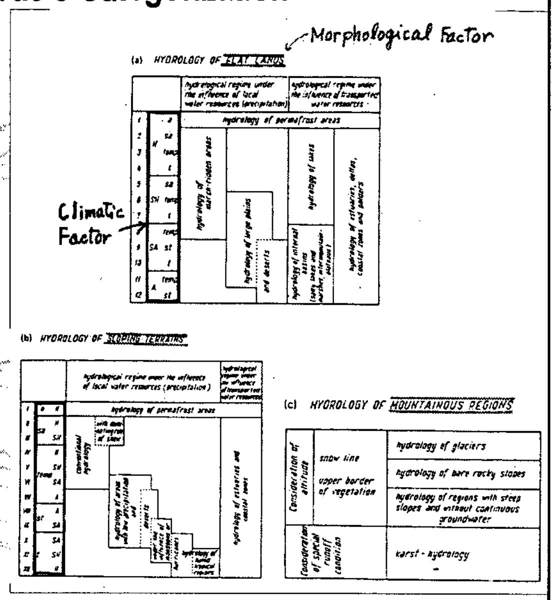
When the development of hydrological sciences became linked to a large international programme, the limitations to the application of conventional methods in areas with different characteristics were immediately recognized.

これまでの方法
適用の限界

Outline of Kovac's Categorization

- Kovac proposed a new systematic categorization by combining morphological and climatic conditions.
- In this categorization, morphological conditions are classified into three sub-divisions such as flat lands, sloping terrains and mountainous regions according to the gradient of the land slope.

- It is partly used as sub-topics for "hydrological problems of specific regions" in the IHP research projects. However, it is too detailed to be applied for relatively small-scale river basins like those in Asian regions.



View-Point of My Proposal

- Usually in Asian region, we consider hydrological characteristics for a start in a river-basin scale in which a series of mountainous areas, sloping terrains and flat lands are included.

- The purpose of my proposal is to provide more macroscopic hydrological regions which enable to express hydrological characteristics common in a river-basin scale especially for Asian region.

Decisive Factors to be Adopted to Express Regional Characteristics in Hydrology and Water Resources

• Generally in the conventional study on the classification of hydrological regions including Kovac's, the climate and the morphology of terrain are considered as decisive factors characterizing regional hydrology

• We also adopt the climate, and not the morphology but the geomorphology of terrain, here in this discussion

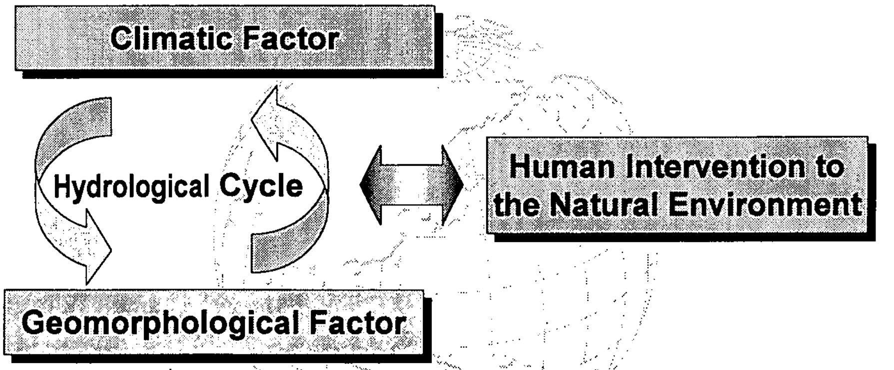
• These two factors, climatic and geomorphologic factors, represent natural conditions for hydrology

• However, the hydrologic features in the river basin are determined not only by natural conditions, but considerably modified also by human activities. Especially, more than 60% of the world population live in monsoon Asia, and an appreciate number of human beings live in plain areas and even in moutain areas as well.

• We have to take various effects of human activities into account.

• Therefore, in addition to the above two factors, we introduce the artificial factor as " human intervention to the natural environment"

Three Major Factors Governing Regional Characterization in Hydrology-Water Resources System



• Hydrology-water resources system in the river basins should be considered in a dynamic interaction among these three factors

What Characterizes each of Factors for Hydrological Features in River Basins in East, Southeast and South Asian Region (or Asia-Pacific)?

Climatic Factor ; Warm Humid Climates ➡ Monsoon Climates (Temperate Humid + Humid Tropics)

Geomorphological Factor ; Tectonic zones

Human Intervention to the Natural Environment ; Paddy Cultivation, Irrigation and Drainage, Flood Control Measures, etc.

Geomorphological Factor

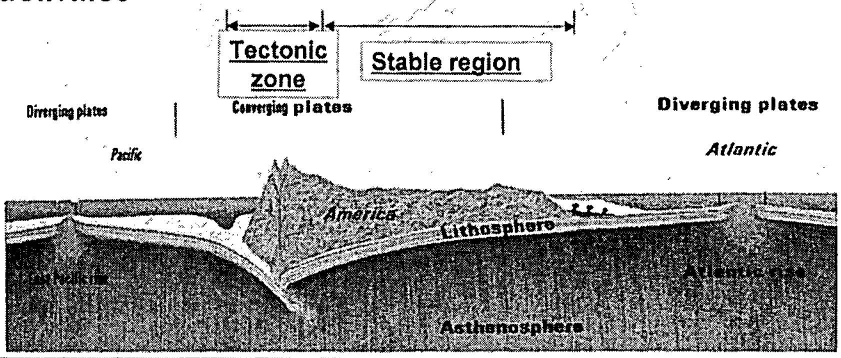
- **Geomorphology: Topography + Geology**
- The geomorphological factor, associated with land cover conditions, has predominant effects on every hydrological processes on the ground such as surface runoff and stream flow, infiltration and percolation, ground water storage and runoff, sediment yield and transport etc.
- In addition, the factor is a decisive factor for human beings to determine the land use

- **How to Classify the Factor from a Global Point of View**
- **Two basic subdivisions of the Continent Masses**
  - Tectonic Zones (Active Belts of Mountain Making)
  - Inactive Regions of Old Rocks ➡ "Stable Regions"

Two Major Divisions of the Earth's Crust

- Tectonic Zones and Stable Regions -

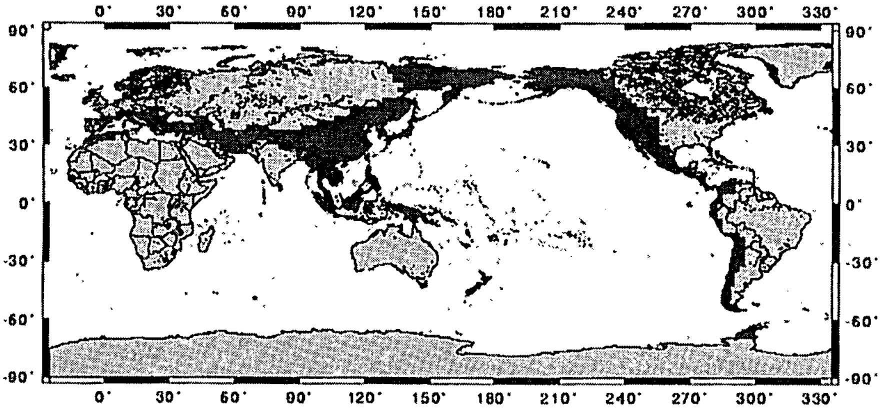
- Tectonic zones: zones where mountain-making activities take place due to tectonic plate motion
- Stable regions: regions which are composed of old geology and not affected by seismic and/or volcanic activities



There are two tectonic zones in the world

-Alpine-Himalayan Zone : Alps -- Mediterranean Coast -- Middle and Near East -- Himalaya -- Sumatra – Java

-Circum-Pacific Zone : New Zealand – New Guinea – Philippines – South-western fringe of Asian continent -Japan Archipelago– Aleutian Islands – West Coasts of both North and South America

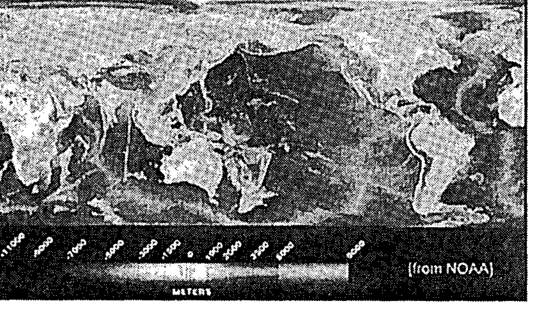


TECTONIC ZONES

Land Conditions particular to Tectonic Zones(1)

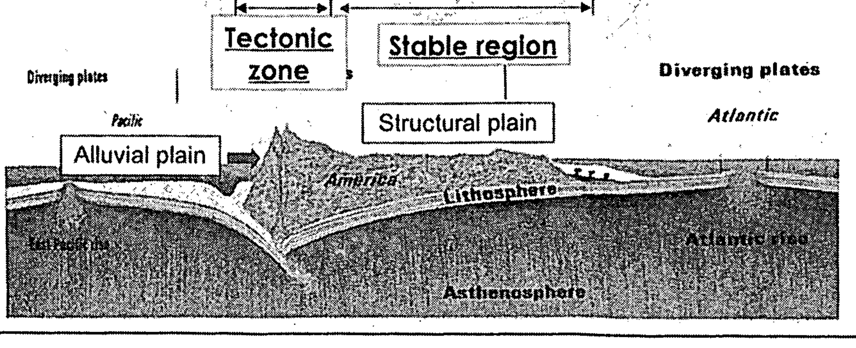
- Most of all high mountains in the world are located in tectonic zones.
- The land is structurally unstable as a result of tectonic plate motion over the past 200,000,000 years, and the motion is still taking place.
- The tectonic zones are characterized by seismic and volcanic activities, and have similar geological components such as igneous rocks, volcanic products, tertiary formations, fractured zones, etc..

--- Basin geology greatly affects the hydrological regime, the sediment yield, the river configuration and the feature of alluvial plains.



Land Conditions particular to Tectonic Zones(2)

- The scale of plains is relatively small in tectonic zones. Large plains in the world are located in stable regions which face mainly Atlantic or Arctic Oceans
- Plains in tectonic zones are mainly alluvial plains, formed up by flooding of rivers, while those in stable regions are mainly structural plains, of which the ground surface is composed of residual soils
- Alluvial plains are a nature vulnerable to be flooded, while structural plains have almost no risk of flooding from rivers



Catchment areas of rivers in tectonic zones are generally smaller than those in stable regions, because of relatively short distance from the mountain to the sea shore.

Large Rivers of the World in order of Catchment Area

□ : River in Tectonic Zones, Flowing into Pacific or Indian Oceans
Others : River in Stable Regions

No.	River	Country at Mouth	Catchment Areas (10^3km^2)	No.	River	Country at Mouth	Catchment Areas (10^3km^2)
1	Amazonas	Brazil	5710	16	Ganges	Bangladesh	1100
2	Congo	Rep. Congo	3970	17	Nelson	Canada	1060
3	Mississippi	America	3170	18	Murtay-Darling	Australia	1060
4	Lena	U.S.S.R	2990	19	Indus	Pakistan	950
5	Nile	Egypt	2940	20	Brahmaputra	Bangladesh	920
6	Ob	U.S.S.R	2880	21	Yukon	America	900
7	Yenisey	U.S.S.R	2660	22	Tokantins	Brazil	900
8	Parana	Argentina	2270	23	Mekong	Vietnam	890
9	Chang Jiang	China	1800	24	Danube	Romania	830
10	Amur	U.S.S.R	1790	25	Orinoko	Venezuela	750
11	Mackenzie	Canada	1780	26	Huang He(Yellow)	China	
12	Volga	U.S.S.R	1440	27	S. Francisco	Brazil	660
13	Zambezi	Mozambique	1310	28	Kolyma	U.S.S.R	630
14	Niger	Nigeria	1100	29	Dnepr	U.S.S.R	500
15	Shatt al Arab	Iraq	1100	30	Irrawaddy	Myanmar	420

➡ **The size of river basins in these zone are suitable for the integrated river basin management**

Climatic Factor : Combination of Aridity Index and Latitudinal Climate Classification

	ETP / P < 1.0 (yearly average)		ETP / P > 1.0 (yearly average)	
	ETP / P < 1.0 (for each season or month) humid	ETP / P > 1.0 (for some season or month) semi - humid	ETP / P < 1.0 (for some season or month) semi - arid	ETP / P > 1.0 (for each season or month) arid
arctic	Humid - arctic	×	×	×
sub - arctic	humid/ sub - arctic	semi – humid · sub - arctic	×	×
temperate	Humid · temperate	semi – humid · temperate	semi – arid · temperate	Arid · temperate
sub - tropic	×	×	semi – arid · sub - tropic	Arid · sub - tropic
tropic	Humid · tropic	semi – humid · tropic	semi – arid · tropic	×

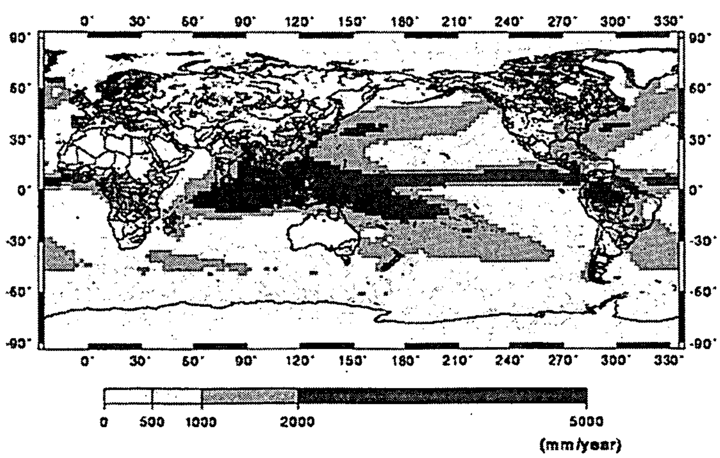
Climatic Factor (Aridity and Latitude)
- Aridity -

- According to the aridity index, the Chao Phraya basin in Thailand (P ≒1200 mm, ETP ≒2000 mm)
  →Semi-Arid (not compatible with our feeling)
- Can we express the wetness only by the ratio of ETP to P ?
- We should consider the absolute value of P, too.

- Modified definition in Monsoon Asia:
  e.g. Humid if P > 1000 mm
  Then, Thailand → Humid

- Humid Climate defined here covers large part of Asia.

Humid Climate defined here
(areas with annual precipitation of more than 1000mm)
covers large part of Asia



Mean Annual Precipitation (Average of 1979-1999)

Climatic Factor (Aridity and Latitude)
- Latitude -

- As for the latitudinal categorization, the summer in East Asian countries like Japan, Korea and part of China located in temperate zone has high temperature similar to Southeast and South Asia located in tropical zone
- Therefore, from a macroscopic point of view, we put temperate and tropic together in the same category, which is defined here as "warm" zone.

- Aridity and Latitude -

- The combination of "warm" and "humid" both defined here makes a new climatic region named "warm-humid".
- The warm-humid climates cover large part of Asian region.

Proposal of a New Hydrological Region : "Warm-humid Tectonic Zone"

- Based on the above discussions, by combining geomorphological and climatic factors, "warm-humid tectonic zones" is proposed as a new macroscopic hydrological region.
- The warm-humid tectonic zone covers wide parts of Asia, island countries in the Pacific Ocean and the south-eastern fringe of Asian continent.
- Similarly, we will be able to define "warm-semi-humid tectonic zone", "warm-semi-arid/arid tectonic zone" and so on, taking "tectonic zone" as a primary geomorphological factor. (The definition of those hydrological classification should be discussed in the future)

Human intervention to the Natural Environment in monsoon Asia

- In monsoon Asia, there are a variety of human activities under geomorphological conditions of tectonic zone and climatic conditions of Asian monsoon which cover from humid to arid climates.
- However, we will focus on warm-humid tectonic zone here in the discussion, to clarify "too much water" issues in monsoon Asia.
- We can observe many types of human activities particular to the warm-humid tectonic zone, such as paddy cultivation, slope agriculture, location of urban areas in alluvial flood-plains, protection of alluvial plain from inundation, etc..

Hydrological and Water Resources Characteristics Common in River Basins along WHT zone in Asia

<u>High Potential of Hydro-power Generation</u>

- (High mountains + Abundant Precipitation) provides "high potential of hydro-power"
- In developed countries along tectonic zones, such as France, Italy, Switzerland, Japan, west coast of Canada and USA, etc., almost of economically developable hydro-power potentials had been developed before the middle of 20th century.
- On the other hand, in developing countries of Asia, most of hydro-power potentials are remained for the future energy development.

	Developable H-Power (MW)	Developed H-Power (MW)	Ratio (%)
Indonesia	7500	3012	40
China	378000	70000	19
Thailand	15000	3900	26
Malaysia	29000	2058	7
Philippine	12310	2230	18
Vietnam	9000	3343	37
India	94000	22448	24
Pakistan	33572	4825	14
Sri Lanka	——	1137	——
Bangladesh	600	230	38

(Source: Electric Power Industry in each country (JEPIC 2000), APEC ENERGY DATABASE)

Hydrological and Water Resources Characteristics Common in River Basins along WHT zone in Asia

Mountain slope cultivation

- Fragile mountain lands formed up due to mountain making activities, such as slopes of volcanoes, fractured zones, Tertiary formation and weathered granite areas, can be cultivated, if they have necessary temperature and water. ⟹ mountain slope cultivation in WHT zones
- On the other hand, they are disaster-risk areas vulnerable to slope failure, landslide, debris/mud flow, etc..
- "Land productivity" and "Disaster risk" are both sides of coin.

Terrace fields on pene-plain of weathered granite – views from Malaysia and Japan

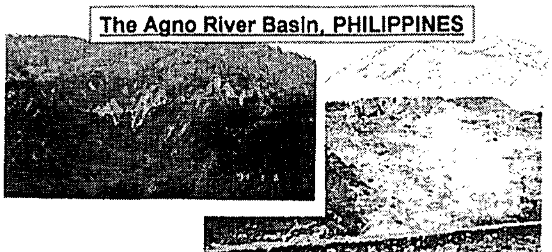
Terrace fields on the slope of Cameron Highlands, MALAYSIA

Terrace paddy fields on the pene-plain in Chugoku district, JAPAN

Hydrological and Water Resources Characteristics Common in River Basins along WHT zone in Asia

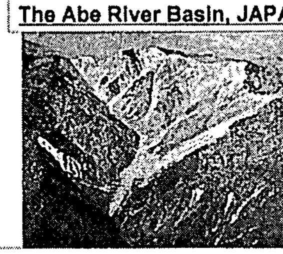
Slope failure due to earthquake and sediment runoff

The Agno River Basin, PHILIPPINES

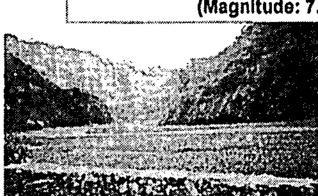


Landslide/slope failure due to Baguio Earthquake (Magnitude: 7.8) in 1990

The Abe River Basin, JAPAN

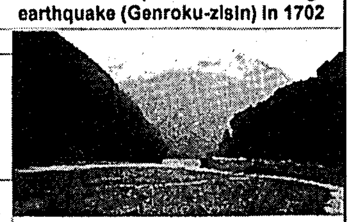


Landslide/slope failure due to big earthquake (Genroku-zisin) in 1702



30-50m riverbed aggradation due to storms after the Earthquake

Geology of both basins is Mesozoic/Paleozoic formations with fractured zones



Partially, riverbed aggradation of more than 100m after the earthquake

Hydrological and Water Resources Characteristics Common in River Basins along WHT zone in Asia

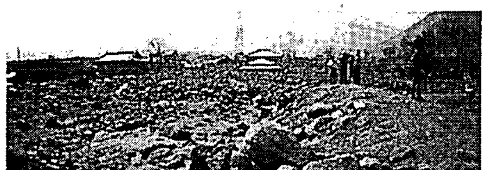
Volcanic eruption and sediment yield/ runoff

Eruption of Mt. Pinatubo, PHILLIPINES, in July 1991

A great quantity of sediment flows down to the lower reaches of rivers

Villages buried by mud flows due to storms after the eruption

Eruption of Mt. Unzen-fugendake, Nagasaki, JAPAN, in Augaust 1991



Village buried by pyroclastic flow

Effects of a volcanic eruption on the river basin last for a very long time

Hydrological and Water Resources Characteristics Common in River Basins along WHT zone in Asia

Debris/mud flow and drifting fallen tree disaster

Debris/mud flow with drifting fallen trees in Ban Nam Kor, Petchaboon (located along the upper reaches of the Pasak River), THAILAND, in 11 August 2001.
The river catchment is composed of Mesozoic formation with limestone.

Debris flow with drifting fallen trees in Kawauchi-cho, Ehime Pref. JAPAN, in 15 September 1999.
The river catchment is composed of Mesozoic/Paleozoic formations.

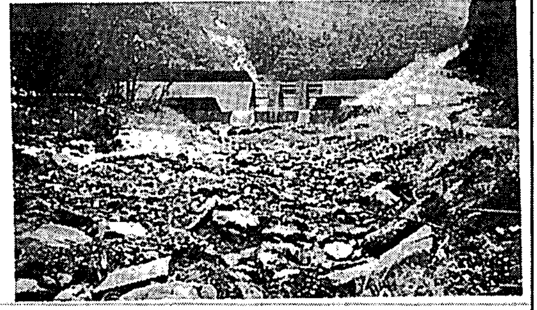
・平成11年9月15日　台風16号による豪雨で数箇所で発生した土石流により自宅が全壊したほか道路各所で被害が発生した(川内町)

Hydrological and Water Resources Characteristics Common in River Basins along WHT zone in Asia

Sabo engineering works

- The steep slope and fragile geology bring about high sediment yield, slope failure, landslide, volcanic eruption and debris/mud flow in mountainous areas.

- Sabo engineering works (debris control, landslide and slope failure prevention works) are applied to prevent or mitigate damages caused by them.



A debris control dam constructed in the upper reaches of the Ade river, JAPAN

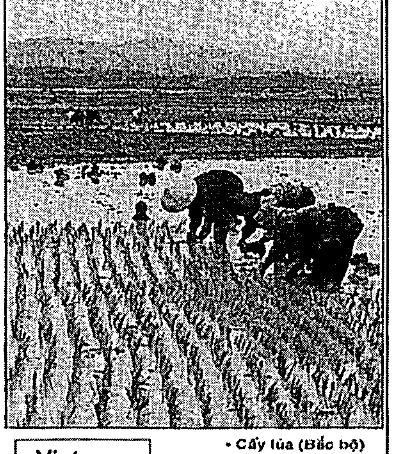
Hydrological and Water Resources Characteristics Common in River Basins along WHT zone in Asia

Paddy cultivation in the alluvial plain

- Since the alluvial plain is low-lying and wet land, it is used for paddy cultivation if the high temperature and sufficient water can be obtained.

- The paddy cultivation is the most suitable crop for the low-lying wet alluvial plain.

- It has a special water management with irrigation/drainage technology different from dry crop cultivations.



Vietnam

- Cấy lúa (Bắc bộ)
- Planting young rices
- La plantation du riz

Hydrological and Water Resources Characteristics Common in River Basins along WHT zone in Asia

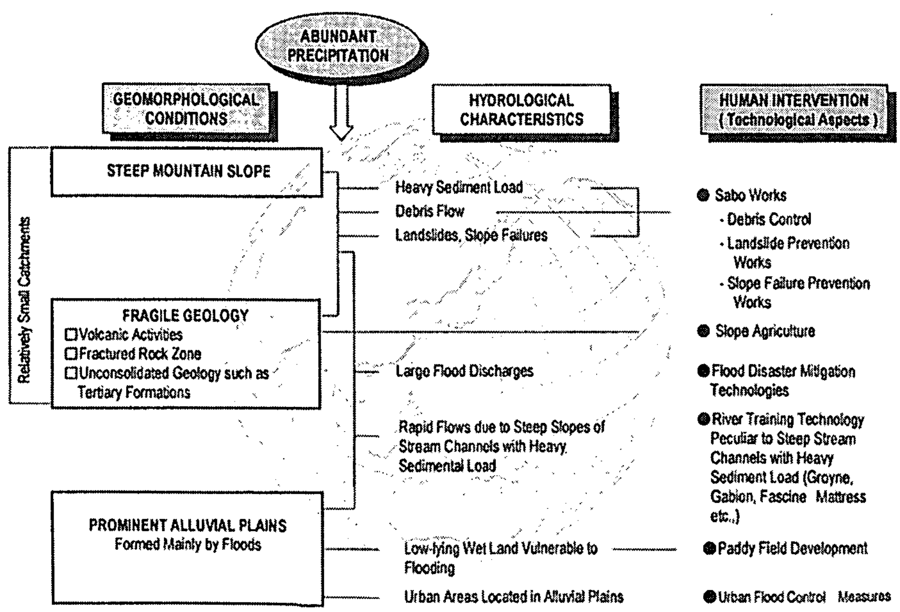
Urban areas located in the alluvial plain

- The alluvial plain is the most densely populated area in tectonic zones ; big cities, town and villages are located in the alluvial plain.
- Alluvial plains, formed up by flooding of rivers, have a nature vulnerable to be flooded. Therefore, flood control and flood disaster mitigation measures are much more important in tectonic zones than in stable regions.

Jakarta, INDONESIA

Flooding in Jakarta city

Hydrological/Water Resources Characteristics Common in Warm-Humid Tectonic Zone



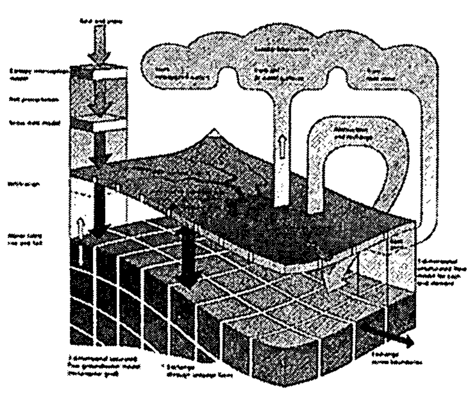
Differences in Hydrological and Water Resources Issues between Warm-Humid Tectonic Zone and Stable Regions

- Physical principles controlling the hydrological phenomena are general and common in the world.
- However, methods developed in a specific region are not necessarily applicable to other regions since the phenomena themselves are strongly affected by geographical conditions.
- Also, targets of research in a specific region may be different from those in another specific region.

Differences in Research Subjects of Hydrology and Water Resources between Warm-Humid Tectonic Zone and Stable Regions

Physically-based distributed hydrological modeling

SHE Model, one of the most sophisticated DHM: No component of lateral sub-surface flow
→ Not applicable to river basins with steep gradient and thick surface soil on mountain slopes (Jha et al, 1995)



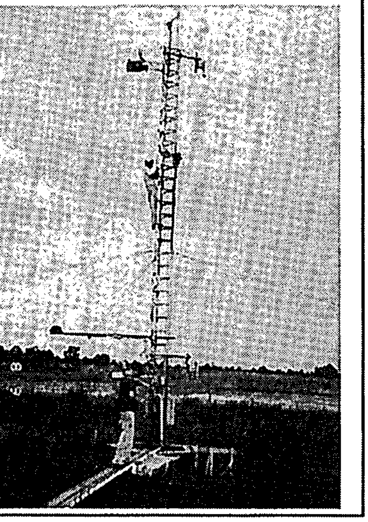
Differences in Research Subjects of Hydrology and Water Resources between Warm-Humid Tectonic Zone and Stable Regions

Land surface scheme for climate models

SiB2, one of the latest Land Surface Model developed in NASA: No scheme for paddy field.

→ By paddy scheme developed in GAME-T, the results of simulation were much improved (Kim et al, 2001)

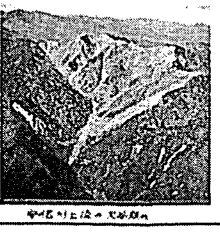
Heat/water flux observation in the paddy field station at Sukhothai, Thailand, carried out in GEWEX Asian Monsoon Experiment- Tropics (GAME-T)

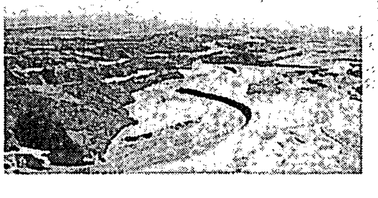


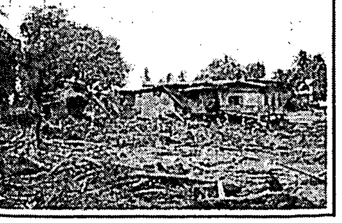
Differences in Research Subjects of Hydrology and Water Resources between Warm-Humid Tectonic Zone and Stable Regions

Sediment yield and runoff

- The source of sediment yield in stable regions is mainly soil erosion. The soil erosion/runoff processes formulated as Universal Soil Loss Equation (USLE) and Revised Universal Soil Loss Equation (RUSLE).
- We have other major sources of sediment in WHT zone in Asia, such as landslide, slope failure, volcanic eruption, debris/mud flow, etc..
- Although the estimation and prediction of sediment yield/runoff are very difficult due to their discontinuous nature, we should carry out systematical studies on them.



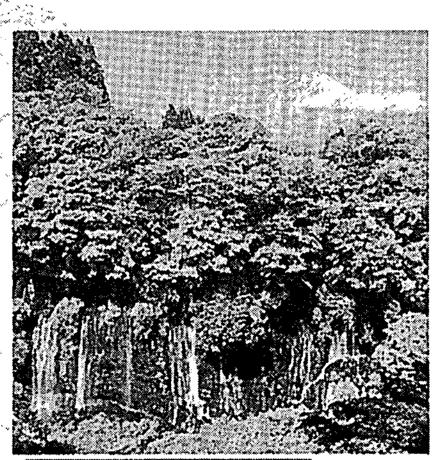




Differences in Research Subjects of Hydrology and Water Resources between Warm-Humid Tectonic Zone and Stable Regions

Volcanic hydrology in Asian tectonic zone

- In Europe mainly composed of old geology, "Karst (limestone area) hydrology" becomes a specific field of hydrology.
- However, we do not establish yet a specific research field of "volcanic hydrology" in Asian tectonic zone.

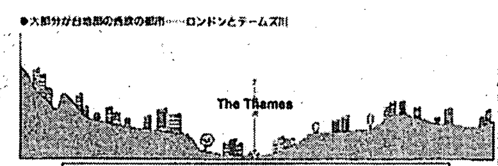


Mt. Fuji and its springs

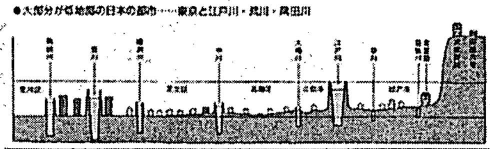
Differences in Research Subjects of Hydrology and Water Resources between Warm-Humid Tectonic Zone and Stable Regions

Flood plain management

- The awareness of flood plains seems to be considerably different between warm-humid tectonic zones and stable regions.
- Generally in stable regions, almost of river reaches are erosive and in those reaches the bottom of valley is flood plain , which is relatively only limited areas. Most of population lives on undulating terrains above the valley.
- In tectonic zones, we have large alluvial flood plains along the middle and down reaches of river, where a lot of people live and human activities are most active.
- Therefore the idea of flood-plain management is basically different between two regions.



The Thames River and London City Area : Flooding areas are so limited



Cross Section of Down Town Tokyo Metropolitan Area: Flooding areas are so large

In stable regions, they apply mainly non-structural measures such as land use restriction without the construction of flood control facilities like large-scale embankment, while we cannot help applying structural measures in tectonic zones.

Differences in Research Subjects of Hydrology and Water Resources between Warm-Humid Tectonic Zone and Stable Regions

Other research subjects particular to the warm-humid tectonic zone

- **Precipitation mechanism and water resources variability in Asian monsoon climate, effects of ENSO/EL Nino on monsoon rainfall, etc..**
- **Irrigation/drainage technologies and water management peculiar to the paddy cultivation.**
- **Flood disaster mitigation, water supply and environmental conservation measures for urbanizing areas located in the low-lying alluvial plain.**
- **Water scarcity issues due to imbalance between water supply and demand (Although the WHT zone receives "too much water", it has "too little water" issues due to "too much water demand", especially for growing big cities like Bangkok, Manila, Jakarta, etc..).**
- **Dam construction harmonized with societal and natural conditions in Asia.**
- ***You can find out a lot of other research topics to be solved in Asia Pacific region.***

What Makes Regional Differences in Hydrology and Water Resources Research ?

- Physical, chemical and biological principles governing the hydrological phenomena are general and common in the world.
- However, researchers in the field of hydrology and water resources deal usually with research subjects surrounding them. (e.g. It is difficult even for an excellent researcher to develop the study on phenomena which does not exist surrounding him)
  In this sense, hydrological studies tend to be site- specific.
- Therefore, scientific concepts and/or methods developed in a specific region are not necessarily applicable to other regions since the phenomena themselves are strongly affected by geographical conditions.
- Also, targets of research in a specific region may be different from those in another specific region.
- In this sense, research subjects and results have considerable differences region by region, especially between tectonic zones and stable regions.

Summary

- In my talk, the main focus is placed on how to recognize the "too much water" problems in monsoon Asia, which are not adequately addressed in the world-wide international societies led by western people.
- For this purpose, a new macroscopic hydrological region, "warm-humid tectonic zone", is introduced, and water resources issues particular to the zone are discussed.
- On the other hand, there are also arid and semi-arid areas, and we should address many research and practical subjects to be solved for the water scarcity in Asian-Pacific regions.
- We can find out a lot of specific research topics particular to our region.

Summary - Introduction of "Asia Pacific Association of Hydrology and Water Resources (APHW)"-

- In order to encourage and promote the exchange of knowledge/experience in water resources management and cooperative research activities in our region, "Asia Pacific Association of Hydrology and Water Resources (APHW)" just launched 1st Sept. 2002.
- The First International Conference on Hydrology and Water Resources in Asia Pacific Region will be held in 13-15 March 2003 (just before the 3rd World Water Forum) Kyoto, Japan. (web site: http://www.wrrc.dpri.kyoto-u.ac.jp/~aphw/APHW2003/WWW/index.html)
- The membership is open for individuals and institutes of every country in the world. We expect that the Association will be grown up by the active participation of many researchers and practitioners in Asia Pacific region


Thank you very much
for your kind attention

Flood and Sediment-related Disasters in Japan

Mr. Yasuo NAKANO
Director
Research Center for Disaster Risk Management
Infrastructure Management
Ministry of Land, Infrastructure and Transport

Flood and Sediment-related Disaster in Japan

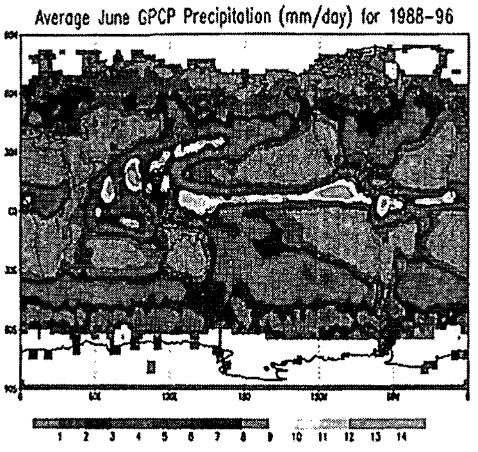
Yasuo Nakano

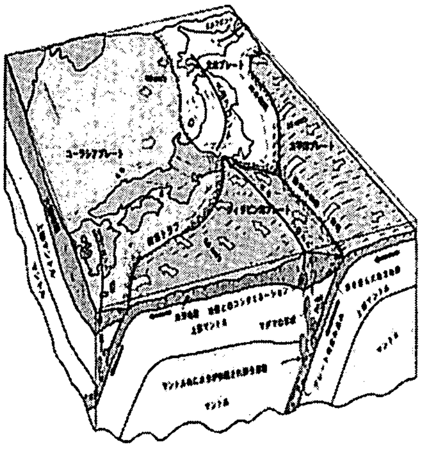
Director, Research Center for Disaster Risk Management, NILIM, MLIT

Outline

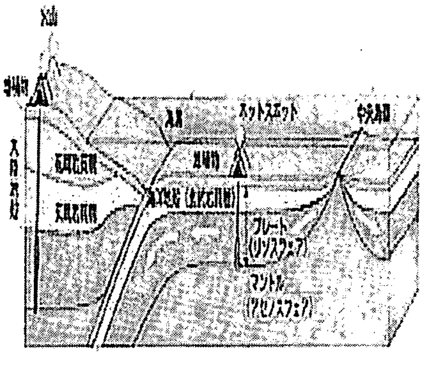
1. Natural and Social Condition in relation to flood and sediment-related disaster
2. Countermeasures for flood and sediment-related disaster in Japan
3. Latest Topics (Amendment to Flood Fighting Law and Establishment of Sediment-related Disaster Law
4. Experiences in Japan

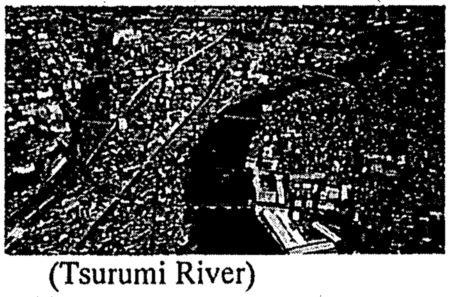
1. Natural Condition (1)
Climate and Orogeny



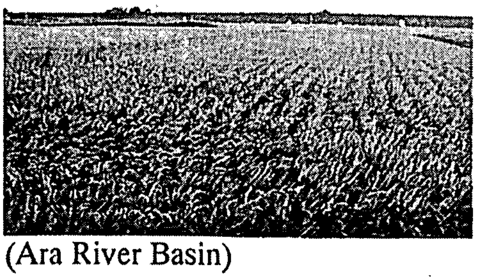


1. Natural Condition in Japan (2)

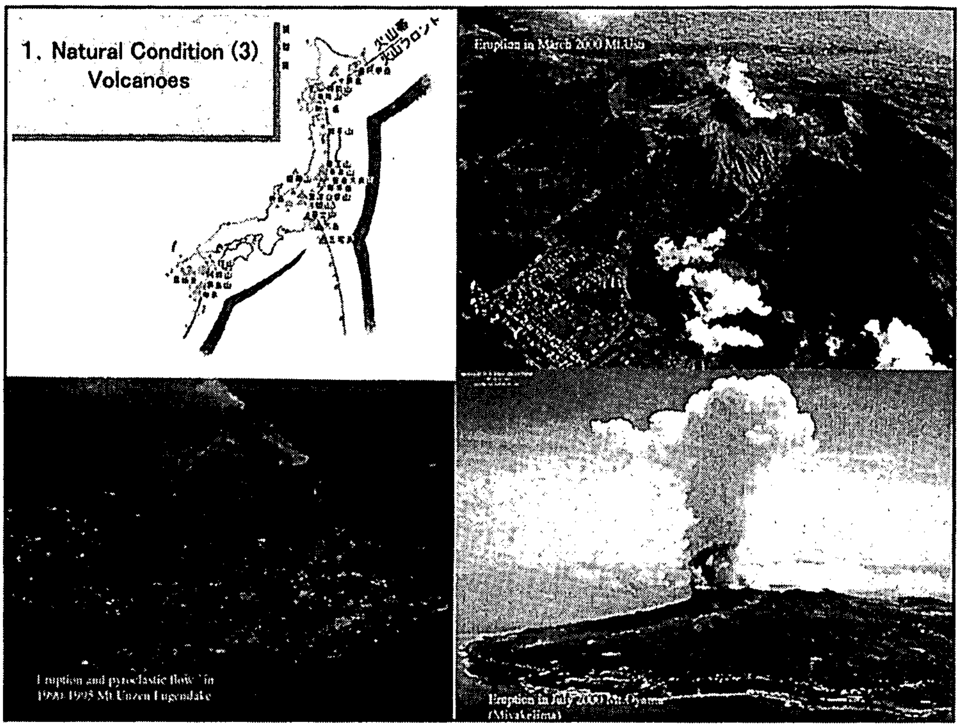




(Tsurumi River)



(Ara River Basin)



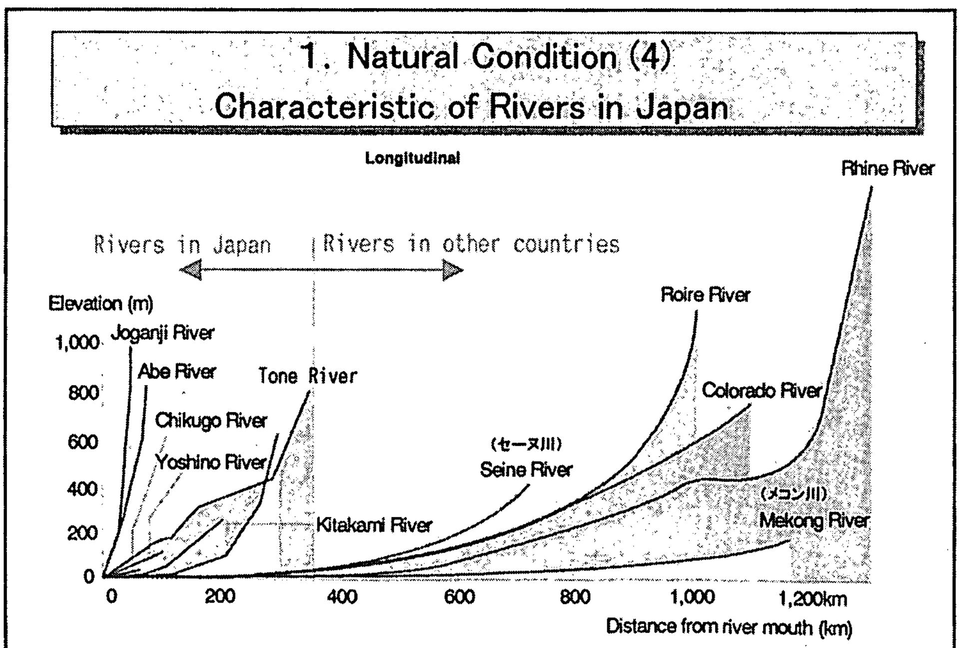
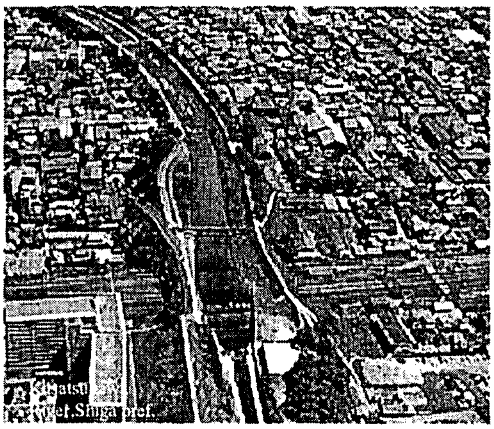
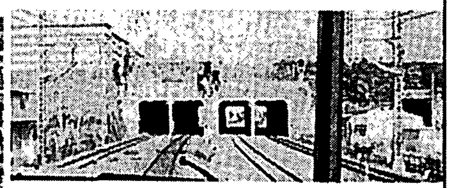
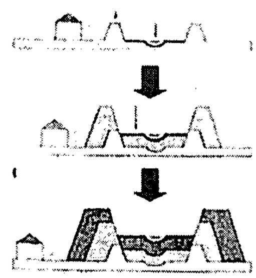


Fig. Longitudinal slope of rivers in Japan and Others

1. Natural Condition (5)
Characteristic of Rivers in Japan
(River with bed above ground)







1. Natural Condition (6)
Characteristic of Rivers in Japan

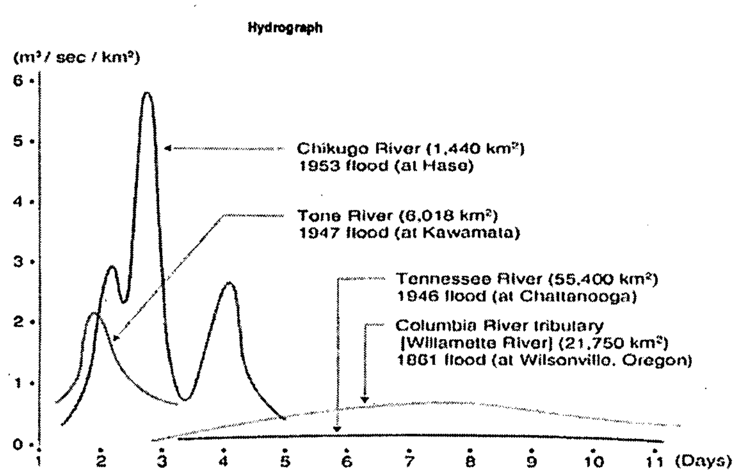


Fig. Characteristic of flood runoff in Japan

1. Natural Condition (7)
Characteristic of Rivers in Japan

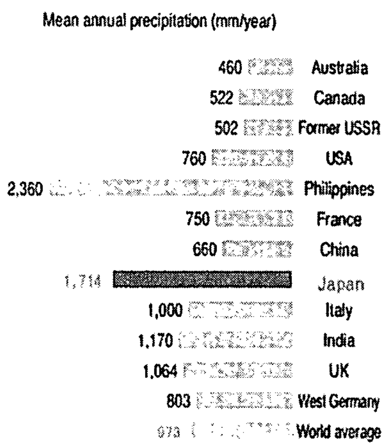


Fig. Precipitation in the world

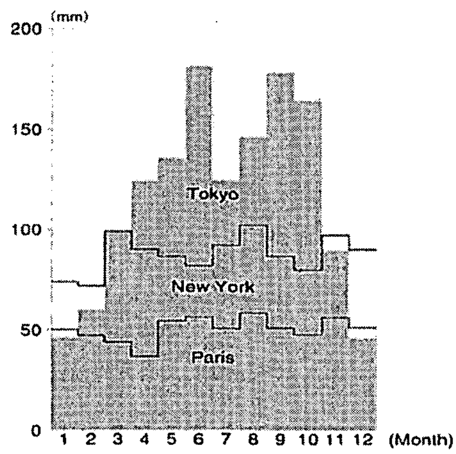
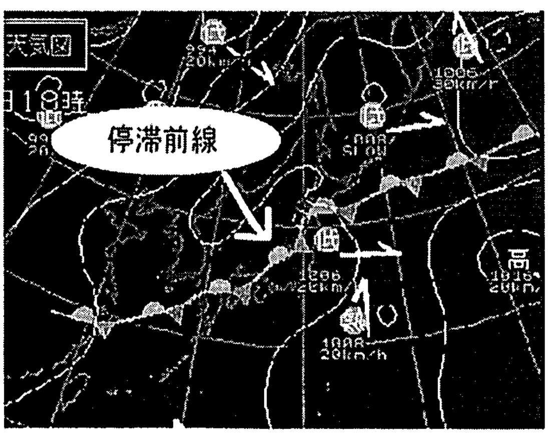
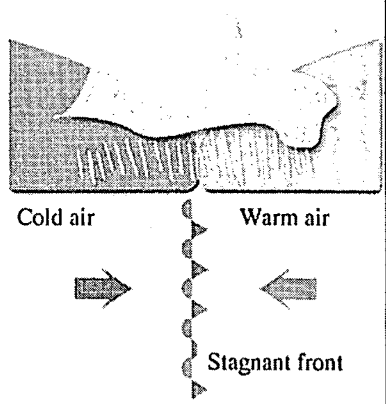


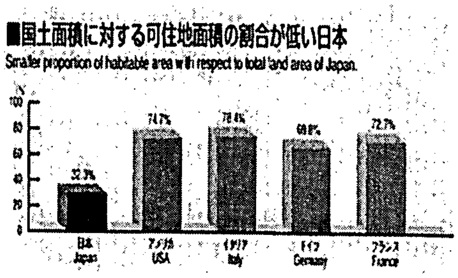
Fig. Monthly precipitation in Tokyo, Paris and New York

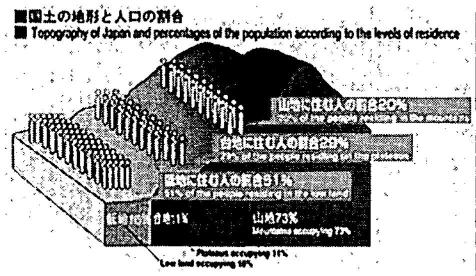
1. Natural Condition (8)
Stagnant front and rainfall





1. Social Condition in Japan (1)





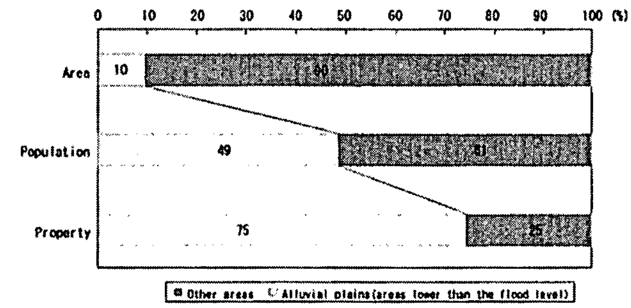


Fig. Concentration of Population and Property in flood prone area

1. Social Condition in Japan (2)

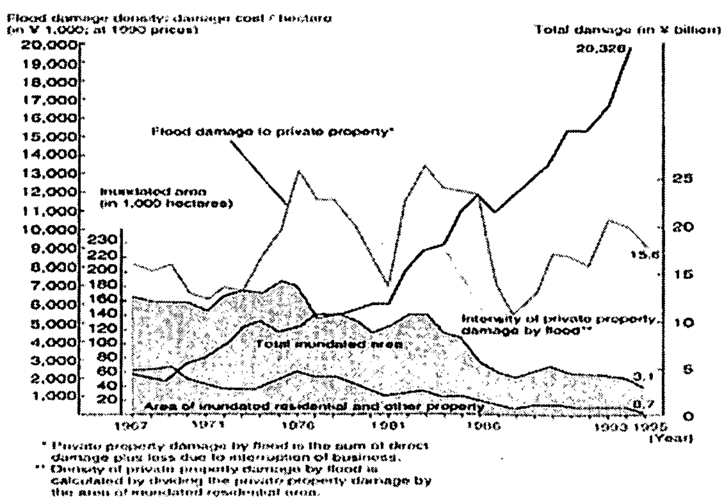
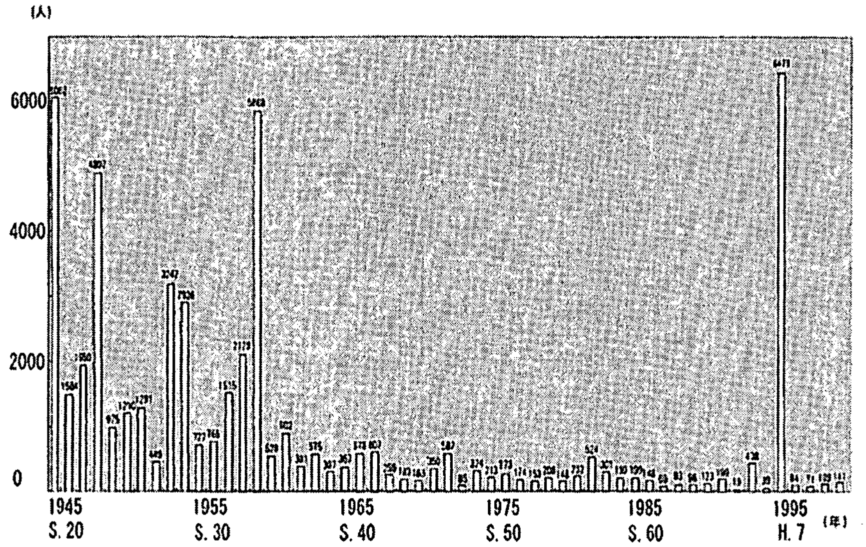


Fig. Changes in intensity of private property damage by flood

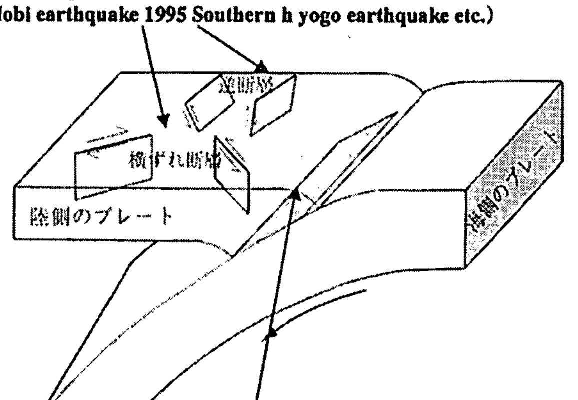
2. Countermeasures for flood disaster in Japan (1)

Death and missing by natural disaster



2. Countermeasures for flood disaster in Japan (2)
Characteristic of earthquakes in Japan

Type of the earthquake at the inland active fault
(cf.1891 Nobi earthquake 1995 Southern h yogo earthquake etc.)

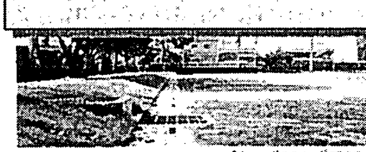


Type of earthquake at the boundary of plates
(cf.1923 Kanto earthquake etc.)

2. Countermeasures for flood disaster in Japan (3)

- Flood control measures
  - Means of civil works technologies measures (Structural measures)
    - Channel improvement (arrangement of embankments or floodways, channel excavation/dredging, channel widening)
    - Construction of flood control facilities (dam, retarding pond, regulating reservoir)
    - Arrangement of rainwater storage/infiltration facilities
    - Arrangement of facilities for the drainage of inner basins
    - Arrangement of forest zones along the river and others
  - Legal and systematic means (Non-Structural measures)
    - Implementation of flood forecasting and warning
    - Preparation and publicizing of hazard maps
    - Flood-fighting activities
    - Distribution of flood prevention information
    - Land use/building regulations and others

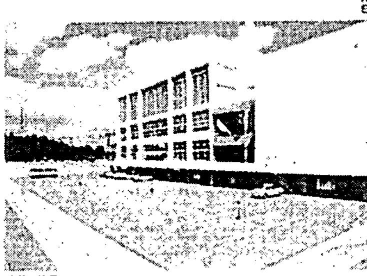
2. Countermeasures for flood disaster in Japan (4)
Examples of Storage and infiltration facilities



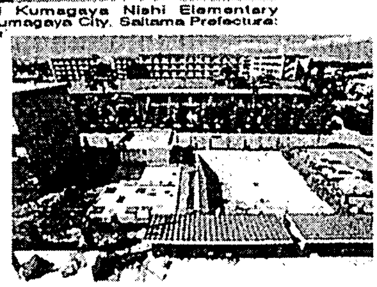
At ordinary times

In the event of a heavy rain, rainwater is detained to control flow into rivers.

Municipal Kumagaya Nishi Elementary School (Kumagaya City, Saitama Prefecture: hi River



Piloti Type
The underground structure of the building and the parking lot absorb water and let it drain gradually so that flooding and water invasion can be avoided.



Storage Plus Filtration
The storage function of the adjusting pond and the filtering of the well serve to both control outflow and process the drained water.

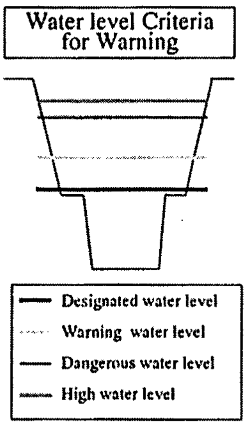
2. Countermeasures for flood disaster in Japan (5)
Designated Rivers for Flood Forecasting

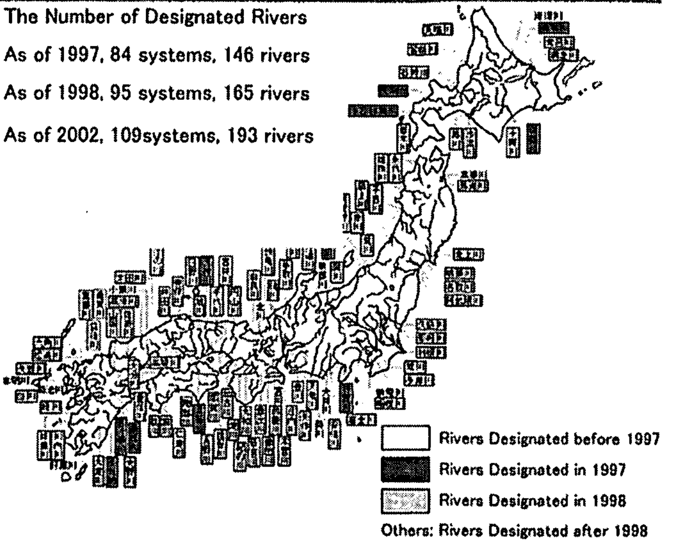
The Number of Designated Rivers

As of 1997, 84 systems, 146 rivers

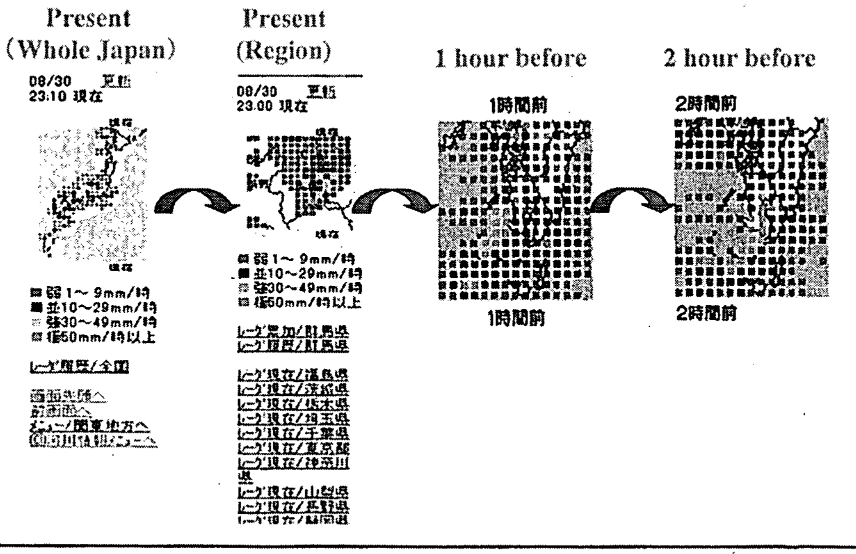
As of 1998, 95 systems, 165 rivers

As of 2002, 109systems, 193 rivers

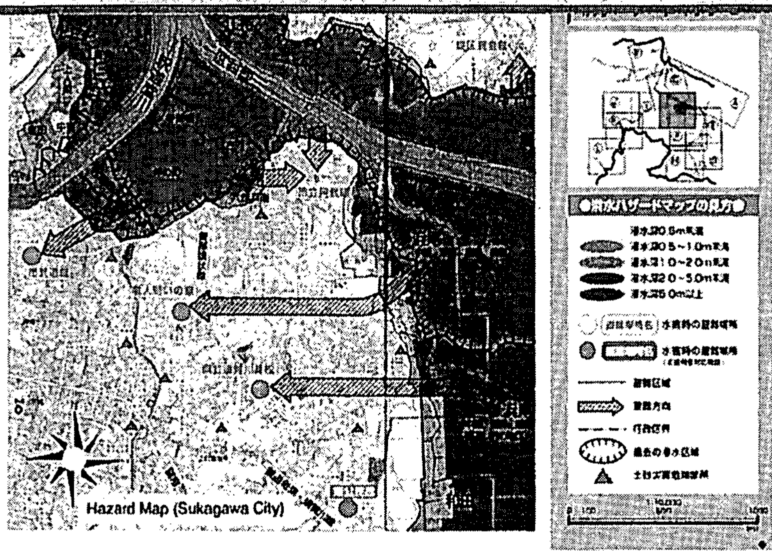




2. Countermeasures for flood disaster in Japan (6)
River Information Service via Cell Phone

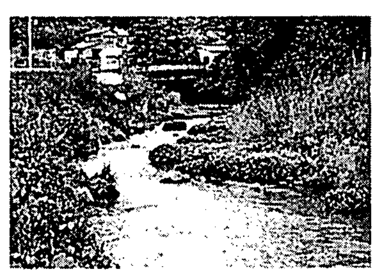


2. Countermeasures for flood disaster in Japan (7)
Examples of flood hazard map



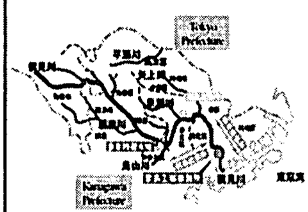
2. Countermeasures for flood disaster in Japan (8)
Examples of river restoration

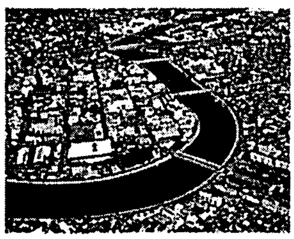
Before implementation
It was shallow in water depth, and the flow was also monotonous, with articulated blocks being exposed on the

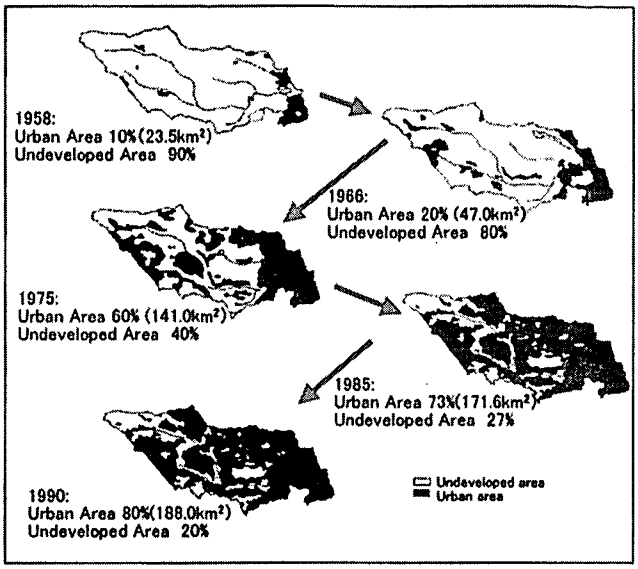


One year and 10 months after implementation
Grassy-leaved sweet flag (Acorus gramineus) and rosegold pussy willow (Salix gracilistyla) have grown thickly on the waterside. (April 1995)

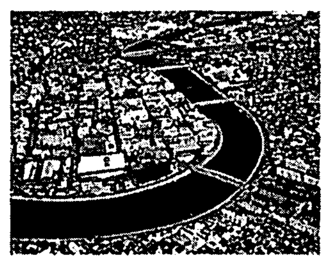
2. Countermeasures for flood disaster in Japan (9)
Trends of Urbanization in Tsurumi River Basin







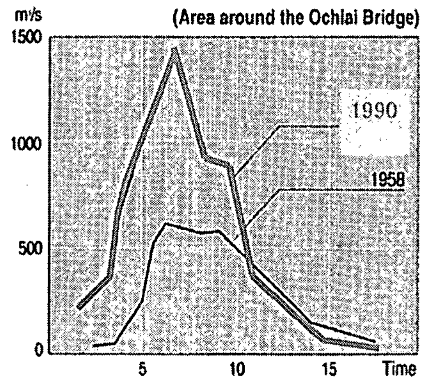
2. Countermeasures for flood disaster in Japan (10)
Discharge Distribution Plan (The Tsurumi River)



Design Flood Discharge (1,940m³s)

- Distributed Discharge (Basin) (640m³s)
  - Water Retention Area (290m³s)
  - Water Storage Area (290m³s)
  - Low-lying Area (60m³s)
- Distributed Discharge (River) (1,300m³s)
  - Channel Discharge (1,100m³s)
  - Planned Retarding Basin (200m³s)

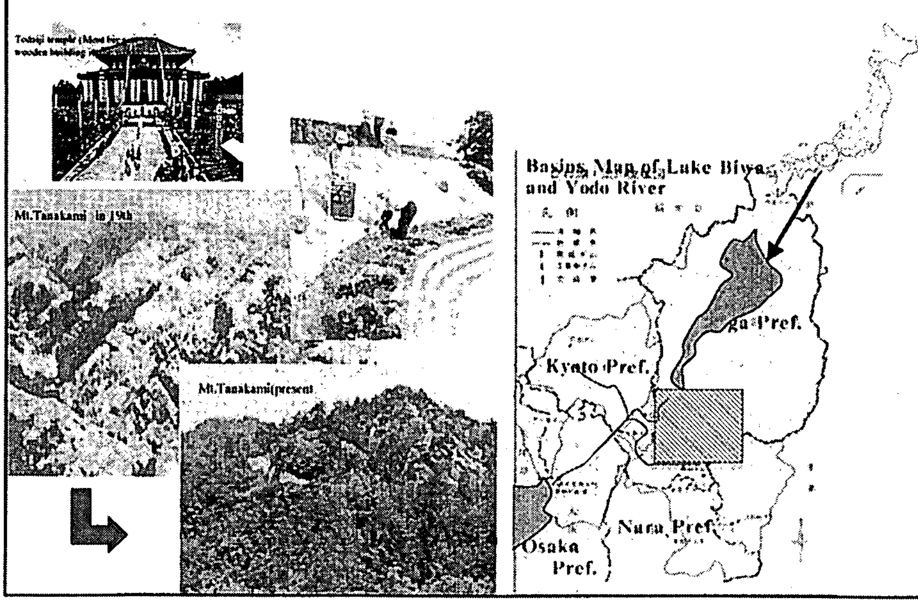
2. Countermeasures for flood disaster in Japan (11)
Flood Peak Discharge and Change of Flood Arrival Time

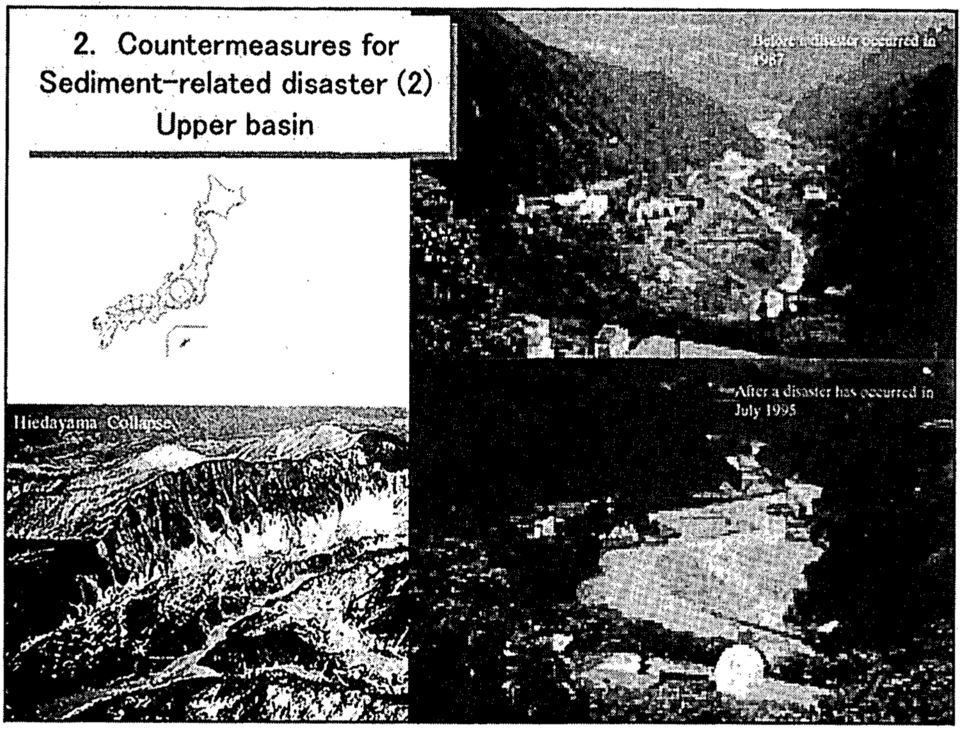


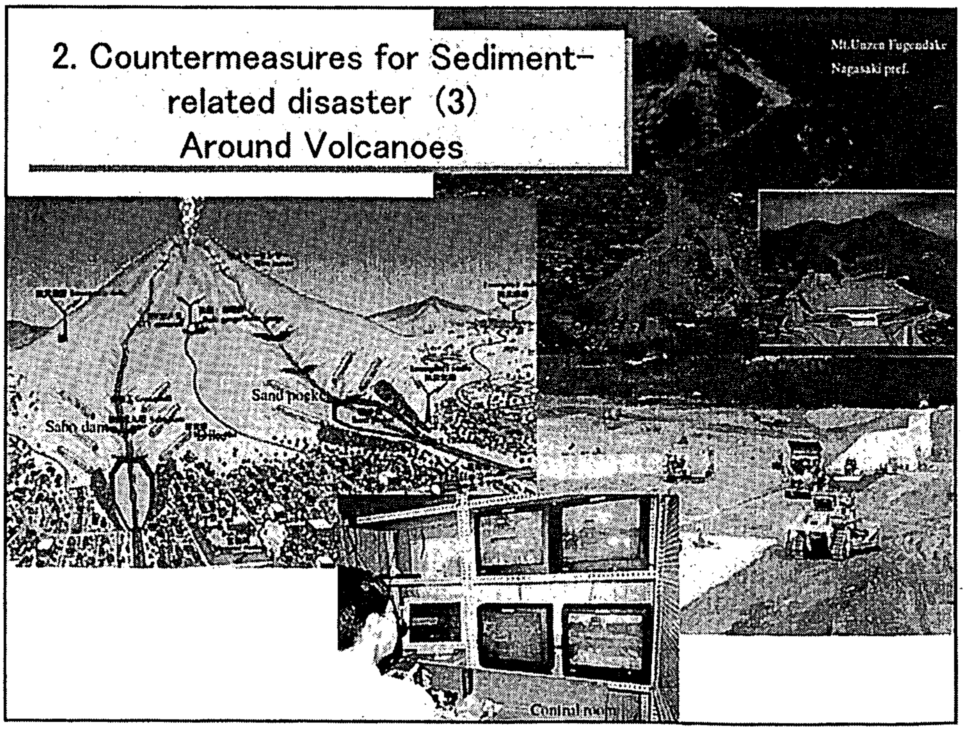
The Amplification of Flood Size due to Urbanization

It is predicted that even with the same rainfall, before the progress of urbanization due to the expansion of city land (1958), the flood peak outflow volume had approximately doubled (1990), and the weakness of the Tsurumi River basin with respect to flooding can be inferred.

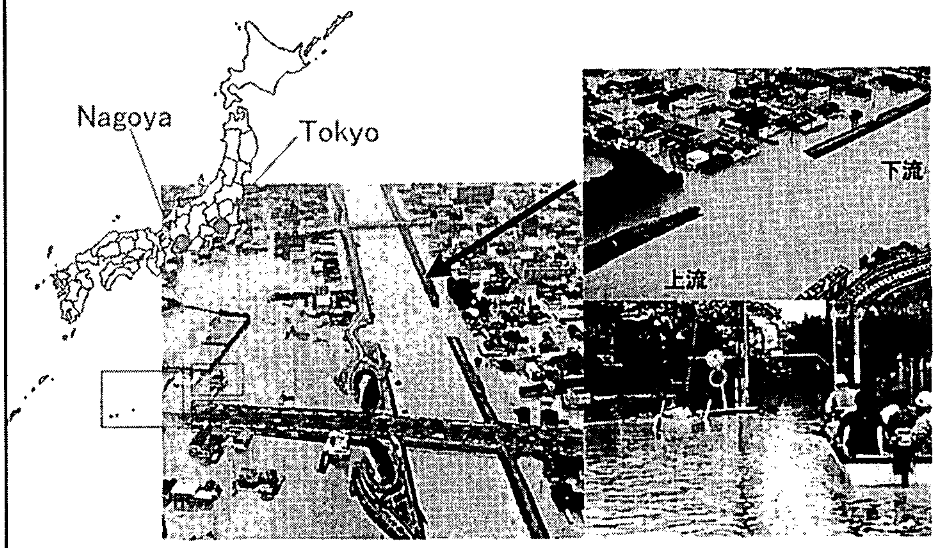
2. Countermeasures for Sediment-related disaster (1)




2. Countermeasures for
Sediment-related disaster (2)
Upper basin
Hiedayama Collapse
After a disaster has occurred in
July 1995


2. Countermeasures for Sediment-
related disaster (3)
Around Volcanoes
Mt.Unzen Fugendake
Nagasaki pref.
Sabo dam

3. Latest Topics (1)
Flood Disaster in Tokai Region (12th Sep. 2000)



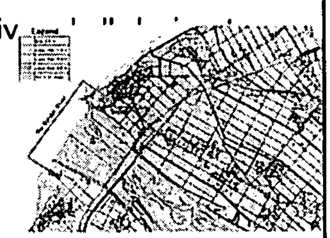
3. Latest Topics (2)
Amendment to Flood Fighting Law

Main point of the amendment

(1) Designated river for flood forecasting and warnings is extended to the rivers administered by prefectural governor.

(2) The administrator of the designated riv
the predicted inundation area.

- Predicted inundation area
- Depth of predicted inundation



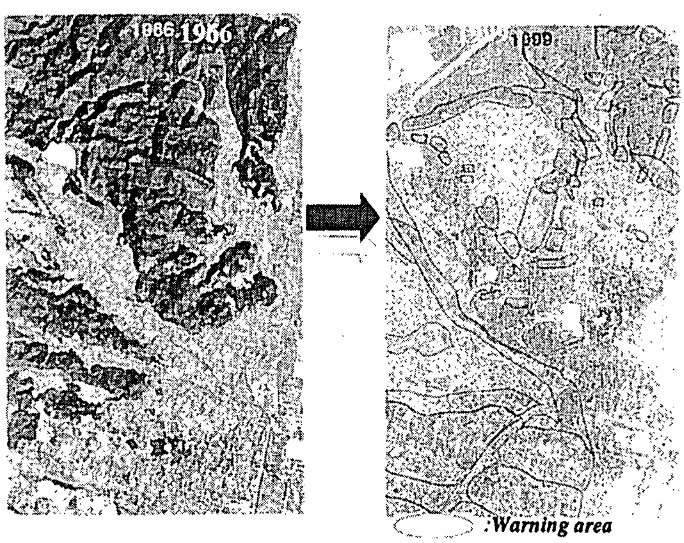
Predicted inundation area map (the Kurobe river)

(3)Cities or municipalities' disaster prevention conference shall establish

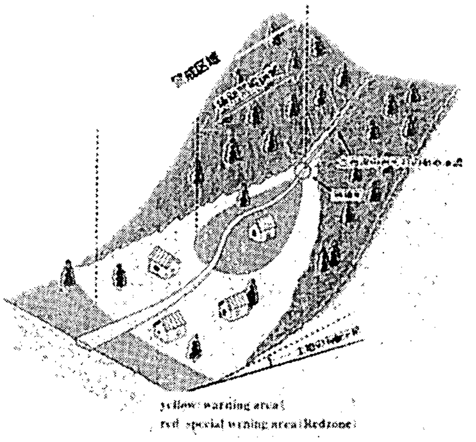
- The way of flood forecasting dissemination
- Evacuation place in each predicted inundation area

3. Latest Topics (3)
Sediment-related disaster in Jun.1999 in Hiroshima prefecture (1)

3. Latest Topics (4)
Sediment-related disaster in Jun.1999 in Hiroshima prefecture (2)



3. Latest Topics (5)
Sediment-Related Disaster Prevention Act



4. Conclusion:Experiences in Japan

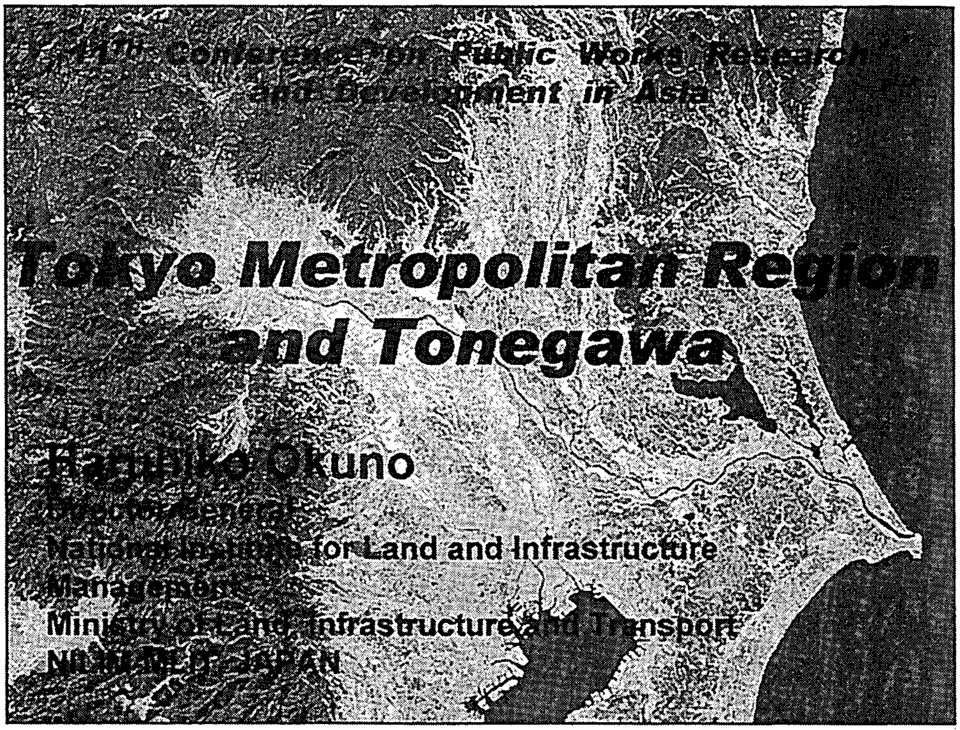
1. Commonality of natural and social condition
   - Japan also experienced rapid population increase and concentration of population in urban area
   - In the future, the population in Asia and Africa increase rapidly and concentrate in flood and sediment disaster prone area
2. Limitation of Structural Countermeasures
   - High cost of structures
   - Take long time to construct structures
   - Impossible to prevent all disasters
3. Suggestion
   - Have recognition of the basin
   - Inform about the disaster prone area and Land use for not living there
   - Establishment of warning and evacuation system
   - Importance of Three Principal — Share part among Government, Local government and other Organizations, "Governmental Help", "Mutual Help"

     → Importance of Community

D. COUNTRY REPORT

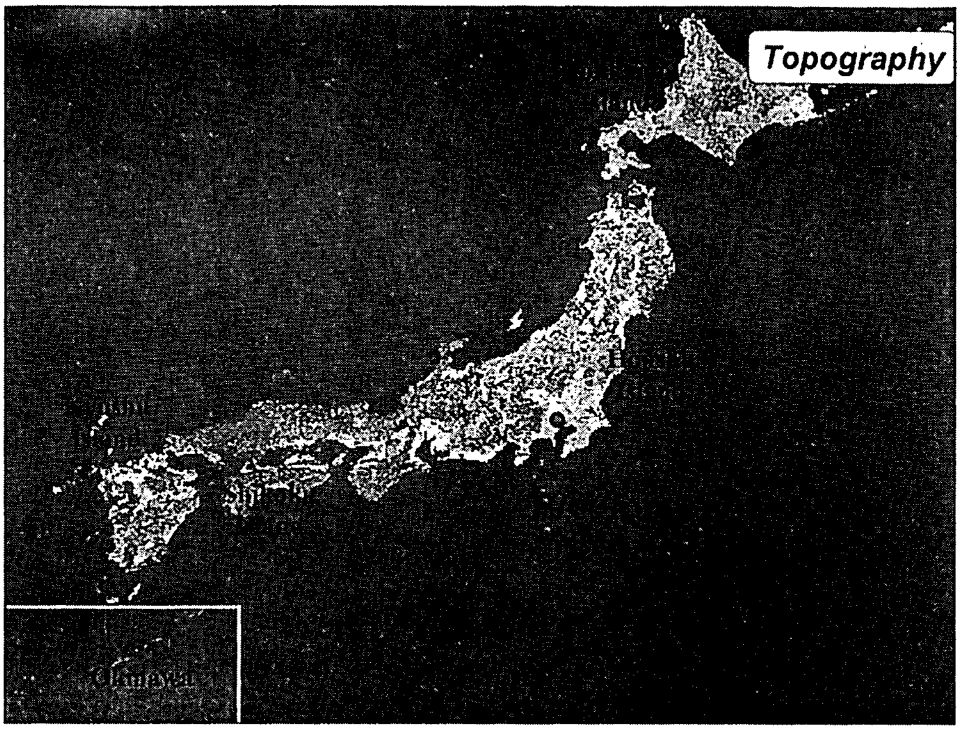
JAPAN

Mr. Haruhiko OKUNO
Director General
National Institute for Land and Infrastructure Management
Ministry of Land, Infrastructure and Transport



Objectives

- Review the history of Tonegawa riverworks projects (from Edo era circa 1600 - today)
- Review the issues arising from societal developments, and the role of river improvement projects, as exemplified by Tonegawa
- Explore future challenges and directions



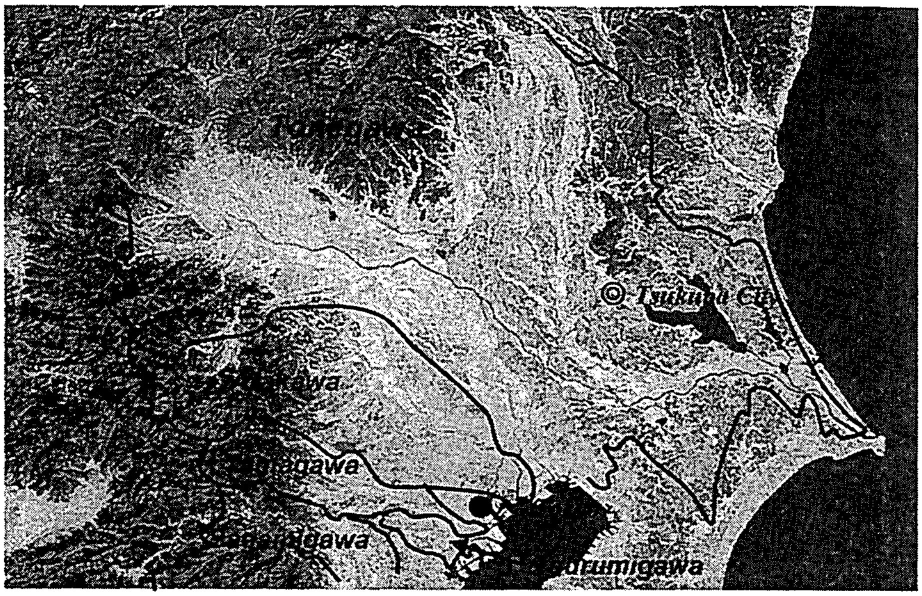
General Characteristics of Japan

- ***There are four major islands: Hokkaido, Honshu, Kyushu, Shikoku, and some 3,900 smaller islands.***
- ***Japan's total area: 377,815 square kilometers.***
- ***Mountains cover about 71% of Japan's land surface.***
- ***The islands of Japan lie in the temperate zone and at the NE end of the monsoon area.***
- ***Average annual rainfall across the country ranges from 1,000 to 2,500 millimeters.***

Tokyo Metropolitan Region

Topography

5 Primary River Basins



General Characteristics of Tokyo Metropolitan Region

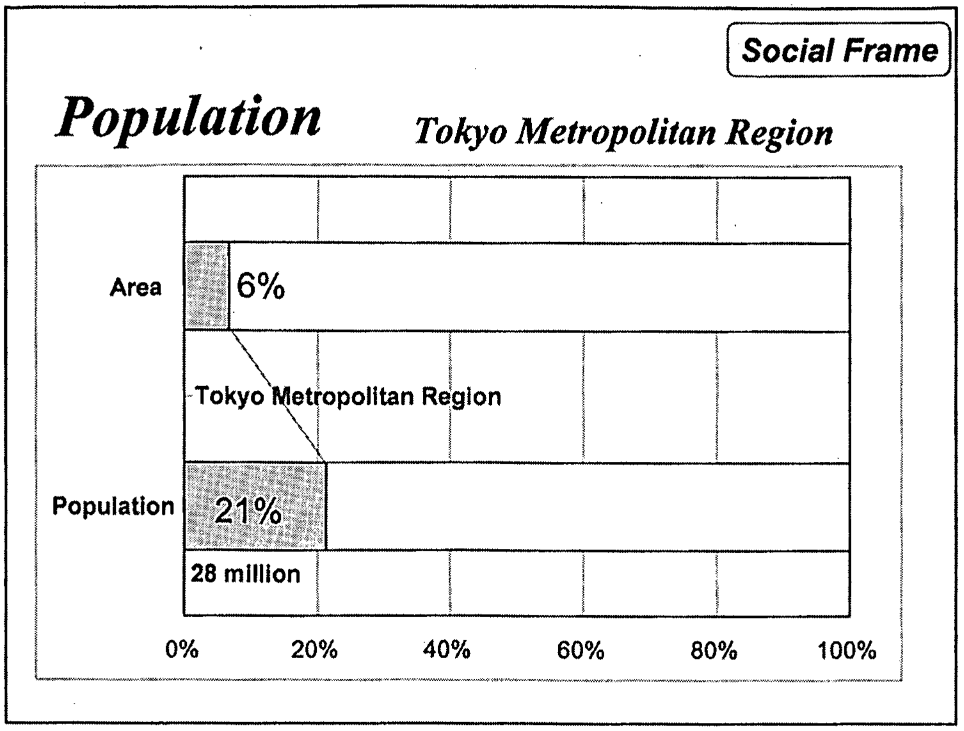
■**RIVER BASINS:**

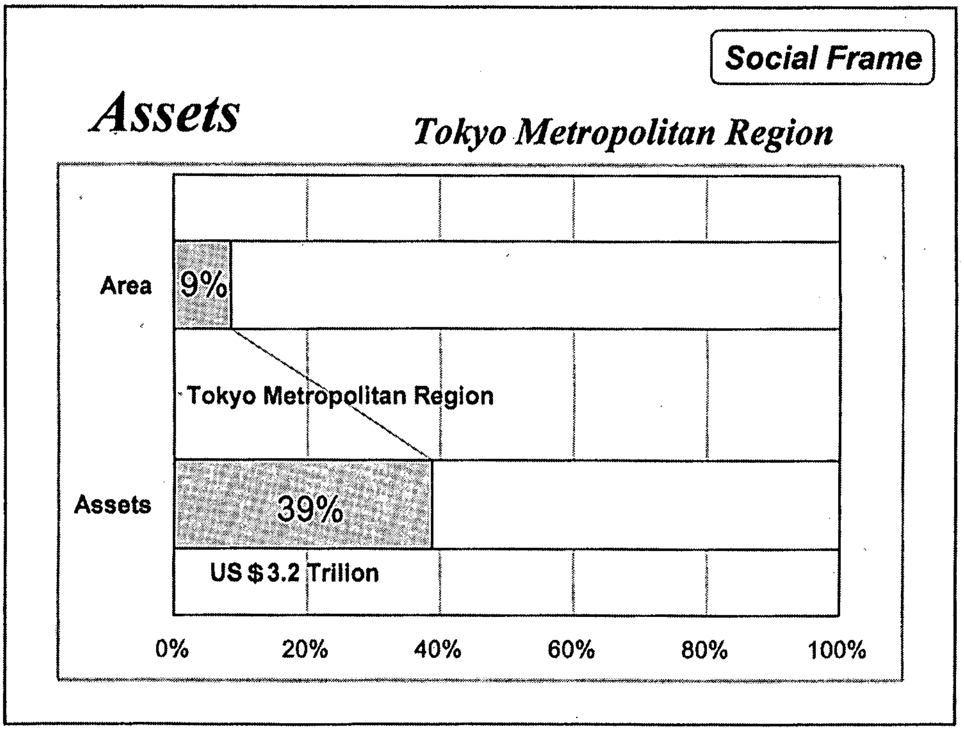
Area of the 5 river basins is about 22,600 km^2, with a total population of 28 million and total assets of about US$ 3.2 Trillion.

■**CLIMATE**

Winter : low humidity with occasional snow

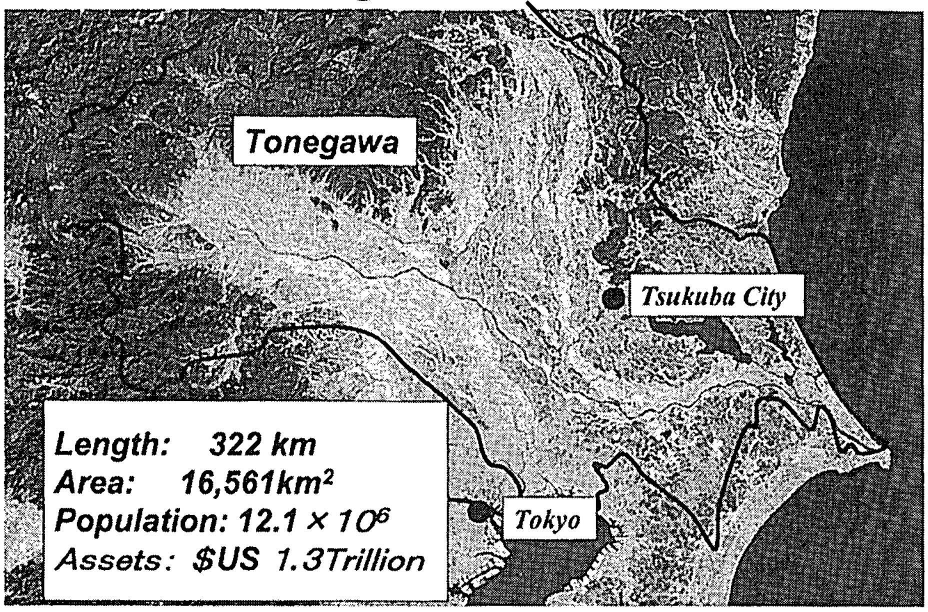
Summer : high temperatures and humidity with an annual average rainfall of about 1500 mm.


Social Frame
Population
Tokyo Metropolitan Region
Area
6%
Tokyo Metropolitan Region
Population
21%
28 million
0%
20%
40%
60%
80%
100%


Social Frame
Assets
Tokyo Metropolitan Region
Area
9%
Tokyo Metropolitan Region
Assets
39%
US $ 3.2 Trilion
0%
20%
40%
60%
80%
100%

Tonegawa

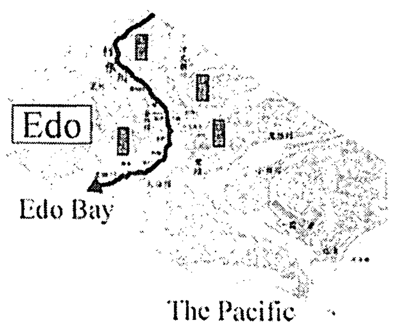
Topography



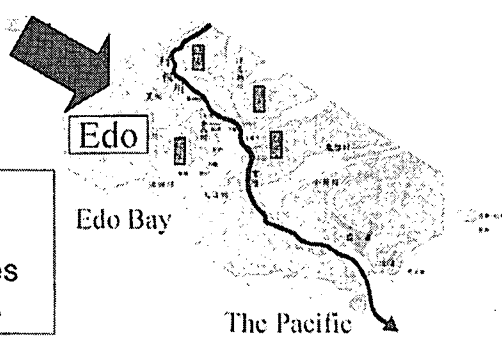
History of Tonegawa Riverworks

Edo era

Diversion Riverworks (1594～1654)



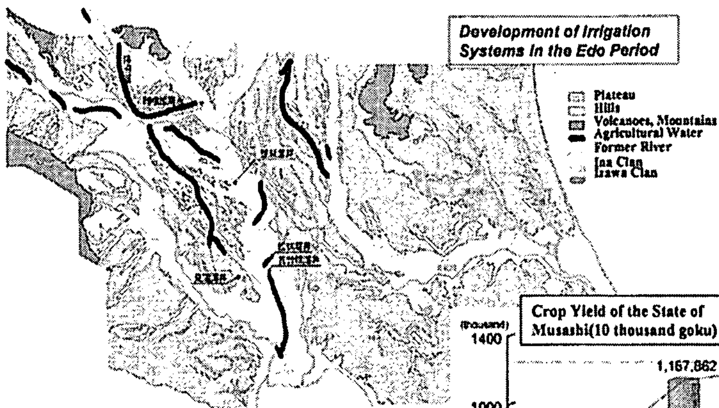
Redirect Tonegawa out to the Pacific Ocean from Edo Bay



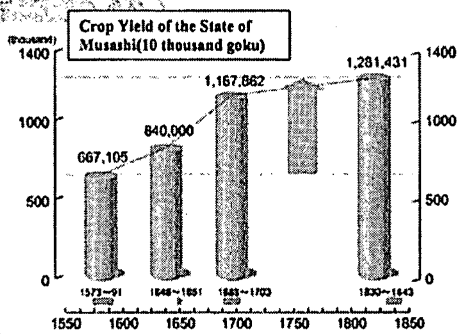
Objectives
1. Prevent floods in Edo
2. Develop new rice paddies
3. Allow navigation of ships

Rice Paddy Development

Edo era

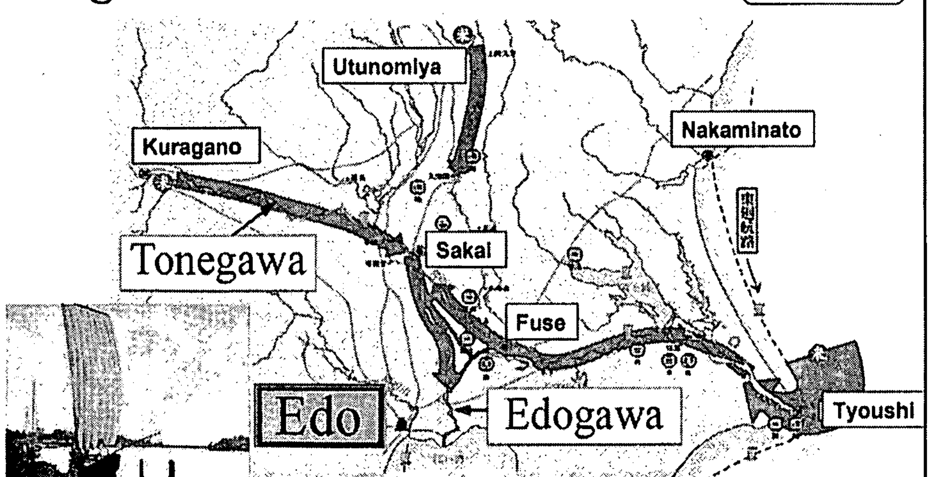


- The Tonegawa Diversion allowed the development of new rice paddies.
- Rice yields doubled, providing solid foundations for Edo's economy.



Navigation

Edo era



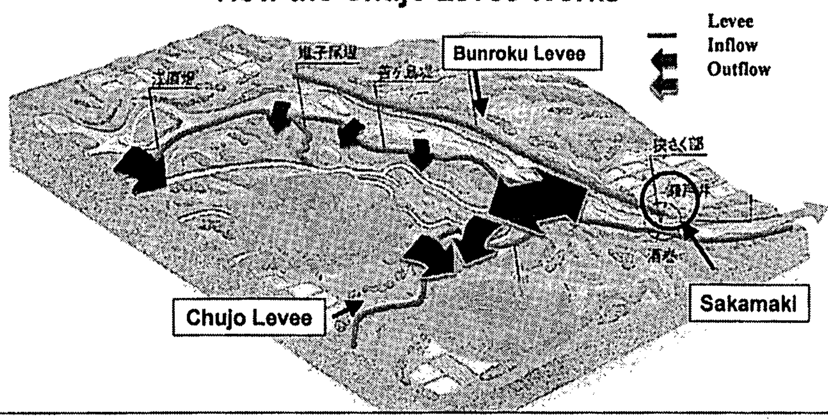
- The Tonegawa Diversion also allowed the development of an intricate inland navigation network, to serve as arteries of the Edo economy.

History of Tonegawa Riverworks

Edo era

Regulating Flow in the Middle Reaches (Chujo Levee)

How the Chujo Levee Works

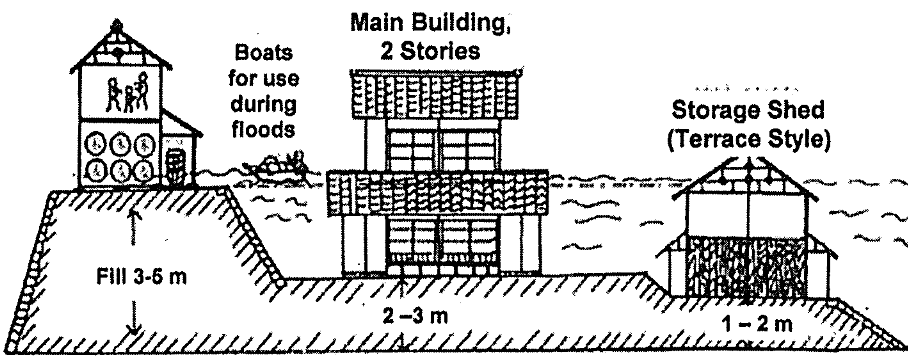


Area: 49 km^2, Capacity: 120×10^6 m^3

Mizuka: A local initiative developed by flood prone areas

Edo era

Mizuka

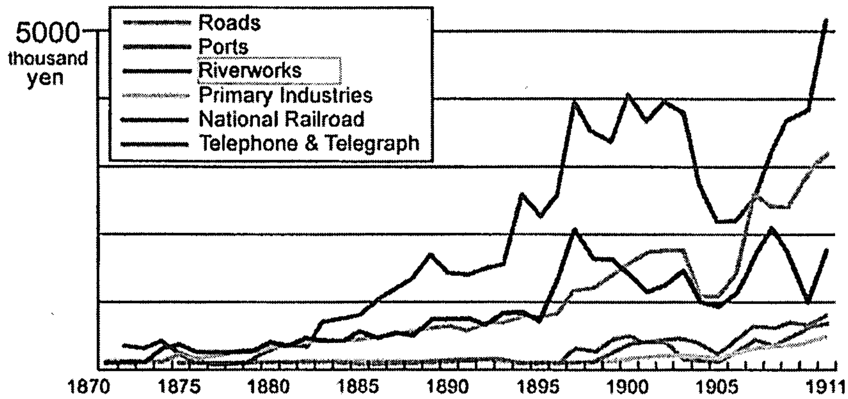


Mizuka: An Evacuation Refuge

Original drawing by Shigeru Miyata, October 1, 1960

Public Investments *(Nationwide)* Meiji era

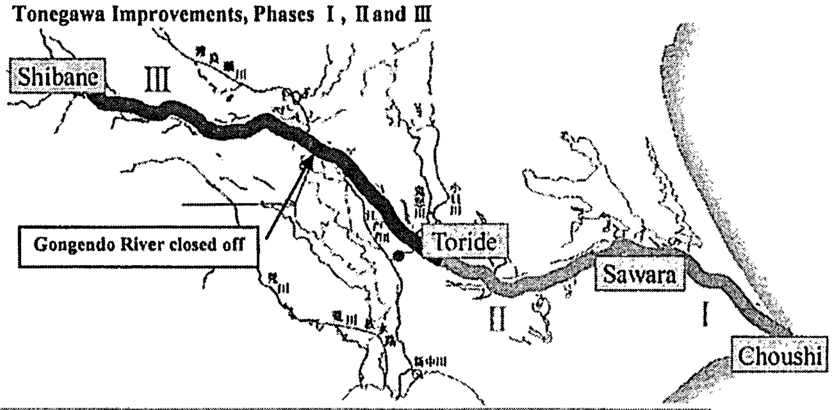
◇ **Comparison of Public Investments in the Meiji Period**



1896: River Law enacted
1900: Greater investment in riverworks

The First Modern River Improvements
(1900~1930)

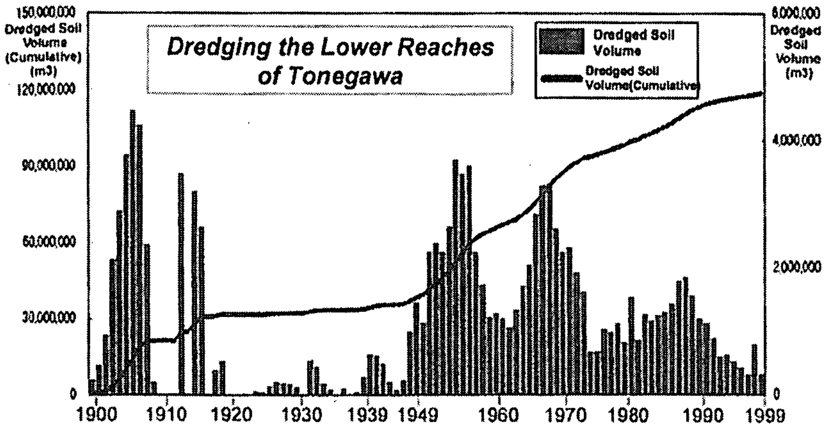
Tonegawa Improvements, Phases Ⅰ, Ⅱ and Ⅲ



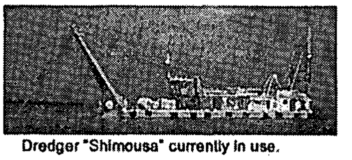
1900 Tonegawa Improvement Plan
Dredging and levee works from
the lower to the upper reaches

Dredging

Enhancing Drainage Capacity in the Lower Reaches

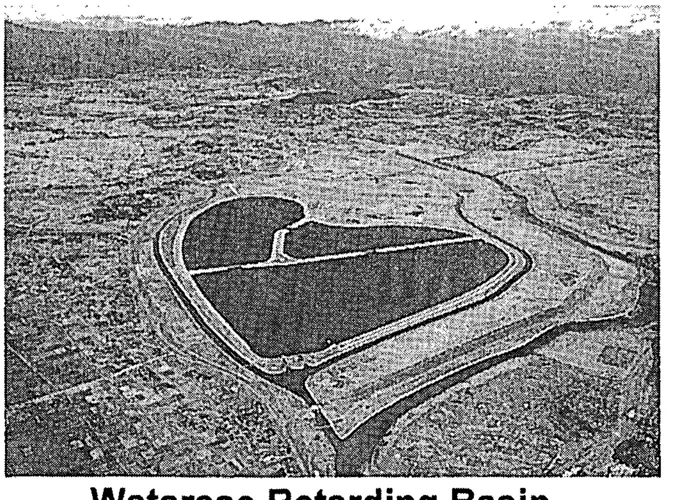


Dredged soil volume between 1900-1930 exceeded the Panama Canal excavation.



Dredger "Shimousa" currently in use.

Construction of Retarding Basins in the Middle and Lower Reaches

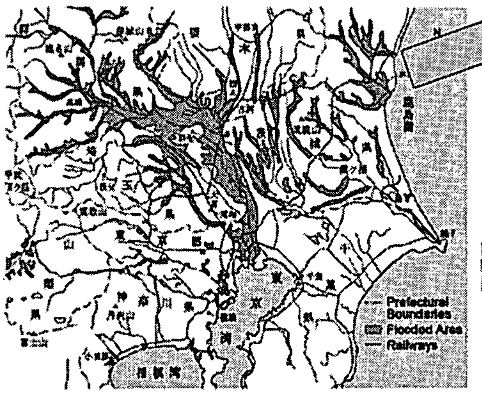


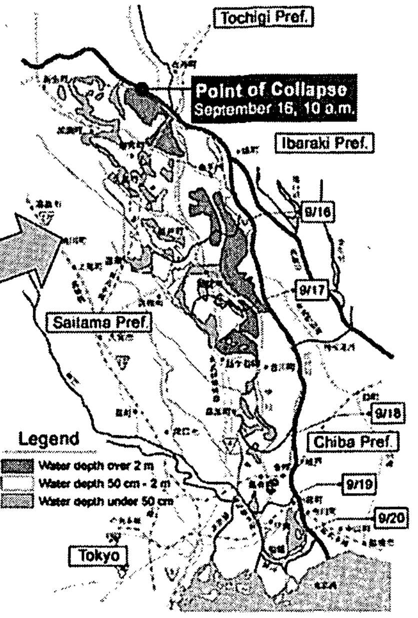
Watarase Retarding Basin (Construction began in 1911)

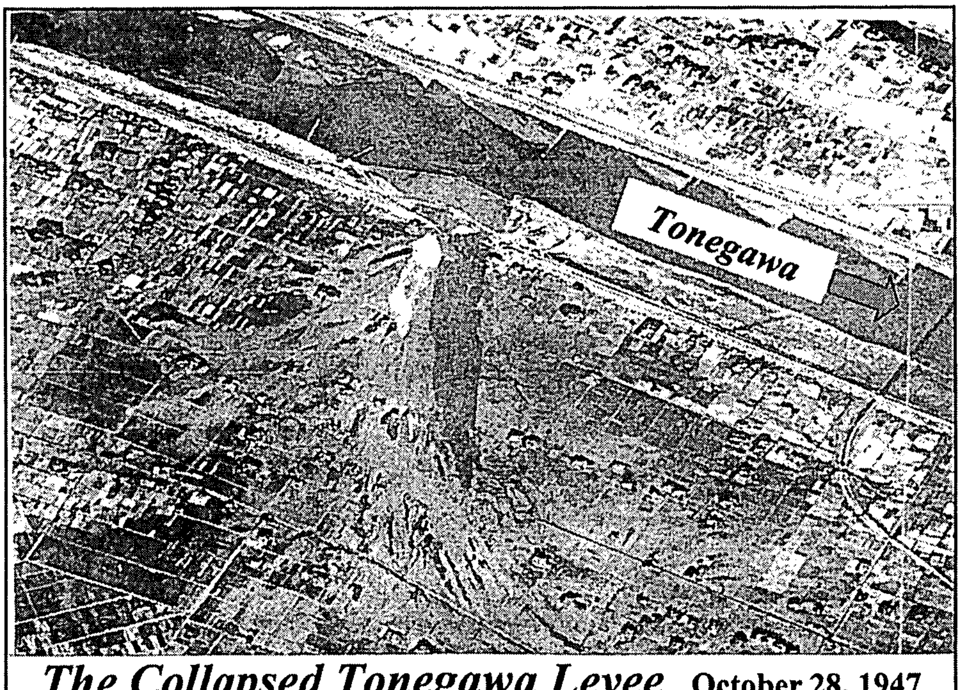
Damage from Typhoon Kathleen (1947)

Point of Levee Collapse	Tonegawa 134.4 km (right bank)
Flooded Area	440 km²
Population within the Flooded Area	600,000
Damage	Approx. 7 billion yen (as of 1947) (general property + agricultural products)

Flooded Area







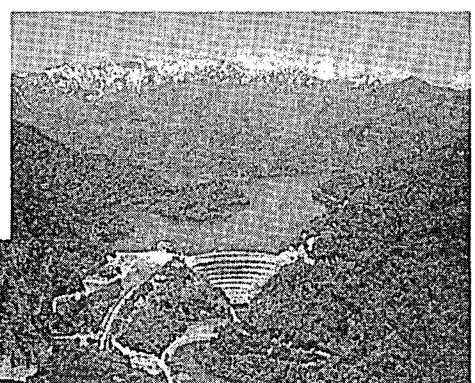
The Collapsed Tonegawa Levee **October 28, 1947**

Sabo Projects at the Headwaters

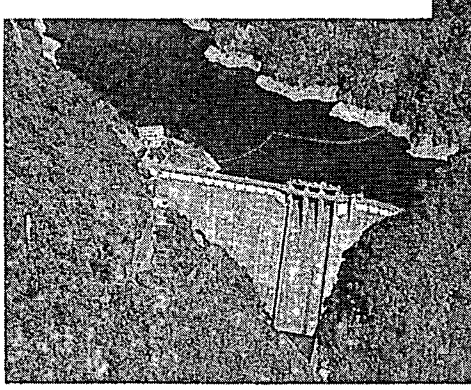
Sabo Facilities for Erosion Controls

Ashio Sabo Dam
(Watarase River)

Dam Construction in the Upper Reaches



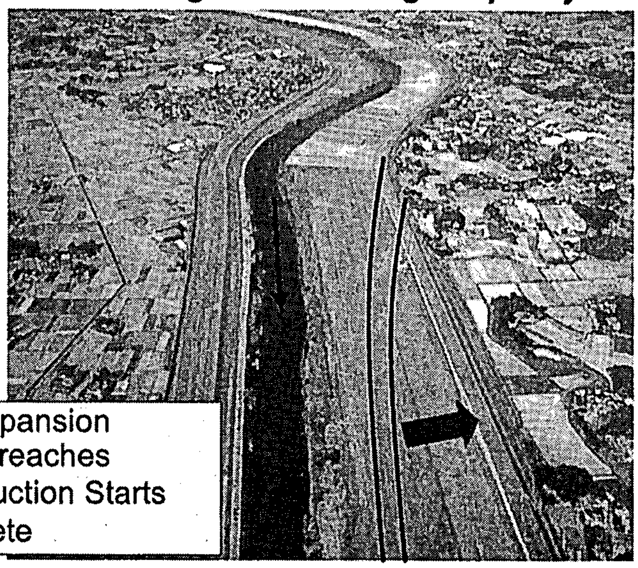
Yagisawa Dam (1967)



Fujiwara Dam (1957)

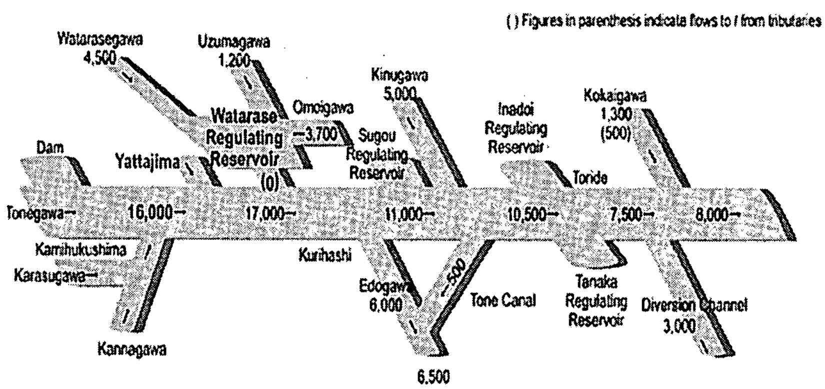
River Width Expansion

Enhancing River Drainage Capacity

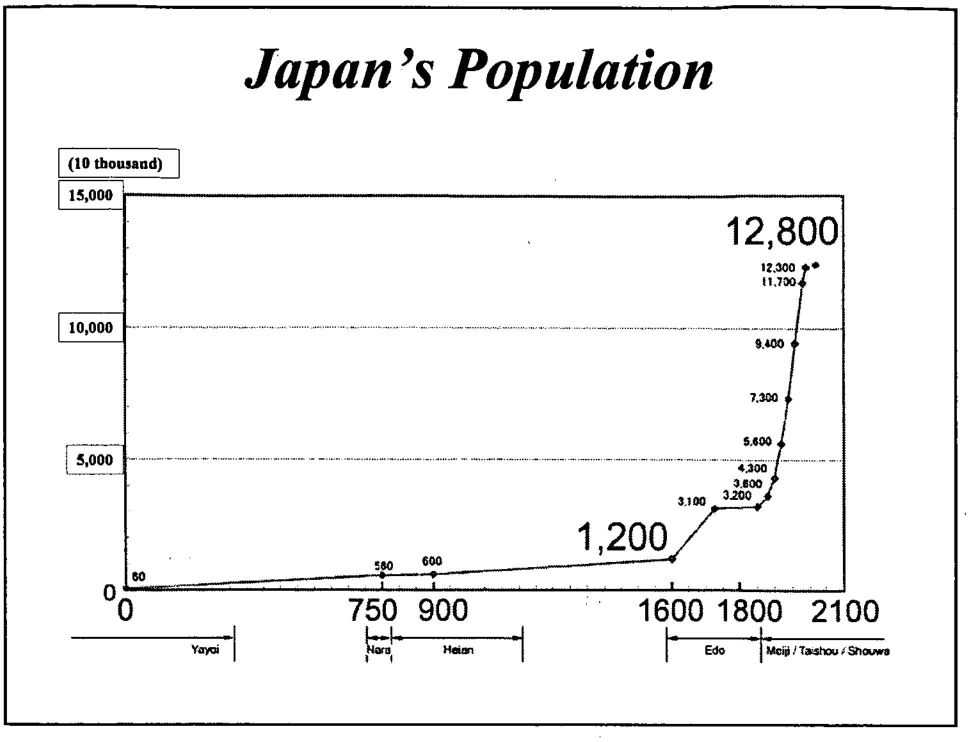


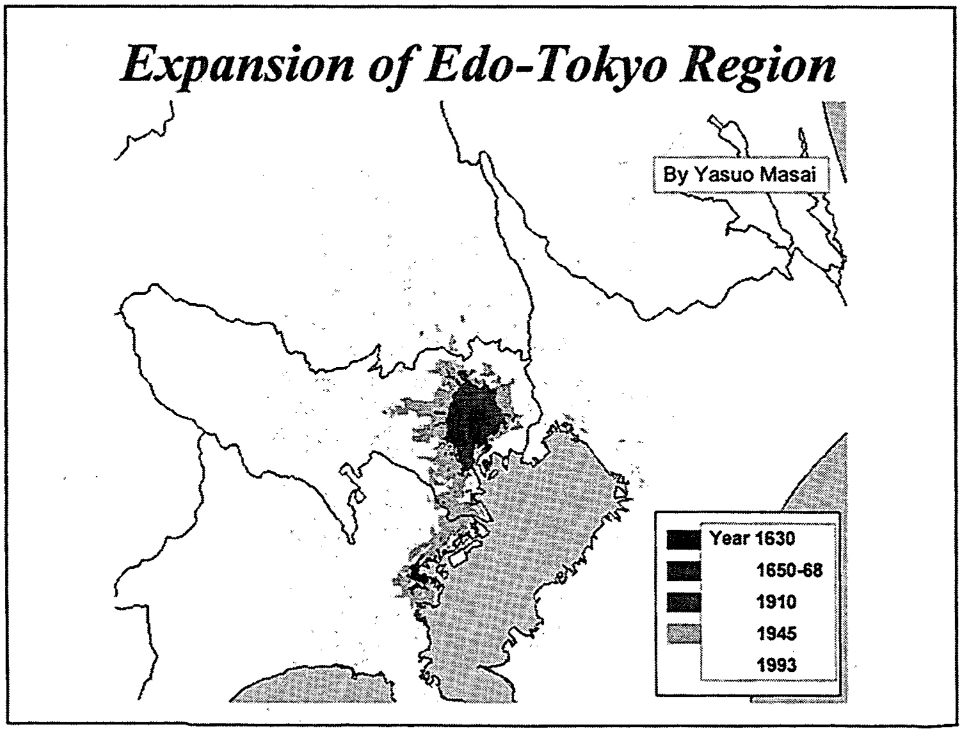
Tonegawa Flow Distribution

Flow Distribution (m³/s)

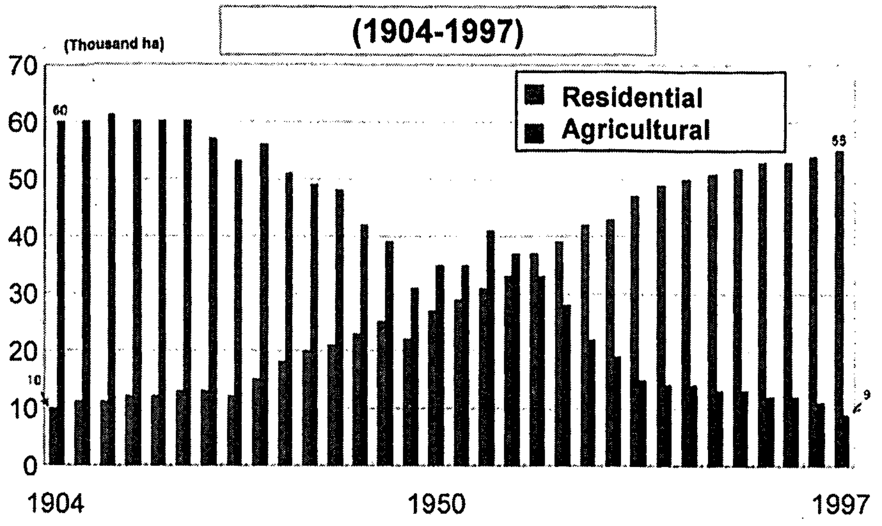


- return period: $P=1/200$
- Yattajima: 22, 000−6, 000 → 16, 000 (m³/s)

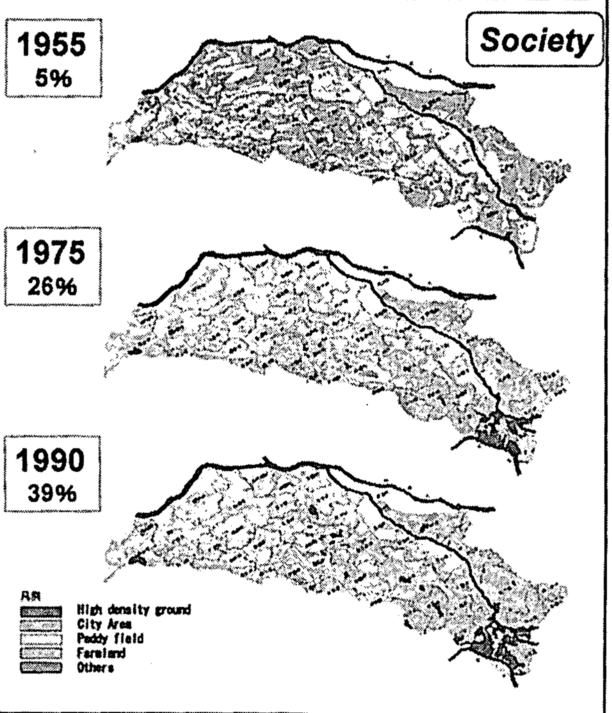

Japan's Population
(10 thousand)
15,000
10,000
5,000
0
12,800
12,300
11,700
9,400
7,300
5,600
4,300
3,800
3,200
3,100
1,200
60
560
600
0
750
900
1600
1800
2100
Yayoi
Nara
Heian
Edo
Meiji / Taishou / Shouwa


Expansion of Edo-Tokyo Region
By Yasuo Masai
Year 1630
1650-68
1910
1945
1993

Changes in Tokyo's Residential and Agricultural Lands

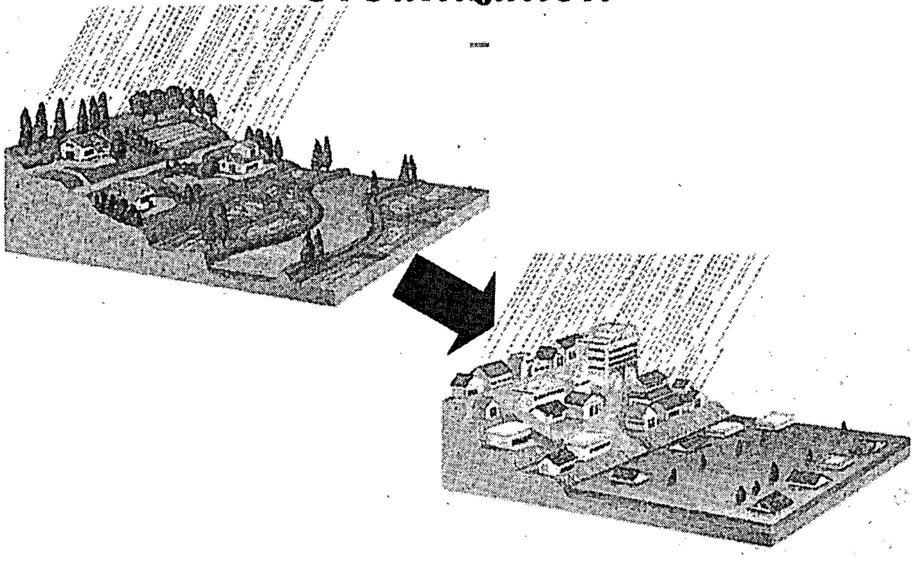


Land Use

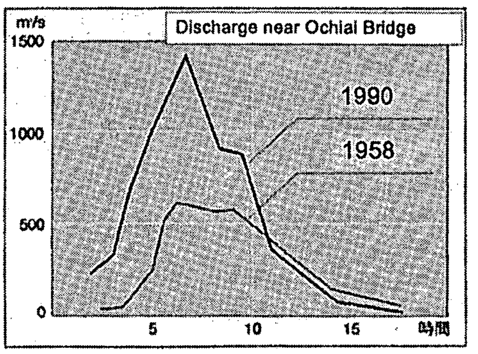


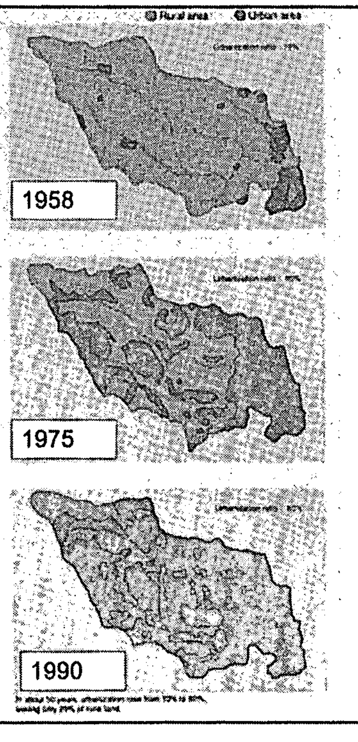
Nakagawa River Basin

Less Water Retention due to Urbanization



Water and Cities



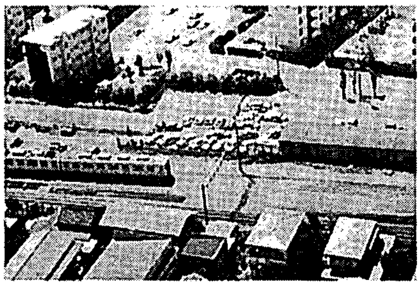


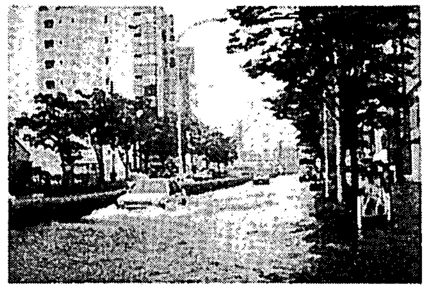
■ ***Urbanization in Tsurumigawa***

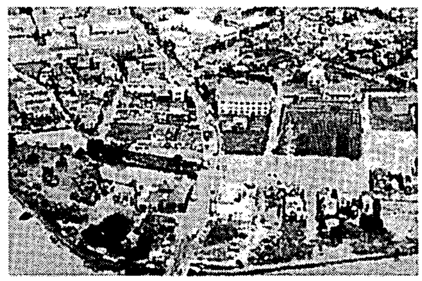
Concrete, asphalt, loss of forests and vegetation increase downstream runoff and aggregate flood damage

Flood (1)

Current Problems



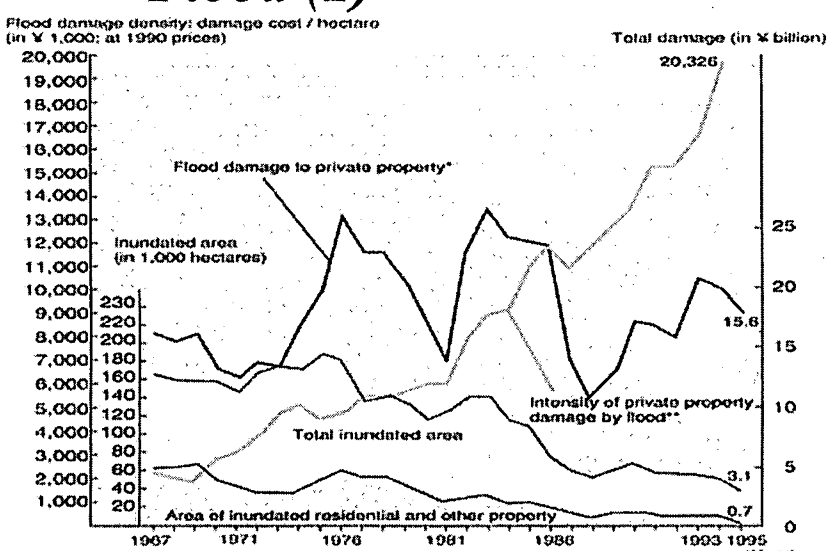




Nakagawa

Flood (2)

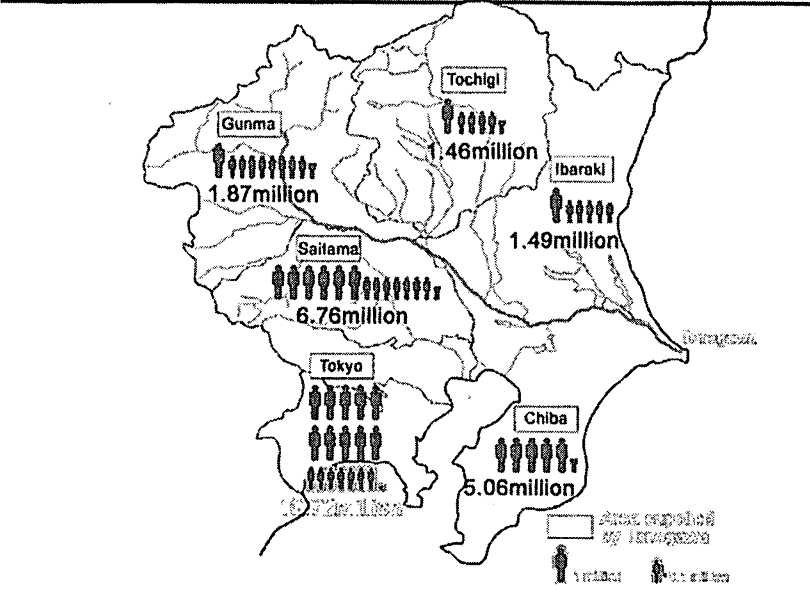
Current Problems



* Private property damage by flood is the sum of direct damage plus loss due to interruption of business.
** Density of private property damage by flood is calculated by dividing the private property damage by the area of inundated residential area.

Tonegawa Supplies Water to 27 Million in the Metropolitan Area

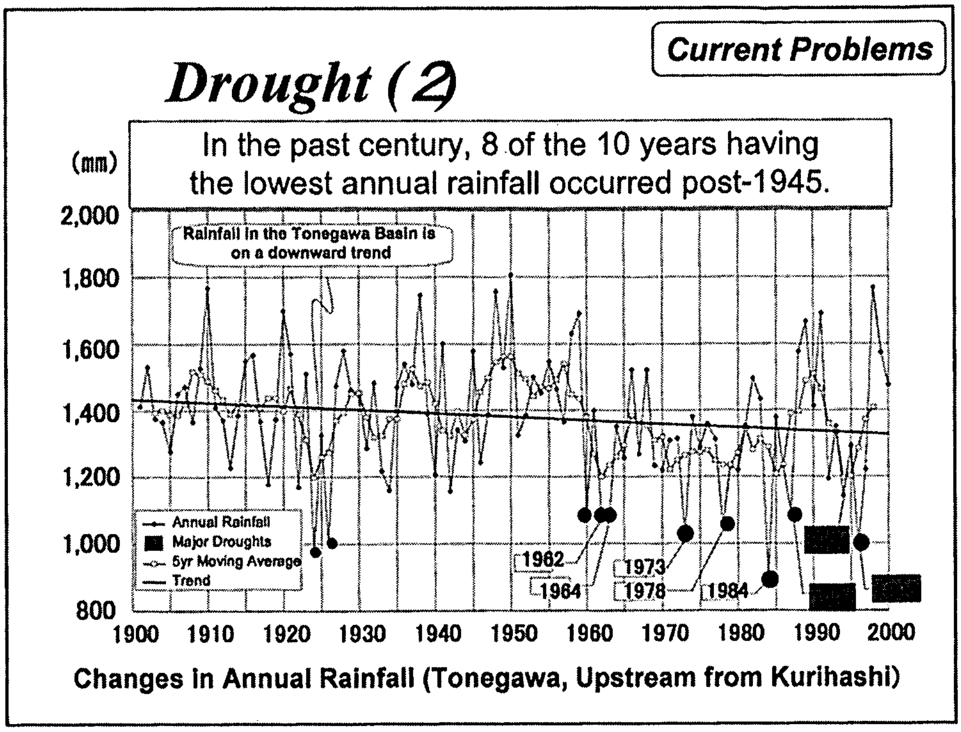
Current Problems

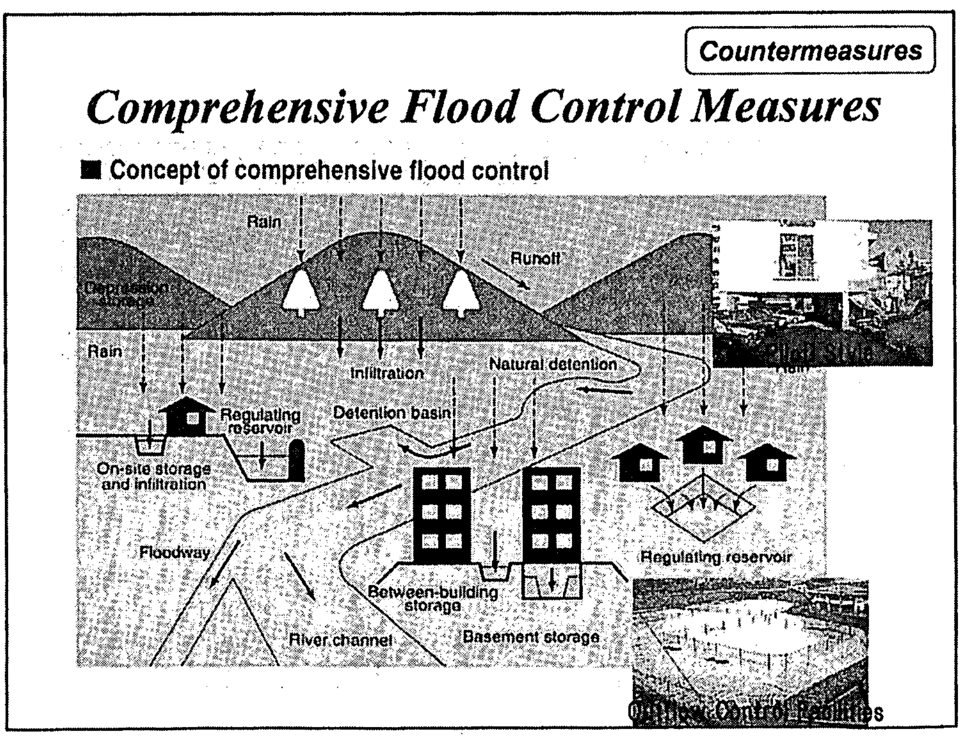


Drought (1)

Current Problems

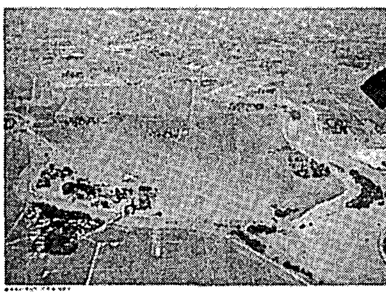
City	Present cycle of water shortage	Target level
Tokyo	3 years	10 years
San Francisco	11 years	Maximum Water shortage to date
New York	7 years	Maximum Water shortage to date
London	15 years	50 years

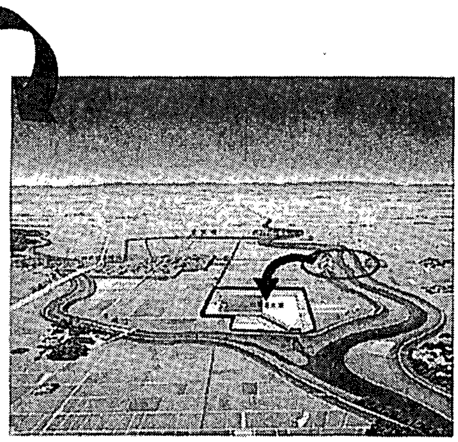

Current Problems
Drought (2)
In the past century, 8 of the 10 years having the lowest annual rainfall occurred post-1945.
(mm)
2,000
1,800
1,600
1,400
1,200
1,000
800
Rainfall in the Tonegawa Basin is on a downward trend
Annual Rainfall
Major Droughts
5yr Moving Average
Trend
1962
1964
1973
1978
1984
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
Changes in Annual Rainfall (Tonegawa, Upstream from Kurihashi)


Countermeasures
Comprehensive Flood Control Measures
■ Concept of comprehensive flood control
Rain
Runoff
Depression storage
Rain
Infiltration
Natural detention
Regulating reservoir
Detention basin
On-site storage and infiltration
Floodway
Between-building storage
Regulating reservoir
River channel
Basement storage

Countermeasures

Construction of Retarding Basins

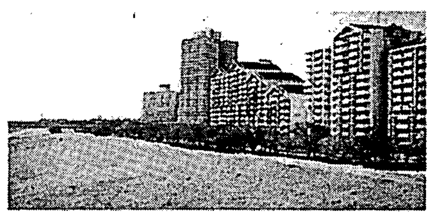




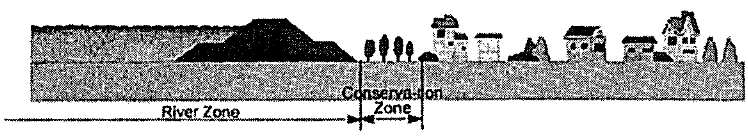
- Relocate communities to higher ground
- Construct retarding basins

Countermeasures

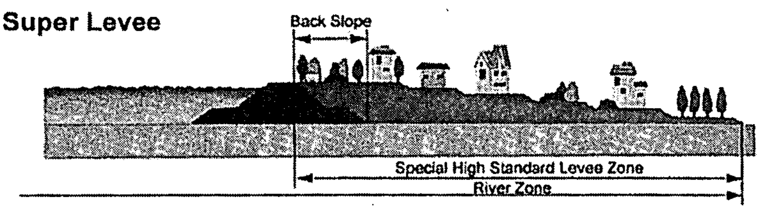
Super Levees



- **Traditional Levee**



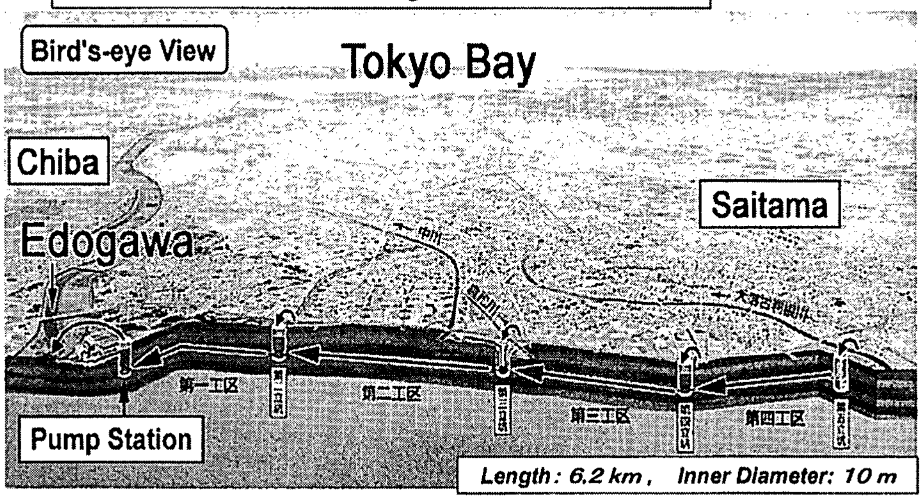
- **Super Levee**



Countermeasures

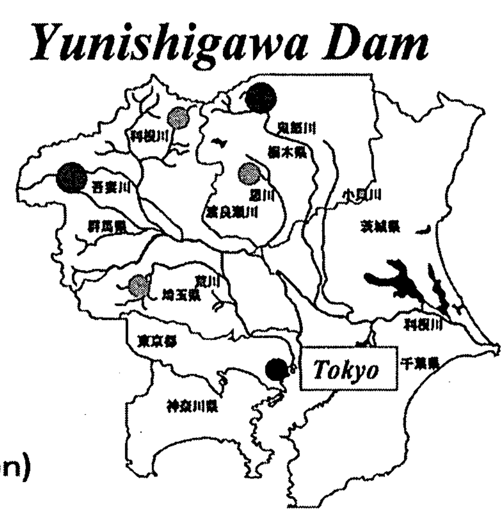
Metropolitan Area Perimetric Diversion Channel

Objective: ·Prevent flood damage
·Provide good residential lots



Countermeasures

Construction of Multi-purpose Dams



● MLIT
● WARDEC
(under construction)

Contribution of Our Research Institute

- **Advanced research to meet the demands of the time, and leadership in Japan's public works programs**
- **Theoretical support for hydraulic calculations, hydrological surveys, river channel planning, levee and dam designs**
- **Large-scale model experiments to better understand phenomena and determine design values**

History and Achievements of Our Research Institute

1925: Seismic Design Theory on Gravity Dams by Dr.Mononobe
1926: Establishment of The First Hydraulics Laboratory in Japan
(Akabane Branch)
1952: Establishment of The Largest Testing Center in the Orient
using river/dam hydraulics model
(Shinozaki Experimental Lab.)
1961: Developed the storage routing model ,
the water-level gauge (Suiken Model 61);
Establishment of the Laboratory using large-scale river/coast
hydraulics model (Kashima Hydraulic Lab.)

Conclusion (1)

At Tonegawa, levees, reservoirs and irrigation channels were developed to secure water and safety.

The flood plain was converted into residential lots and farmland to support livelihoods.

Population growth and urbanization led to increases in discharge volume and assets within the flood plain.

Potential damage during major floods has not decreased.

Comprehensive programs covering the entire basin, combining structural and nonstructural measures are necessary.

Conclusion (2)

Man has constantly modified nature to meet his needs , thereby coexisted with nature.

As this relationship continues in the future, it is important to implement measures that meet with the demand of the era.


Thank You

INDIA

Mr. Kaushal Narayan AGRAWAL
Additional Director-General
Central Public Works Department
Ministry of Urban Development

WATER RESOURCES AND RIVER MANAGEMENT FOR SUSTAINABLE DEVELOPMENT IN INDIA

by

K.N.Agrawal
Chief Engineer, CPWD
Govt. of India, New Delhi

INTRODUCTION

All development projects have environmental, economic and social consequences, some beneficial and other adverse. Water resources projects are no exception to this. With the increase in economic activities and the consequent potential for stress on ecosystems and natural resource stocks, the study and recognition of linkages between freshwater issues and other sectoral and cross sectoral issues are becoming increasingly important.

The main challenge facing the management of water resources is how to maximize all the positive impacts and minimize the adverse impacts; how to ensure reliable water supply and efficient use in the agricultural sector, mitigate flood damages, control water pollution and at the same time reduce environmental and social impacts, such as rehabilitation and resettlement of displaced people, mitigate the problems of water logging and salinity and reduce the spread of waterborne diseases and the problems associated with pollution. The idea of environmentally sound water management or sustainable development and management of water resources is to convey the concept that development is to be accomplished with minimum damage to the environment. However, translating the concept into a reality is a difficult task.

India has 15% of the world population but only 4% of the world's water supply. Preserving the quality and the availability of the freshwater resources is the most pressing of the many environmental challenges being faced by the nation. It is imperative that conservation, recycle, reuse of precious water and treatment of wastewater are given serious attention for sustainability of built environment for our populous country.

This report attempts to bring out the Indian scenario of various related issues concerning water resources including those of Flood Disasters, Sediment Disasters, Water shortages, Water contamination and damage to ecosystems.

1. FLOOD DISASTERS

Floods are natural phenomena, which particularly occur in plains, where inadequate riverbed slopes result in inundation of a large width of the valley. The flat gradients of the plains also cause silting of rivers that in turn results in higher flood levels. With the spillover of human activities on such flood plains, the floods become a cause of disaster. Over 40 million hectares, which is about 12% of the total geographical area of India, experiences periodic floods. The average area affected by floods annually in India is about 7.5 m. ha of which crop area is about 3.5 m. ha. Floods have claimed on an average about 1500 human lives and 94000 cattle ever year. The floods are also a cause of large-scale damages to forests & crops besides causing deaths of aquatic and wildlife, in various National Parks, delta region, low altitude hilly areas and alluvial flood plains of several Indian states like Assam, Arunachal, Uttrarakhand, U.P., Bihar, Orissa and West Bengal.

1.1 Flood Prone Area

The *flood prone area* may be a single index that may be useful in preliminary assessment of problem of flood in a region or country as a whole.

Rashtriya Barh Ayog (RBA – the Indian National Commission on floods) attempted in 1980 to project the picture of area liable to floods, using the data for the period 1953 to 1978. While assessing the area liable to floods as about 34 m. ha., the RBA recognized that annual flooding is not coextensive and that different areas are often flooded in different years by different streams. It further recognized that some protected areas in India till then could have been affected in some of the years on record. The 'protected area' till then was indicated by RBA as 10 m. ha. The area liable to floods was taken by it to be about 40 m. ha (instead of 44 got by adding 10 and 34 m. ha). Thus the figures of area prone to floods have not so far related the maximum area affected in a year with the probable return period of such flood and is more an estimate based on some judgement rather than a reliable basic data to prepare a Perspective Plan. Further, the assessment would change if the unit were changed to taluka/district.

1.2 Water Logging

Another important problem concurrently with flooding is water logging of flat land, such as the vast Indo-Gangetic plain and the deltaic area of main rivers such as Mahanadi, Godavari, Krishna and Cauvery and smaller rivers in the East Coast. The water logging is a consequence of -

1.2.1 Stagnation of rainwater during monsoon storms over flat areas primarily from lack of adequate capacity of outlet channels or adverse topography of the terrain. The extreme flat slopes even up to 1 in 10,000 to 20,000 in Punjab, Haryana, Uttar Pradesh, Bihar & West Bengal and deltaic area in the East Coast with slopes of 1 in 10,000 contribute to such condition.

1.2.2 Over bank spill of floodwater, which enters the unprotected area and stagnates over low lands and saucers in the basin and can not return back to the main river even after the flood recedes.

1.3 Flood Control Measures

The structural measures of flood management apart from constructing embankments include reservoirs, channel improvements, anti-erosion spurs etc. The non-structural measures include flood plain zoning, flood proofing, disaster preparedness, flood forecasting and warning etc.

1.3.1 Structural Measures

Major embankment projects taken up are on rivers Kosi and Gandak (Bihar), Godavari and Krishna (Andhra), Mahanadi, Subernaekha (Orissa) and Brahmaputra (Assam). These embankments played an important role in providing reasonable protection to affected areas, even with occasional breaches and other problem like drainage congestion, and enabled economic development.

There are few cases of reservoirs built only for flood control purpose. Multi-purpose reservoirs would involve a balancing of different interests like irrigation, power generation and flood control, which are often at variance with one another. The aim is to realize optimal benefits from the project as a whole. A reservoir is more effective for flood control if a designated space is reserved and a reservoir regulation arrangement is laid down. As far as possible, co-operation of existing reservoirs be planned in such a manner that flood moderation is achieved to the maximum extent even where no specific storage has been provided for flood cushion. There is opposition to water storage projects by environmental activists by exaggerating minor adverse environmental impacts while suppressing their tremendous beneficial socio-environmental impacts.

1.3.2 Non-Structural Measures

a) Flood Plain Zoning (FPZ)

The basic concept of FPZ is to regulate land use in flood plains to restrict flood damage by determining flood risk locations and their extent. It envisages limiting if not preventing, indiscriminate development in such areas so as to minimize the losses in the event of major floods, beyond what the protection measures are designed for or in case of their failure. Central Water Commission (CWC) of India has circulated essential features of flood plain management, to the State Governments apart from giving wide publicity in various fora.

The Working Group on flood control program for the 10^{th} Five Year Plan of Government of India recommended that it would be best to seek flood management as an integral part of the package of measures that may include multipurpose storage dams, embankments, detention basin etc, as may be appropriate in specific cases. The emphasis is to work out a comprehensive strategy for the entire basin, including non-structural measures like flood plain zoning, flood forecasting and warning etc.

The Working Group also suggested enacting legislation to effectively ensure flood plain zoning. The areas, which are prone to floods of different return periods, can be first delineated and identified. It recommended that a Standing committee of experts should be set up to lay down detailed norms and prepare pilot flood risk and zoning maps for typical river basins /sub basins and generally monitor and guide the states in FPZ activities. It should comprise Central and State Officials as also outside experts and NGOs in addition to representatives of people living in flood-vulnerable areas.

The people and authorities concerned should be made aware of the risk of living in these flood plains and the consequences thereof. Instruments such as differential insurance rates, additional surcharge on the premium of properties in risk areas, etc. can be used for encouraging desirable measures and discouraging harmful ones.

b) Flood Forecasting

Flood forecasting is an important part of disaster preparedness under the non-structural measures of flood mitigation, which can reduce the potential flood damages considerably. Technical advancement can help in predicting the flood and giving a longer lead-time for action. Flood forecasting can be used as an important tool in taking up integrated development of the basin and meeting multiple demands. CWC has established a flood forecasting system covering 62 major rivers covering almost all the flood prone states of India that however needs to be modernized and strengthened.

1.4 Rashtriya Barh Ayog's Recommendations

The aspects emphasized by RBA- the National Commission on Floods, include the need to assess flood damage rationally; review the performance of embankment system and incorporating the same in the flood control plan of the State; coordination among concerned organizations to ensure reduction of flood problems; adoption of suitable flood control measures as a part of comprehensive planning for water resources. Preparation of contour maps for flood prone basins, studies of erosion patterns and project maintenance works etc. are also needed.

1.5 Disaster Preparedness

Developing nations, which can ill afford such disasters, are also the least prepared and as a result suffer the devastating impacts. The developments, if haphazard and on piecemeal basis, increase the vulnerability against natural disasters such as floods. The expenditure incurred in disaster preparedness is repaid several times over in savings of unbudgeted disaster relief and recovery expenses. Disaster Preparedness would minimize the impact of natural hazards like floods.

2. SEDIMENTATION DISASTERS

Sediment flow in rivers is a natural process caused by erosion, transportation and deposition of sediments. Civilization owes itself to this process as it came into being in the valleys of the Nile, Tigris, Euphrates, Indus and the Yellow rivers, brought about by the fertile deposits of these rivers. However what was a boon in that time & space has now acquired the dimensions of a disaster. This is especially true in the context of water storage projects. Loss of topsoil with the runoff from precipitation, loss of generated biomass by way of grazing, pilferage of firewood and brushwood for fuel etc. has been taking place at an alarming rate due mainly to various human factors. Reduction in vegetative cover by felling of trees and grazing makes the topsoil more vulnerable to the action of wind and rain. With the loss of topsoil, chances of survival of grass, herbs, shrubs, bushes and trees on the uncultivated land appreciably reduce, thereby exposing the soil to further degradation. This process continues in most of the watersheds, in the process of struggle for survival by the rural landless laborers in the vicinity. In the absence of such harmful intervention of human beings, natural degradation is a slow process and often restorative by nature. There is an obvious need to take steps to prevent such degradation of the catchment area.

Uncontrolled deforestation, forest-fires, over-grazing, improper methods of tillage, improper agricultural practices and various human activities are responsible for accelerated soil erosion. Due to impact of rain and water flowing over land surfaces, in gullies and stream channels, large quantities of top soil is eroded from the catchment and carried by the rivers, not all of which reaches the sea. Earthquakes, large-scale landslides and other activities such as cutting of forests, mining, road building and other construction activities accelerate this process.

Out of India's total land area of 329 million hectares, about 175 million hectares is prone to sediment erosion. It is estimated that about 6000 million tonnes of soil is eroded every year in India as a result of sheet erosion. Besides, gully and ravine erosion ravages 8000 ha annually. The sediment erosion and transportation causes serious problems such as loss of fertility of soil, reservoir sedimentation, channel aggradations, increase in peak flood flows, depletion of ground water flow etc. The 1950 earthquake of magnitude 8.6 on Richter Scale that occurred in the Indian state of Assam, brought so much sediment down the Brahmaputra river that some of the tributaries silted up and caused major changes in the morphology of the river. It also caused flooding in large portions of the Brahmaputra Valley in the next several years.

Sedimentation causes serious problems in engineering projects for irrigation, navigation, and hydropower development and flood control. Costly maintenance, loss of efficiency and in some cases, damage of important engineering works have been experienced due to deposition of sediments in reservoirs, navigation and irrigation channels. Depletion of storage in a reservoir on account of sediment deposition causes many problems. Besides, storage loss which is of much economic significance, there are planning and operational problems due to silting of reservoirs. The entry of sediments in the canals or in the turbines may cause serious operational problems as well as sometimes jamming of hydraulic gates.

Various measures for watershed development and catchment area treatment are undertaken in India for soil and water conservation which help in prolonging life of storage reservoirs, reduction in watershed degradation, improving fertility of soil, augmenting supply food, fodder and fuel, moderating floods and enhancing total production, employment and income.

3. WATER RESOURCES OF INDIA AND WATER SHORTAGES

India experiences extremes of climate. Normal annual rainfall varies from 100mm in Western Rajasthan to over 11,000mm at Cherapunji, in the northeastern part of the country. The annual average rainfall is of the order of 1,170mm, which together with snow melt yields nearly 4,000km^3 of water. After deducting for infiltration and evaporation, the average surface flow in the river systems of the country is estimated at 1,869 km^3. The constraint in exploiting the available water is that the major part of the flows occurs as floods during short periods and there are obvious limitations in storing all the quantity. The utilizable surface flow is estimated at 690km^3. The utilizable groundwater potential is estimated at 432 km^3. Thus, the total utilizable water resources of the country are about 1,122km^3.

3.1 Water resources assessment

(a) <u>Surface water</u>

Out of the average annual flow of 1,869 km^3 a live storage of only 171 km^3 of water has been developed through about 3,000 large dams. An additional live storage of 3 km^3 is estimated to have been created through medium projects, each having a capacity less than 10 million m^3. Thus, the total live storage is about 174 km^3 at completed projects. Dams to create additional live storage of 72 km^3 are now under construction and for 132 km^3 are being planned. With the live storage of 25 km^3 of minor tanks, the ultimate live storage would be 403 km^3, which would be around 22 per cent of the average annual flow of the rivers.

The Central Water Commission, Government of India has a network of 877 key stations through the country in collect and compile hydrological data, as well as to take measurements of river flows on a regular basis. In addition, silt observations and water quality observations are made at a few selected sites. Most of the hydrological data collection activity is manual, though automation has been introduced at some of the stations. Snowmelt and glacial ice melt provide a major part of the run off in the mountainous areas of the Himalayas. The snow melt forecasts provide an important input to the river management. Remove sensing techniques have been found useful in predicting the snowmelt run off.

To improve India's institutional and technical capability to measure, collate, analyze, disseminate and use data concerned with quantities and qualities of surface and ground water, including the use of data for hydrological design a project entitled "Hydrology Project" is being implemented in peninsular river basins of India under the World Bank Assistance.

(b) <u>Groundwater</u>

With the increased emphasis on groundwater in the last few years, a scientific assessment of the groundwater potential of the country was undertaken and extensive exploration work was carried out in the country. In the reassessment based on guidelines laid down by a Ground Water Estimation Committee of 1984 and the additional available data, the annual replenish able ground-water is estimated as 432 km^3. The present annual utilization is 115 km^3 through 15.3 million groundwater structures. A hydrographic network of about 15,000 stations monitors the levels and the quality of groundwater. Monitoring shows that some areas as exhibiting signs of over-exploitation. There is a proposal to extend the network to 17,000 stations.

(c) Need of Storage Dams

It must be noted that future demands of water can be met only by exploiting almost all the 1122 bcm of utilizable water by conventional means. It would thus be essential to utilize the entire 690 bcm of the utilizable flows for which storages of the order of 400 b.cu.m will have to be created. Water demands forecasts show that Rajasthan, Maharashtra, Gujarat, Haryana, Karnataka and Tamilnadu could face heavy water supply shortfalls. The water shortages would be far more serious in the water short basins like the Cauvery, Pennar, Sabarmati, Mahi, and Krishna etc. To meet the bulging water requirements, it would be necessary to ensure substantial augmentation of water supplies; requiring sufficient raising of water storage capacities, thus necessitating completion of new large water storage projects.

The recent Supreme Court Judgement for Narmada Projects has also highlighted that against the utilisable storage 690 cu. km. of surface water resources out of 1869 cu. km.; so far storage capacity of all dams in India is only 174 cu. km., which is incidentally less than the capacity of Kariba Dam in Zambia/Zimbabwe with a capacity of 180.6 cu. km. and only 12 cu. km. more than the Aswan High Dam of Egypt. The impact on environment should be seen in relation to the project as a whole. Water of poor quality leads to ill health, whereas water in insufficient quantity claims large chunks of time spent in augmenting the supply; otherwise, the significant time could be spent on more remunerative tasks.

3.2 National Water Policy - 2002

National Water Policy was first adopted in 1987. Since then a number of issues and challenges have emerged in the development and management of the water resources. Therefore, The National Water Policy has been reviewed and updated in April 2002.

National Water Policy - 2002 sets out the following water allocation priorities: (1) drinking water; (2) irrigation; (3) hydropower; (4) ecology, (5) Agro-industries and non-agriculture industries (6) navigation and other uses. Its highlights are given below:

- Water is a scarce and precious natural resource, to be planned, developed conserved and managed as such, and in an integrated and environmentally sound basis, keeping in view the socio-economic aspects and needs of the states. Efforts to develop, conserve, utilize and manage this crucial resource in a sustainable manner have to be guided by the national perspective.
- Water resources development and management is to be planned for a hydrology unit, such as a drainage basin as a whole or for a sub-basin, multi sectorally, taking into account surface and ground water for sustainable use incorporating quantity and quality aspects as well as environmental considerations. Individual development projects and proposals should be formulated within the frame work of over all plan keeping in view the existing agreements/ awards for a basin/sub-basin for optimal results.
- Water resources projects involve a number of socio-economic issues such as sustainability, appropriate resettlement and rehabilitation of project-affected people, public health concerns of water impoundment, dam safety etc. Problems of water logging and soil salinity have emerged in some irrigation commands, leading to the degradation of agricultural land. Complex issues of equity and social justice in regard to water distribution are required to be addressed. The development and over-exploitation of groundwater resources in certain parts of the country have raised the concern and need for

judicious and scientific resource management and conservation. All these concerns need to be addressed on the basis of common policies and strategies.

- Improvements in existing strategies, innovation of new techniques resting on a strong science and technology base are needed to eliminate the pollution of surface and ground water resources, to improve water quality. Science and technology and training have to play important roles in water resources development and management in general.
- Water resource development projects should as far as possible be planned and developed as multipurpose projects. Provision for drinking water should be a primary consideration. The study of the likely impact of a project during construction and later on human lives, settlements, occupations, socio-economic, environment and other aspects shall form an essential component of project planning. In the planning, implementation and operation of a project, the preservation of the quality of environment and the ecological balance should be a primary consideration.
- The adverse impact on the environment, if any, should be minimized and should be offset by adequate compensatory measures. The project should, nevertheless, be sustainable.
- The planning of projects in hilly areas should take into account the need to provide assured drinking water, possibilities of hydro-power development and the proper approach to irrigation in such areas, in the context of physical features and constraints of the basin such as steep slopes, rapid run-off and the incidence of soil erosion. The economic evaluation of projects in such areas should also take these factors into account.
- Special efforts should be made to investigate and formulate projects either in, or for the benefit of, areas inhabited by tribal or other specially disadvantaged groups such as socially weak, scheduled castes and scheduled tribes. In other areas also, project planning should pay special attention to the needs of scheduled castes and scheduled tribes and other weaker sections of the society. The economic evaluation of projects benefiting such disadvantaged sections should also take these factors into account.
- The drainage system should form an integral part of any irrigation project right from the planning stage.
- For construction of storage and the consequent resettlement and rehabilitation of population a skeletal national policy needs to be formulated so that the project-affected persons share the benefits. States should accordingly evolve their own detailed resettlement and rehabilitation policies, taking into account the local conditions. It is to be ensured that the construction and rehabilitation proceed simultaneously and smoothly.
- Both surface water and ground water should be regularly monitored for quality. A phased programme should be undertaken for improvements in water quality. Effluents should be treated to acceptable levels and standards before discharging them into natural streams. Minimum flow should be ensured in the perennial streams for maintaining ecology and social considerations. Principle of 'polluter pays' should be followed in management of polluted water. Preservation of existing water bodies by preventing encroachment and deterioration of water quality.
- Efficiency of utilization in all the diverse uses of water should be optimized and an awareness of water as a scarce resource should be fostered. Conservation consciousness should be promoted through education, regulation, incentives and disincentives. The resources should be conserved and the availability augmented by maximizing retention, eliminating pollution and minimizing losses. For this, measures like selective linings in the conveyance system, modernization and rehabilitation of existing systems including

tanks, recycling and re-use of treated effluents and adoption of traditional techniques like mulching or pitcher irrigation and new techniques like drip and sprinkler may be promoted, wherever feasible.

- There should be a master plan for flood control and management for each flood prone basin. Adequate flood-cushion should be provided in water storage projects, wherever feasible, to facilitate better flood management. In highly flood prone areas, flood control should be given overriding consideration in reservoir regulation policy even at the cost of sacrificing some irrigation or power benefits.
- From the present emphasis on the creation and expansion of water resources infrastructures for diverse uses, there is now a need to give greater emphasis on the improvement of the performance of the existing water resources facilities. Therefore, allocation of funds under the water resources sector should be re-prioritized to ensure that the needs for development as well as operation and maintenance of the facilities are met.
- For effective and economical management, the frontiers of knowledge need to be pushed forward in several directions by intensifying research efforts in various areas, such as - hydrometeorology; snow and lake hydrology; surface and ground water hydrology; river morphology and hydraulics; assessment of water resources; water harvesting and ground water recharge; water quality; water conservation; evaporation and seepage losses; recycling and re-use; better water management practices and improvements in operational technology; crops and cropping systems; soils and material research; new construction materials and technology (with particular reference to roller compacted concrete, fiber reinforced concrete, new methodologies in tunneling technologies, instrumentation, advanced numerical analysis in structures and back analysis); seismic design of structures; the safety and durability of water-related structures; economical designs for water resource projects; risk analysis and disaster management; use of remote sensing techniques in development and management; use of static ground water resource as a crisis management measure; sedimentation of reservoirs; use of sea water resources; prevention of salinity ingress; prevention of water logging and soil salinity; reclamation of water logged and saline lands; environmental impact; regional equity.

In summing up the National Water Policy emphasizes the vital importance of water for human and animal life, for maintaining ecological balance and for economic and developmental activities of all kinds. Considering its increasing scarcity, the planning and management of this resource and its optimal, economical and equitable use has become a matter of the utmost urgency. Concerns of the community need to be taken into account for water resources development and management. The success of the National Water Policy will depend entirely on evolving and maintaining a national consensus and commitment to its underlying principles and objectives. State Water Policy backed with an operational action plan shall be formulated in a time bound manner say in two years.

4. WATER CONTAMINATION AND DAMAGE TO ECO SYSTEMS:

4.1 Water Pollution

The growth of urban megalopolis, increased industrial activity and dependence of the agricultural sector on chemicals and fertilizers has led to the over loading of the carrying capacity of our water bodies to assimilate and decompose wastes. The increasing discharge of domestic and industrial wastes has also led to the contamination of ground water, making it unfit for human consumption at many places. It is estimated that 80% of all diseases and over $1/3^{rd}$ of deaths are caused by consumption of contaminated water and on an average as much as $1/10^{th}$ of each person's productive time is sacrificed to water related diseases.

4.2 Protection of Natural Water Resources

Responsibility should be assigned to various civic and industrial authorities to treat the wastewater before disposing it in conveyance drains or natural streams. Water quality should be monitored regularly at every outfall drain. State wise river basin conservation plan should be formulated for different basins. The pathogenic, toxic and biological, physical and chemical effects of various types of water pollution in different scenario and regions should be scientifically analyzed, collated, understood and suitable action plans should be framed.

4.3 Water Quality Improvement

Strict environmental laws (command and control measures) or market – based instruments for controlling water pollution must be scrupulously applied and implemented to large and medium scale enterprises. Common effluent treatment plants (CETPs) can provide a viable solution to the problem of water pollution by small scale industries, which are not able to bear the cost of treatment of their effluents on an individual basis. We should strive hard for strengthening of monitoring capabilities of various organizations regular monitoring of discharges by firms and public access to information on discharge by polluters and ambient air & water quality.

4.3.1 Water quality criteria

Any stretch of river or coastal water may be subjected to more than one organized use. The list contains irrigation, drinking, industry, power generation, fisheries and wild life propagation, navigation, recreation and aesthetics, and even receptacle for treated wastes. In any stretch there would be one use which would be demanding the highest quality of water and that stretch is designated by that best water quality use (designated best use). The recognized designated best uses along with nomenclature (class of water) are listed in table 1. Based on critical analysis of water quality carried out by them the Central Pollution Control Board (CPCB) has classified four rivers as in table 2.

Table 1. The recognized designated best uses along with nomenclature (class of water)

Designated best use	Nomenclature (class of water)
Drinking water source without conventional treatment but after disinfection	A
Outdoor bathing	B
Drinking water source with conventional treatment followed by disinfection	C
Fish culture and wild life propagation	D
Irrigation, industrial cooling or controlled waste disposal	E

Table 2. Classification of critical rivers in India

River	Total length (km)	% of length in various categories				
		A	B	C	D	E
Ganga	2,525	--	11	56	33	--
Yamuna	1,376	--	36	64	--	--
Brahmi	799	--	23	77	--	--
Subarnarekha	395	--	--	90	--	10

4.3.2 Ganga Action Plan Phase-I

The Ganga Action Plan Phase-I was initiated in February, 1985 to combat the problem of pollution of the Ganga. The Action Plan envisaged diversion and treatment of domestic wastes in 27 important towns situated along the river. In all, 261 schemes were undertaken for sewage interception and diversion, sewage treatment, low cost sanitation measures, electric crematoria and river front development. The various schemes have been aimed to reduce the pollution in the Ganga by atleast 75 per cent. Of the 261 schemes, 211 have been completed by now and the remaining are expected to be completed in the next two years.

4.7.3 Ganga Action Plan Phase-II

The second phase of Ganga Action Plan (GAP) for pollution abatement of Yamuna and Gomti rivers at an estimated cost of Rs. 4,210 million has been approved. The second phase of GAP has also envisaged formulation of Action Plan for Pollution Abatement of River Damodar. The works that were required but were not included in the first phase of GAP are proposed to be covered under this phase.

4.7.4 National River Action Plan

An approach paper on the National River Action Plan (NRAP) has been approved by government at an estimated cost of Rs.10,000 million spread over a period of 100 years. NRAP will include grossly polluted stretches of all those rivers of the country not covered in the GAP Phase I and II.

4.8 Environmental Aspects

India is a land of rivers having predominantly agriculture based economy. Development of a river valley projects has become a lifeline of progress and prosperity of the country. Water Resources Development (WRD) Projects are indispensable as they are inextricably linked to the country's economy besides their need for the welfare of the people. However, in the last two decades, a very strong opposition has been voiced to the construction of large dams arguing that irreparable damage to the environment may result due to such projects. On the one hand a fear syndrome has been created in recent years against WRD projects by exaggerating the likely or assumed adverse environmental impacts and by ignoring or suppressing their tremendous benefits. On the other hand, controversial debates are generated on the grounds that the possible environmental impacts are not properly evaluated in many projects. As a result, many potential economic development activities, which could generate wealth and employment to people have been blocked in several large cities, towns and villages due to acute shortage of water especially during the dry season. At the same time, progress floods routinely continue to affect the economic causing large scale loss of lives and properties.

4.8.1 Rehabilitation & Resettlement

The problem relating to resettlement and rehabilitation (R&R) are far more complex than are generally perceived by the public policy makers or the project implementing authorities. The objective of any R&R package should be to provide the same quality of life, if not better to the affected persons than what they have been enjoying before displacement. Generally suitable compensatory measures such as providing alternative land to the affected persons should be made. Unfortunately some projects had to be shelved on this account alone. An argument is made that the tribal population should not be displaced at all, as they cannot adapt in a different environment. This approach may result in perpetuation of their backwardness. Experience in the northeastern region indicates that the tribal people definitely want water storage projects for bringing in overall economic prosperity to them. Awareness and persuasive approach are needed to tackle this problem. At the same time the rehabilitation packages should provide for more than one option and be made attractive enough at a fractional cost of the project benefits, so that affected people are induced to accept them.

Meanwhile, the construction of multi-purpose projects like Sardar Sarover and Tehri Dam attracted the attention of a large number of Non Governmental Organizations (NGOs) both in India and abroad, mainly on the issue of R&R. There has been an adverse publicity regarding these projects, particularly relating to the problems in proper implementation of the resettlement and rehabilitation of PAPs.

Government of India has recently evolved a draft National Policy for R&R of displaced people to help the State/Project authorities in expediting construction activities. The policy is under consideration for adoption.

4.8.2 Safety of Water Resources Projects:

There are about 3,600 dams in India of which more than 2,300 are of 15m and more in height. 45 of them have been classified as dams of national importance that have heights of 100m and above and/or having storage capacities of 1 cubic km or more. The Dam Safety Organization in India was created in Central Water Commission in the year 1979 to assist the state governments to locate the causes and potential distress areas that could affect the safety of dams and allied structures.

Reservoir induced seismicity is generally considered as a source of the man made disaster associated with the creation of a reservoir. Koyna dam in Maharashtra is often cited as an example. Though it has not been conclusively proved that the creation of reservoir induces seismicity, yet as a precautionary measure a number of seismological stations are set up at the dam sites for observations and analyzing the results for planning necessary preventive measures. Dams are also designed to withstand the seismic forces considering the maximum design flood. Dam break analysis is also carried out as an integral part of the design activity of large storage structures so as to plan and take necessary mitigation measures in the event of occurrence of unlikely disaster.

4.8.3 Flora and Fauna

In case some unique or endangered species of flora and fauna are threatened by the project, suitable measures are to be taken for their rehabilitation. Similarly, if the project interferes with wild life migration, suitable arrangements ought to be made for their habitat. An extremely rare step for environmental protection would be to abandon a project, if it endangers rare species of plants or animals, in order to preserve the natural heritage. However, as the project submerges only a small fraction of forestland, it should be feasible that the endangered species of plants or animals are provided for in the vicinity of the project in the same watershed. Gene banks to preserve Species and to regenerate them in favorable conditions, elsewhere, are also possible.

Silent Valley project in Kerala, though a promising project planned to develop hydropower, was shelved, as it was affecting prime virgin forest with rare species of plants. On a positive side Heran reservoir in Gujrat which provided assured water enough for wild life has actually helped in population growth of wild life and crocodiles which were on verge of extinction. Pong reservoir is now acting as a resting place for migratory birds and number of rare species of birds have now been sighted in these areas. Water reservoir projects have in general enhanced the natural environment for development of flora & fauna in its vicinity.

Significant increase in the numbers of tigers, panthers, elephants and Cheetals have been observed in the famous Jim Corbett National Park with the availability of green fodder, clean water throughout the year and improved climatic conditions after construction of the Ramganga Multipurpose Dam Project. Rare species of birds also flock there. Similar phenomenon of an increase in birds and wildlife has also been observed around the Rihand and Matatila reservoirs, which were previously barren lands. Some of the best tourist places of India like Ukai tourist resort, Periyar wild life sanctuary, Shalimar garden, Brindavan garden, Pinjore garden, Kalindi-Kunj, Matatila Garden, Dhyaneshwar Udyan and the Ramganga Udhyan are the bye-products of river valley projects.

4.9 Water Conservation & Improving Water Use Efficiency

In almost all major urban centres there is an acute problem of adequate water supply while the sources of augmentation are very few. It is roughly estimated that in urban water supply, 30 to 40 % of the municipal water is wasted through the distribution system. In Industrial sector too, there is a scope of economy in use of water. It is estimated by Bureau of Industrial Costs and Prices that 10 to 30% saving in water consumption in industries is possible by recycling, modifications in processing, evaporation control etc. Apart from ensuring leakage control, water conservation strategy in industries should include introduction of appropriate technology to ensure efficient use of cooling and process water and necessary pollution control mechanisms and maximum recycling and reuse.

In irrigation, the efficiency of water use can be increased by improved methods of irrigation such as drip and sprinkler irrigation and by careful planning of conjunctive use of ground water with surface water. Linking of canal distributaries are also tools for controlling water losses. In the industrial sector there is a vast scope of water saving by recycling and reuse of the wastewater.

5. OTHER WATER RELATED PROBLEMS

5.1 Reuse and Recycling of Water

The water intake by the industries is affected by the extent to which water is reused. Reuse is common in large-scale industries using substantial quantities of water. Pollution of water by the effluents discharged by the industries is a serious hazard increasingly being faced by the country. Although fresh water is a renewable source, generation of new and complex wastes by industries is adding to the complexity of water pollution. Both surface water and ground water are affected by such pollution.

Recycling and reuse of wastewater is, therefore, being increasingly resorted to wherever fresh water supplies are inadequate. Wastewater discharged by an urban center or an industry at a particular point in a river gets diluted by the river and another city or industry on the downstream draws the river water and uses it after the necessary treatment. This is generally referred to as indirect reuse. Apart from this, even within an industry a certain amount of water is normally recycled after necessary treatment for specific purposes. A high percentage of demand for industrial water is for cooling purposes. Recycle of industrial processed water should be introduced for cooling purposes wherever economically feasible, since cooling can tolerate low quality of water. Reuse of processed water reduces fresh water consumption as well as the quantity of wastewaters.

Treating municipal wastewater and reusing it for industrial purposes has been successfully accomplished by certain industries in the city of Mumbai. Other cities are now being encouraged adopting the same as far as feasible.

5.1.1 Options and Initiatives

There are various options for recycling and reuse of grey water (bathroom and kitchen wash) and black water (sewage). However, the grey water and black water from large residential complexes like Cooperative Housing Societies, multistoried buildings and industrial effluents from large industries can be recycled and reused for various purposes other than drinking.

The grey water may be put into various types of treatment such as grease trap, anaerobic filter etc and the filtered water may be let into wet land, polishing ponds etc. and can be reused for gardening and horticulture etc. The black water may also be put into various types of treatment such as screen, grit removal primary, secondary and tertiary treatment etc. and the treated waste water can be let into wet land for irrigation or for ground water recharge.

The State Governments may create Urban Development Fund for Urban Infrastructure development and the same can also be used for setting up of pilot projects for waste reuse, recycling and resource recovery.

5.1.2 Incentives and Legal Aspects

Suitable fiscal concessions and subsidies may be considered by the Central and State Governments to the industries, commercial establishments and any other agencies which adopt/practice waste reuse, recycling and resource recovery. Similarly, in case the Urban Local Bodies on their own would like to take the initiative and set up waste reuse, recycling and resource recovery schemes in their respective areas, similar fiscal concessions and subsidies may also be made available to them by the Central and State Governments. In fact, it may be made mandatory in phases that large industry and commercial establishments must meet a sizeable percentage of their non-potable water requirements from the reclaimed water. Similarly, for irrigating crops, horticulture, watering public lawns/gardens, flushing of sewers, fire-fighting etc. reclaimed water should only be used and to this effect, there is a need for legislation or amendment in the municipal bylaws.

5.2 Questionable Use of Water as a Carrier of Wastes

Removing wastes from industries, and homes by using water as carrier over long distances, to extract most of the waste in the sludge, and then leaving polluted water as effluent, need to be closely examined. Better alternatives need to be found to treat the waste at its origin, without using so much water. Use of low flushing and dry toilets as well as use of 'grey water' drained from showers, kitchens and laundries to flush the toilets, should be targeted for adoption in at least in all new construction of commercial institutions and planned colonies in all class I and II cities We have to adopt water sensitive urban planning so that rainwater is used adequately and the runoff from impervious areas, such as car parks, roads and footpaths can be infiltrated into the aquifer after ascertaining its quality without endangering the aquifer.

5.3 Archeology and Heritage

At times mineral deposits, archaeological monuments or shrines are threatened by submergence due to reservoirs. Mineral wealth can be exploited to the possible extent before inundation. It is also possible to protect the mineral wealth and monuments falling in the shoreline zones by constructing ring bunds.

Sometimes historical and cultural monuments may fall in the submerged area of a reservoir. The temple of Abu sibel in Egypt and the Nagarjunkonda in India are living examples of how ancient monuments have been saved and given a greater lease of life. Many temples have been successfully shifted with religious fervour in the Bargi, Srisailam and Sardar Sarovar projects. The Jyotirling temple has been preserved in the planning of the Omkareshwar Dam and improvement in the approach roads and bridges would also be integrated with the project. Similarly, Dargah at Galiakot, which would have come under submergence of Kadana reservoir on the river Mahi in Gujarat, was protected from submergence by constructing a ring bund. Srisailam, Narayanpur and Almatti reservoirs are good examples; where historical monuments have been rehabilitated successfully.

CONCLUSION

A balance between the thrust areas of development (infrastructure and consumer goods), which are said to improve the quality of life, and the social aspects like bare necessities of life in the areas of water, food, fiber, power, education, health, housing and nutrition is needed. The media plays an important role in shaping the thoughts of the people, and it should set its focus right to set the agenda and making the society conscious through balanced & informed public debate. Due to the large temporal variations in river flows, storage of water becomes inevitable. Non-development of water storage projects is not a viable or available option. It is imperative that conservation, recycle, reuse of precious water and proper treatment of wastewater are given serious attention for sustainability of built environment for our highly populated country.

While water is a medium for the transmission of water borne diseases; water is also a primary contributor to the control of infectious diseases through its use for personal and domestic hygiene. Availability of water in India is under tremendous stress due to growing population, rapid urbanization, industrial growth and other demands for maintaining ecology. Integrated water management is of vital importance for poverty reduction, environmental sustenance and sustainable economic development in India because water has the potential for both disease causation and prevention.

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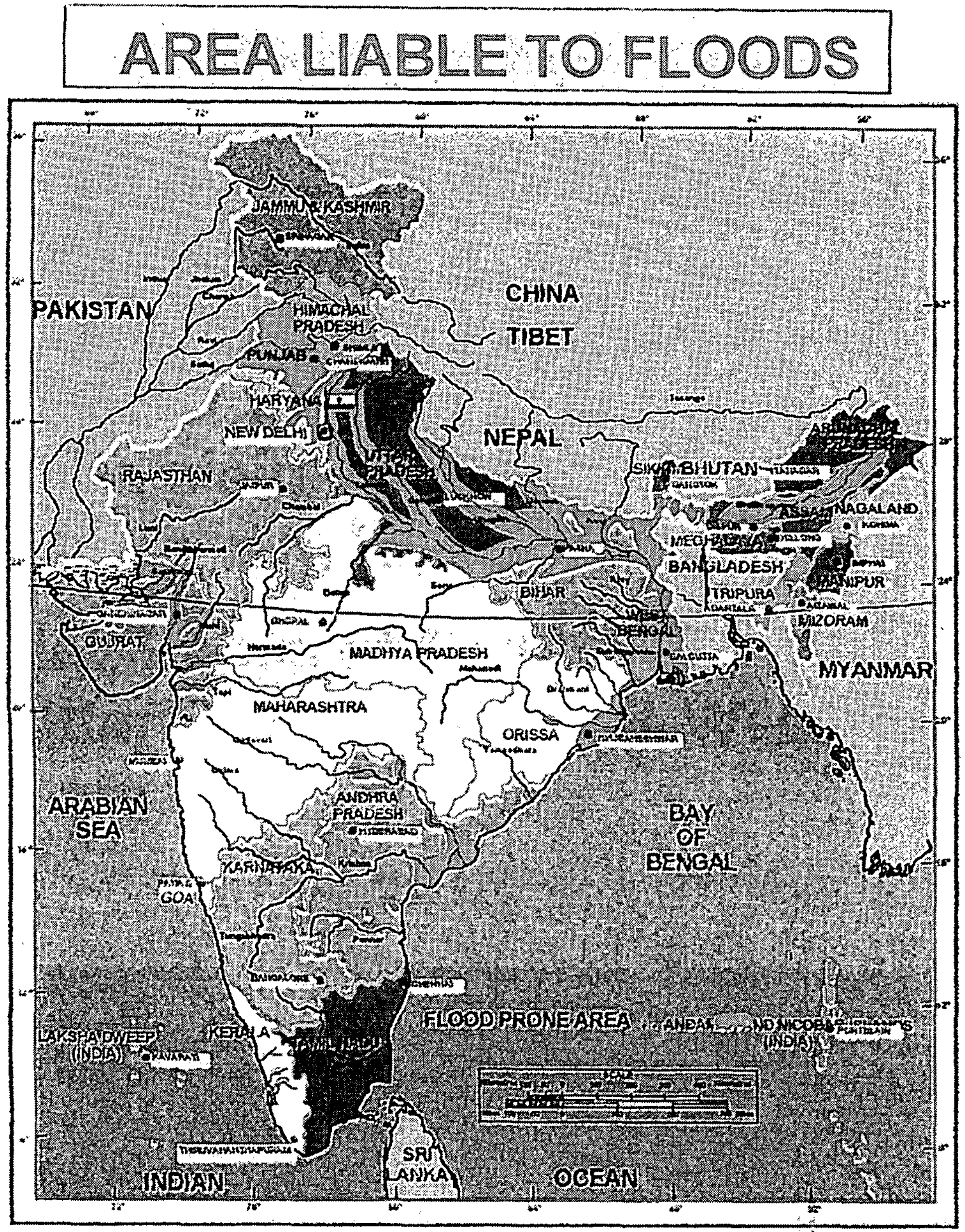

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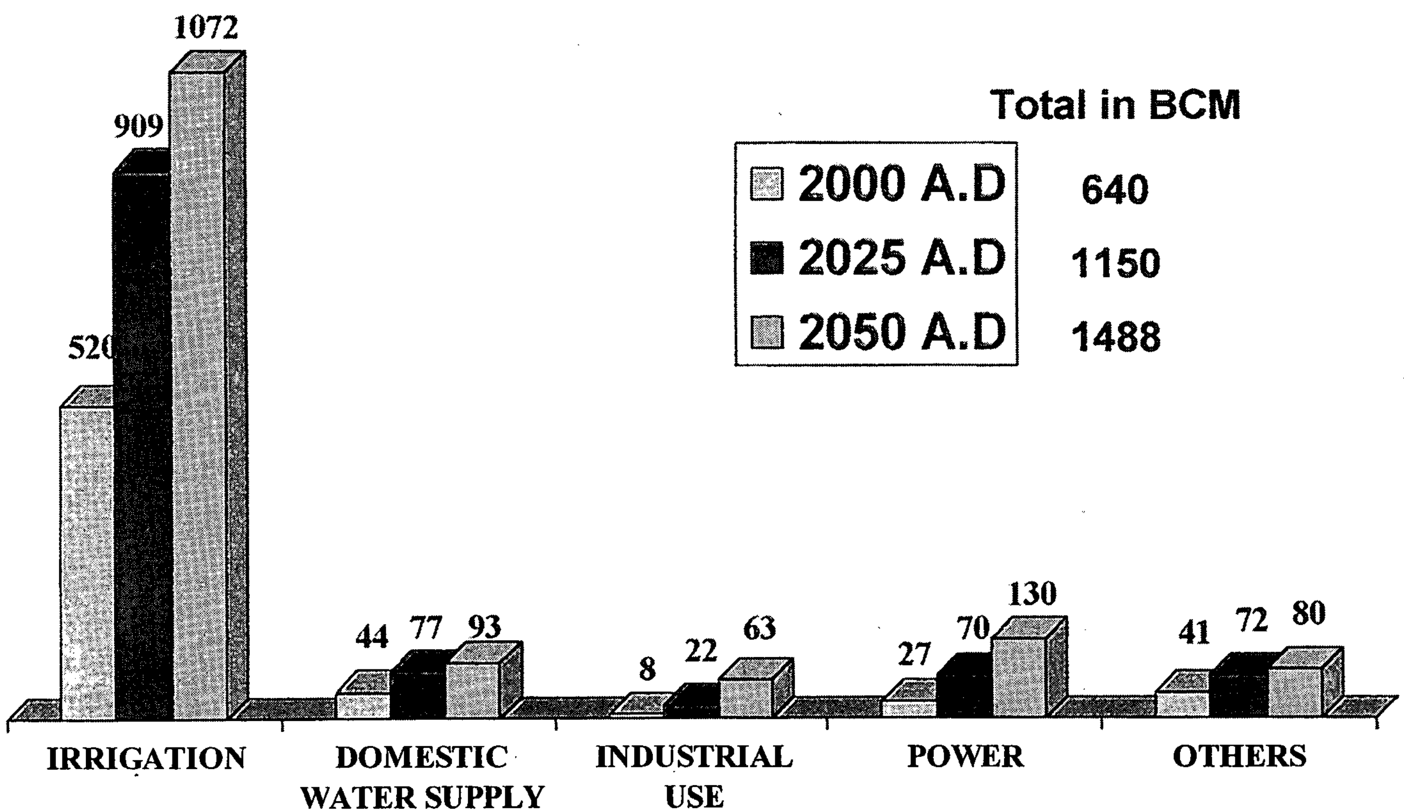
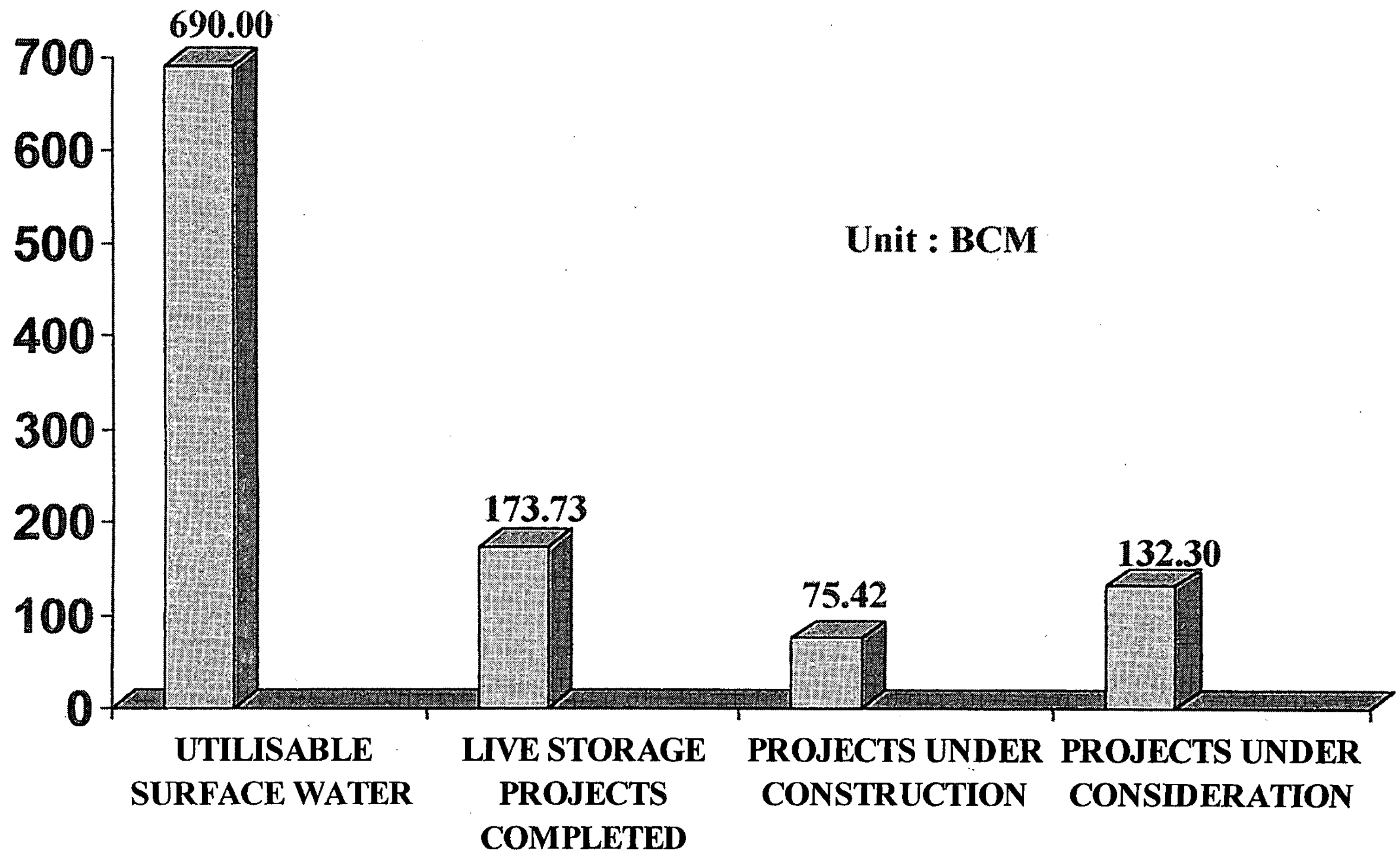
WATER DEMAND PROJECTIONS



STATUS OF CREATION OF RESERVOIR STORAGES IN THE COUNTRY



Tokyo, Oct-2002 "Public Works & Management" INDIA

INDONESIA

Mr. Djoko MURJANTO
Secretary of Board
Construction and Investment
Development Board
Ministry of Settlement and Regional
Infrastructure

Subject of Common Interest

A. Flood disasters

A.1 Causes of Flood Disasters

In order to mitigate flood disasters comprehensively several factors that cause flood disasters have to be understood. There are three (3) major factors cause of flood disasters in Indonesia, those are:

1) Static natural conditions:
2) Dynamic natural phenomena:
3) Dynamic socio-economic activities of community:

A.2 Counter measures to mitigate flood disasters

1) Structural counter measures
   - Dike: to prevent river overflowing when river flows exceed river discharge capacity
   - River normalization and floodway: to lower elevation of flood discharge water level
   - Reservoir and the use of low lands for flood retentions: to control river discharge, i.e., to reduce the peak of flood discharges
   - Polder and pump: to protect low lying areas from floods and to drain excess water on these areas.

2) Non-structural approaches to flood management:
   a. Flood proofing is the provision of long-term non-structural or minor structural measures to mitigate the effects of floods
   b. Flood response planning is preparing the community for event that floods occur and then, by implementing certain organizational measures (like evacuation), ensuring that disruption and damage caused by the floods is kept to a minimum

   Non-structural counter measures that have been implemented in Indonesia, among other are as follows:
   - Disaster relief: The organization (at national, provincial, district/town levels) and provision of emergency rescue of and short-term relief for those subjected to major flood damage or evacuation as a result of floods.
   - Flood fighting: Actions undertaken during floods to prevent loss of live, damages and failure of flood control structures, as well as to divert floods from sensitive areas. Flood fighting may include evacuating residents of threatened areas, closing roads according to a preplanned schedule, providing medical care, reinforcing police protection, using portable pumos to relieve surcharging in sanitary sewers, sandbagging, building temporary earth dikes, activating floodproofing measures, and continuously inspecting flood control facilities.
   - Flood warning: Issuing the results of a forecast to the public or public authorities. Advance notice that a flood may occur in the near future at a certain station or in certain river basin.

3) Comprehensive programs on flood management:
   Recently Government of Indonesia has launched a comprehensive program for flood management, those are as follows:
   a) Reviewing and revitalization of spatial planning to balance utilization and conservation of natural resources.
   b) Intensification of flood control management by implementing three (3) measures, e.g., flood protection, flood proofing, and flood response planning based on river basin approach, i.e., *one river, one plan, and one management*
   c) Provision of adequate urban infrastructures related flood management, such as drainage facilities, garbage management and solid waste and waste water management.
   d) Provision of low cost housing to accommodate resettlement of squatters on river levee and slump areas.
   e) Improvement of public service by applying *good governance* principles.

A.3 Progress of flood protection measures

- The number of flood prone areas recorded is about 1.4 mill to 1.9 mill hectares. Among those flood prone areas, about 420.000 hectares have been protected from flood with return period ranging from 5 to 25 years.
- According to a rough estimation, flood control measures required on 600 rivers are: (i) dike of about 30,000 km, and (ii) river channel normalization of about 15,000 km. Flood control measures that have been completed up to the year 2001 are: (i) dike of about 2,600 km or 8% of the total dike required, and (ii) river channel normalization of about 1,500 km (10% of the total dike required).
- Most of major cities in Java, i.e., JABODETABEK (Jakarta, Bogor, Depok, Tangerang, and Bekasi), Bandung, Semarang and Surabaya and off Java such as Medan, Padang and Makassar have a Master Plan for flood control development. However, its implementation requires a large amount of investment, and therefore stage wise implementation plan is adopted and the result is partial completion of the total infrastructures required.

B. Sediment Disasters

As a result of growing population pressure and changes in the nature and intensity of economic activity throughout Indonesia, issues of land and water uses have become increasingly important and has caused increase in number of degraded watersheds/river catchments overtime. Number of degraded river catchments was recorded 22 in 1984, increase to 39 in 1992 and become 59 degraded river catchments in the year of 1998.

In Java, river catchments degradation has caused severe problems of unstable river flows. During the wet season river flows bring high rates of sedimentation due to excessive erosion on the upstream watershed. These cause very fast sedimentation rates on reservoirs and lakes, making the lifetimes of reservoirs shorter than planned as well as reductions on storage capacities.

In islands outside Java, soil erosion and high fluctuation of river flows between the rainy and dry seasons due to upper watershed degradation threaten optimal functions and sustainability, which in turn results in a high cost for Operation and Maintenance (O&M) of recently completed water resources infrastructures. High sedimentation on the lower reach of river such as that has occurred in several main rivers in Kalimantan, threatening accessibility of natural harbors on the river mouth as well as inland water transportation especially during the dry season. This condition constrained foods transportation to upper areas and may cause temporary foods scarcity.

Sedimentation problems on rivers that caused by mountain eruption, i.e., Mountain Merapi, Kelud, Semeru, and Galunggung (all in Java) and Mountain Agung in Bali are relatively well controlled by construction of sabo dam systems which were built since about 20 years ago under technical assistance of JICA and construction loan of JBIC (OECF previously).

C. Water Shortages

C.1 Water Resources Potential

Indonesia has over 5590 rivers. Excepts for rivers in Kalimantan and a few river in Java, most rivers are short with limited flood carrying capacity. Although Indonesia has an abundance of rainfall, with a national average of over 2500 mm/year of which 80% falls during the rainy season; however large regional variations in the rainfall exist over the country. It ranging from the very arid areas of Nusa Tenggara, Maluku and parts of Sulawesi Islands (less than 1,000 mm), to very wet areas in parts of Irian Jaya, Java and Sumatra (more than 5,000 mm)

The average annual renewable water resources, or surface water potential per island, can be expressed in terms of per capita population (1990), by dividing the islands into their relative catchments and estimating run-off using a rainfall/run-off relationship (UNDP/FAO, 1992). These vary between a maximum of 543.230 m3 in Irian Jaya, to minimum of 1,767 m3 in Java and Madura, and 2,003 m3 in Bali.

Using this approach, the average annual surface water potential for the whole of Indonesia is 18,178 m3/capita (1990). With estimated total annual per capita demands of approximately 40 m3, the water resources availability would not yet appear to be significant constraint on further socio-economic development in Indonesia.

However, when water resources availability is considered regionally by taking each islands as an independent unit of water, a very different picture emerges. The annual surface water potential per capita in Java (including Madura) is estimated at 1,767 m3. in Java, where there is an estimated population of 120,4 million, the annual per capita water demand amount to 482 m3, or 27% of the available water resources, when high water demand can become a limiting factor on national development.

C.2 Water Resources Demands

The demand on water resources has rapidly increased as the nation implements its development program to meet the sharply increasing needs for irrigation, safe drinking water, industrial water, energy, etc.

By making estimating of the population growth rates and the corresponding requirements for domestic, municipal and industri (DMI) uses, it is possible to project the total DMI demand in the year 2020. Similarly, predictions can be made for irrigation demands, based on population projections and food (rice) requirements to maintain self-sufficiency. River maintenance water demand is estimated by multiplying projected urban population by per capita flushing water requirement. Total annual water demand on each island in year 2020 is shown in Table 1 below.

Table1. Annual Water Demand and Estimated Natural Basic Discharge in 2020

Unit: MCM

Region	DMI	River Maintenance	Irrigation	Fishpond	Livestock	Total Demand	Estimated Natural Basin Discharge
Sumatera	2.630	2.733	15.992	1.275	155	22.766	482.173
Jawa & Bali	9.850	9.799	54.918	809	258	74.569	122.699
Kalimantan	768	820	3.643	753	29	6.014	556.700
Sulawesi	686	769	14.243	354	110	16.612	143.343
Maluku & Nusa Tenggara	406	444	5.526	40	69	6.485	45.909
Irian Jaya	107	124	48	0	2	281	496.422
Indonesia	14.401	14.670	94.370	3.213	623	127.277	1.847.246

Out of 1,847 billion m3 of available water (natural basin discharge per year), about 127 billion m3 will be used for DMI, Irrigation, River Maintenance, etc. Balanced of about 1,720 billion m3 is available for another new development of DMI, Mining, Agricultural uses, etc. However, water surplus can not be used all, since wet season surplus water can not be used for dry season without any large scale water reservoir.

Obviously when taken on an individual catchment basis, there may be some water shortages in meeting all demands at certain periods during dry season. This confirms the need for "real-time management" of all water resources in each river basin, with full regard to water allocation and the operation of each scheme under normal and emergency condition. Consideration will also have to be given to the releases required from reservoir for hydropower generation, for aquaculture, maintaining minimum flows in rivers and for flushing. This can only be achieved by adopting the integrated approach to river basin planning, with the necessary regulations and procedures in place, to provide the means of "managing" the water resources in the fullest sense of the word.

Policies for achieving these targets include; water resources policy, institutional, legislative and regulatory reform program, improving and productivity in water utilization; increasing the supply of human settlement, agriculture, industry, tourism and electricity generation; extending irrigation networks; improving water utilization through development of fair and efficient allocation systems; controlling damage to the environment; strengthening water resources institution; and supporting regional water resources development.

D. Water Contamination and Damage to Ecosystems

Because of its multiple roles—economic, ecological, and socio-cultural—most issues of sustainable development in Indonesia are related in one way or another to the management of land. As a result of growing population pressure and changes in the nature and intensity of economic activity throughout Indonesia, land-related issues of efficiency, sustainability and equity have become increasingly important. On Java, the conversion of upland forests and coastal wetlands to agricultural use has led to soil erosion, watershed degradation and the loss of valuable marine resources. The rapid—but often uncoordinated—expansion of urban areas results in less-than-optimal land use densities and efficiency in the provision of infrastructure. The spread of industrial firms in and around urban areas have little regard, until recently, to their impact on the environmental or the health and welfare of surrounding communities.

Java which has 60% of the population, 70% of irrigated agriculture, and 75% of industry, issues of water quantity and quality include emerging conflicts between competing uses (agriculture, industry, and municipal), and between surface and groundwater use in rapidly growing urban areas. In the aggregate, Java is well endowed with rainfall. The problem is one of seasonal and annual variations, with dry season flow in the main rivers only 20% of annual flows—and as little as a 10% in a dry year. This is compounded by the fact that river basins on Java are relatively steep and short (less than 150 km on average) and almost all of their upper catchments are facing serious degradation, resulting in most of the wet season water running unused into the sea and very little flows during the dry season. During the wet season river flows bring high rates of sedimentation due to excessive erosion on the upstream watershed. These cause very fast sedimentation rates on reservoirs and lakes, making the lifetimes of reservoirs shorter than planned as well as reductions on storage capacities. While a number of dams have been built in major river basins such as Citarum, Brantas, Serayu-Bogowonto, Bengawan Solo and others, their reservoirs hold less than 5% of total river flows. Most of the reservoir capacities of those river basins were planned to meet the water demand for various uses up to the planning horizon of

2010. Several additional sites have been identified for possible future dams, but implementation is likely to be constrained by high population densities and the social and economic costs of resettlement.

In volume terms, water use in agriculture currently accounts for 80% total demand, while industrial and municipal requirements together account for only about 20%. The consumption of water by households and businesses will rapidly grow over the next two decades, but their needs will reach an amount to about 25%-30% of total demand by the year 2020. To support continued rapid growth and improvement in human health and welfare, however, these needs will have to be met. This will require a shift of water in the dry season from agriculture to municipal and industrial use. Such diversions are already beginning to occur, but greater attention is needed to the process of water allocation so as to minimize the social and economic costs for farmers and the potential disruption to agricultural output. Government of Indonesia is aware of the need to manage its water resources on an integrated river basin basis, and is currently assessing the regulatory and institutional changes that would require. It will be especially important to ensure the coordination of groundwater –as well as surface water— use. Many of the aquifers in Java's rapidly growing urban centers are already suffering from over-extraction, resulting in salt-water intrusion and ground subsidence in coastal areas.

The challenges of meeting the demand for water in the dry season are complicated by the growing volume of pollution from urban and industrial sources. Most of the major rivers on Java are seriously polluted with a combination of untreated human waste, uncollected municipal refuse, and largely uncontrolled effluents from industry—including increasing amounts of toxic and hazardous waste. During the dry season, when river flows are greatly reduced, the concentration of pollution loads increases dramatically. One solution of this problem is to release water from storage reservoirs to "flush" these wastes away from urban areas. This provide only temporary relief, however, at a high cost in term of alternative uses in agriculture. The groundwater aquifers in many urban centers are also polluted, primarily by human waste, but with increasing evidence of industrial waste as well. Fecal contamination of water supplies represents a constant hazard to human health, and this is compounded during the rainy season by the flooding of low-lying areas—in part due to the clogging of drains and canals by solid waste. Over the longer, toxic and hazardous waste poses an even more serious threat to human health and welfare. Sample of groundwater in Jakarta, and marine life in Jakarta Bay, for example, already show evidence of contamination by toxic metals (e.g., mercury).

E. Other Water Related Problems

Water Availability and Sustainability

Issues of water quantity include increasing competition between alternative uses (agriculture, industry and municipal), and between surface and groundwater in rapidly growing urban areas.

In the aggregate, Java is well endowed with rainfall. The problem is one of seasonal and annual variations, with dry season flow in the main rivers only 20% of annual flows, and as little as 10% in a dry year. This is compounded by the fact that river basins on Java are relatively short, resulting in most of the wet season running unused into the sea. While a number of dams have been built in major river basins such as Citarum, Brantas, Serayu-Bogowonto, Bengawan Solo and others, their reservoirs hold less than 5% of total river flows. Most of the reservoir capacities of those river basins were planned to meet the water demand for various uses up to the planning horizon of 2010. Several additional sites have been identified for possible future dams, but implementation is likely to be constrained by high population densities and the social and economic costs of resettlement.

In volume terms, water use in agriculture currently account for 95% of total demand, while industrial and municipal requirements together account for only 5%. The consumption of water by households and business will grow rapidly over the next two decades. To support continued rapid growth and improvements in human health and welfare, however, these needs will have to be met.

Currently the rate of coverage of pipe water service (from surface water) for almost all of major cities in Java is at the range of 40%-60% of total demands. The remaining is fulfilled by groundwater. The heavy reliance on groundwater to serve industrial and domestic needs in large urban areas cannot continue indefinitely. This is particularly true for the northern coastal cities of Java where groundwater is being abstracted at greater than replenishment rates, leading to saltwater intrusion and land subsidence—with attendant increases in floods and waterlogging which, in turn, aggravates groundwater pollution from septic tanks and leaching pits. In Jakarta the overdraft is causing land subsidence ranging from 4 to 9 cm a year, increasing the risks of flooding and threatening superstructure stability. Moreover, there is clear evidence that the overabstraction is causing salinization of the groundwater along the coast.

LAOS

Mr. Viengsavath SIPHANDONE
Director General
Department of Roads
Ministry of Communication,
Transport Post & Construction

The 11th Conference on Public Works Research & Development in Asia
14-25 October 2002

Riverbank Protection in the Lao PDR

Viensavath SIPHANDONE

Director General, Department of Roads

Ministry of Communication, Transport, Post and Construction

Lao PDR

I Introduction

The Lao People's Democratic Republic (the Lao PDR) is a small developing country, which is one of the poorest countries in the world. Per capita GDP is 329US$ (in 2001) and the growth rate is 5.7% from 1990 to 2001. Infant mortality rate is 8.2% (in 2000) and under-5 mortality rate is 10.6% (in 2000). It is said that about 40% of the population lives in poverty.

90% of the state of the Lao PDR forms part of the Mekong River Basin. Furthermore, of all the member countries of the Mekong River Commission (MRC), the Lao PDR has the greatest length of the Mekong River. Therefore the Mekong River Basin is of great importance to the Lao PDR. The presence of the river has both advantages and disadvantages. One of the disadvantages is the damage caused by the river.

Riverbank erosion is the most serious damage. This has been a serious constraint on poverty reduction and socio-economic development in the Lao PDR.

II Riverbank Erosion

The water level of the Mekong River changes seasonally by more than 10m. When the water level is high, riverbanks are eroded by the river current and, when the water level falls at the beginning of dry seasons, many riverbanks collapse not only along the Mekong River but also along its tributaries.

The Lao PDR has been suffering from damage caused by the riverbank erosion. The damage extends to the urban lands, houses, electric cables roads and so on. The erosion ha menaced National Road 13, which is the most important trunk road in the Lao PDR, with destruction.

Poor people are the main victims of the riverbank erosion. Their houses and their community facilities such as roads, temples, etc are in the danger of being destroyed by the riverbank erosion.

III Riverbank Protection

1. Past Activities

In order to cope with the riverbank erosion situation, the Government of the Lao PDR (GOL) has executed riverbank protection works mainly with gabions. However, even gabion works are expensive for the Lao PDR, because iron mesh baskets must be imported.

The Lao PDR is one of the most poorest countries in the world and the budget of the GOL for riverbank protection is only about US$100,000 / year.

With this budget, only about 60m can be protected in a year, if we use gabions.

Therefore the use of gabions is not a sustainable riverbank protection method for poor countries such as the Lao PDR. The Lao PDR has been looking for effective and low-cost riverbank protection techniques.

2. Transfer of Riverbank Protection Techniques from Japan

The GOL has been introducing riverbank protection techniques using natural materials with the assistance of the Japanese Government. These techniques are effective, environment-friendly and low-cost, because the necessary materials can be secured in the country. Therefore these techniques can be sustainable for poor countries such as the Lao PDR.

(1) Groyne Construction in Bokeo Province

In Bokeo province, a village near the border with Myanmar and Thailand, "the Golden Triangle", was being seriously damaged by riverbank erosion. The GOL had planned to protect the riverbank with gabions. However the GOL followed a JICA Expert's technical advice and changed the plan. A local labor force began to construct rock groynes with local materials in 1998.

These groynes are very effective for riverbank protection, because these slow the river current and promote sedimentation along the riverbank.

In addition, the cost is about 500US$/m, which is almost ¼ of the cost of gabion works.

The GOL has already completed 11 groynes and is planning to construct other 30 groynes.

(2) Experimental Work using "SODA" mattress

The Ministry of Land, Infrastructure and Transport of Japan and the Infrastructure Development Institute of Japan experimentally protected 80m of a riverbank using "SODA" Mattress that is a Japanese traditional riverbank protection technique.

This experimental work was implemented in 2001. The "SODA" Mattress has experienced one rainy season and is still protecting the riverbank effectively. This has proved the effectiveness of "SODA" Mattress for the protection of the Mekong Riverbank. In addition, the cost is estimated about 1,000US$/m which is almost half of gabion works.

The GOL is planning to practice the use of "SODA" Mattress by itself in

2003 and 2004, and disseminate this technique to local governments.

(3) JICA Development Survey on Mekong Riverbank Protection around Vientiane Municipality

The Japan International Cooperation Agency (JICA) started its Development Survey on "Mekong Riverbank Protection around Vientiane Municipality" in 2001.

The objectives of this survey are:

1. To study practical, low-cost and sustainable riverbank protection techniques for the Lao PDR
2. To transfer such techniques to the Lao PDR through pilot works
3. To formulate a master plan for the Mekong Riverbank protection around Vientiane Municipality, based on the monitoring of the pilot works

In this dry season, pilot works will start at 3 sites as follow.

Sites	Length	Techniques
Ban Dongphosi	648m	Cobblestone with Willow Branch Work and "SODA" Mattress
Wat Chom Chen	240m	Wooden Pile Dike Groin Work with "SODA" Mattress
Wat Sibounheuang	150m	Cobblestone with Willow Branch Work and "SODA" Mattress

IV Conclusion

In poor countries such as the Lao PDR, effective and low-cost riverbank protection techniques are absolutely necessary to protect poor people's lives and property.

After the on-going JICA Development Survey has finished in March of 2005, the GOL will independently use and disseminate the transferred techniques for poverty reduction and socio-economic development in the Lao PDR.

The 11th Conference on Public Works Research and Development in Asia
Japan, 14-25 October 2002

Riverbank Protection in the Lao PDR

Viengsavath SIPHANDONE
Director General
Department of Roads

Ministry of Communication, Transport, Post and Construction
Lao PDR

Content

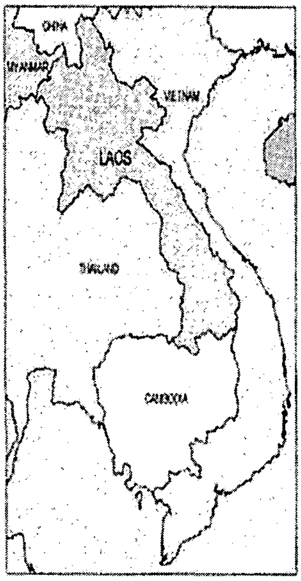
I . Introduction

II . River Bank Erosion

III . River Bank Protection

IV. Conclusion

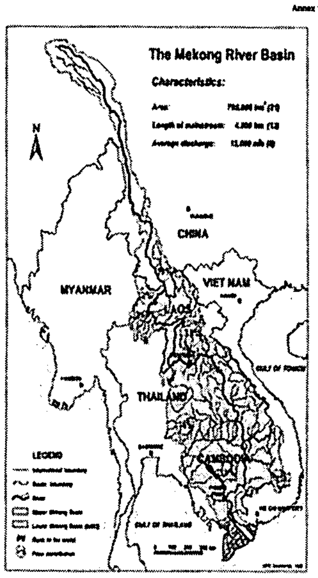
I . INTRODUCTION



- **Location**: A Land Lock Country in South East Asia, Sharing Border with China, Myanmar, Thailand, Cambodia and Vietnam.
- **Total Area**: 236,800 sq.km.
- **Population**: 5.2 million.
- **GDP** : 329US$ (In 2001) One of Poorest Country in the World and the growth rate is 5.7% from 1990 to 2001.
- Infant mortality rate is 8.2% and under -5 mortality rate is 10.6% in 2000.
- About 40% of the population lives in poverty.

THE MEKONG RIVER

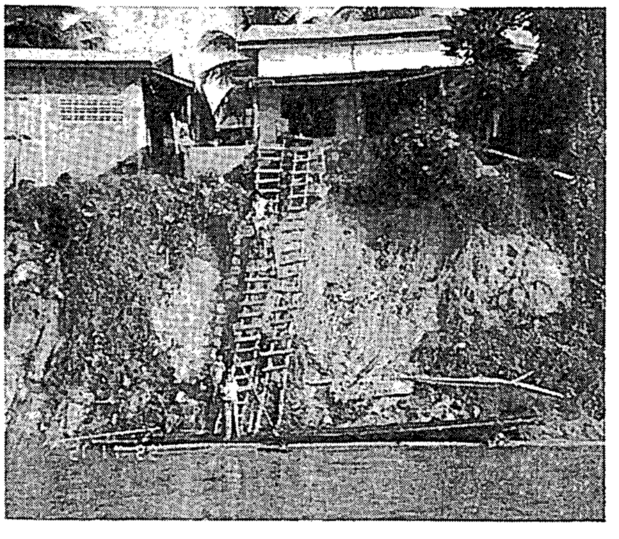
Annex 1



- The Mekong river is the largest river in South East Asia.
- Its runs through six riparian countries of the basin such as : China, Myanmar,Lao PDR, Thailand, Cambodia &Vietnam China ,it has a total length of approximately 4,800 km
- Mekong river: each year about 457,000 million m^3 of water flows into the sea.
- Total Mekong river basin area of approximately 795,500 km^2
- 28 important tributaries on the left bank with the drainage area >1,000 km^2 .

II. RIVERBANK EROSION

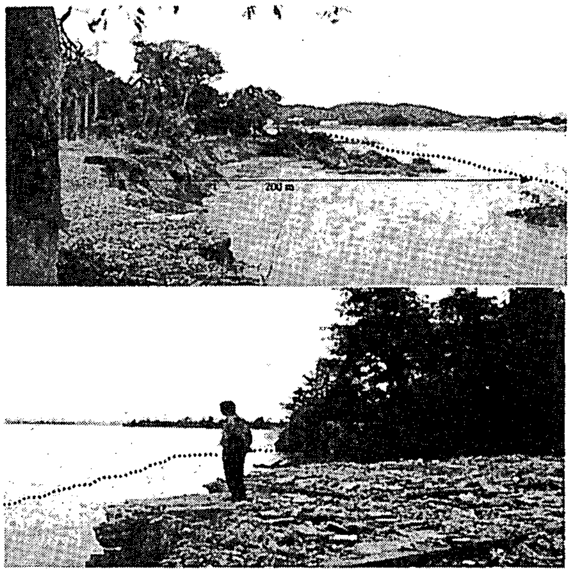
- The water level of the Mekong River changes seasonally by more than 10 m.
- Riverbank erosion is one of disadvantages of the river.
- Riverbank erosion is the most serious damages in Lao PDR.
- The damages by riverbank erosion extends to the urban lands, houses,electric cable ,agriculture lands roads and so on.
- Poor people are the main victims of the riverbank erosion.

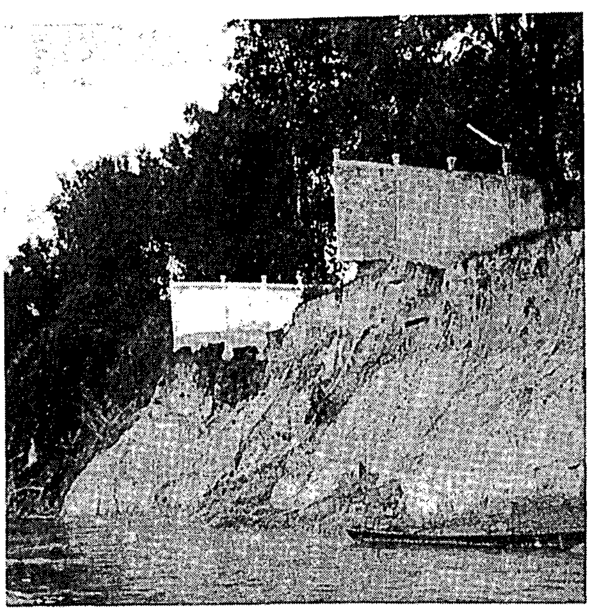


Houses damage caused by the riverbank erosion in Vientiane City

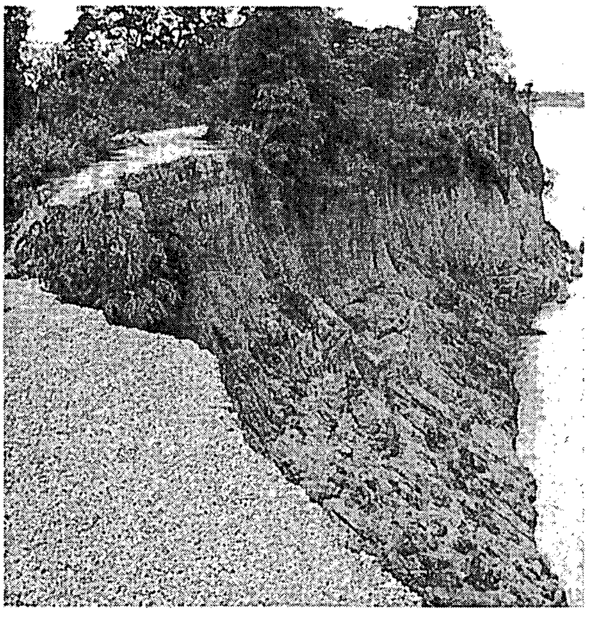
SERIOUS RIVERBANK EROSION IN BOKEO PROVINCE

AUGUST 28,2002





Urban land and property damage caused by riverbank erosion



Road damage caused by riverbank erosion

III . RIVER BANK PROTECTION

Past Activities

- The government of Lao PDR (GOL) has executed riverbank protection works mainly with gabions.

- The gabion works are expensive for the Lao PDR.

- The budget for riverbank protection is about US$ 100,000 per year can be protected only about 60 m in a year, if we use gabion.

- The Lao PDR has been looking for effective and low cost riverbank protection techniques.

RIVERBANK PROTECTION

AT WATSOP TEMPLE VIENTIANE MUNICIPALITY

2. TRANSFER OF RIVERBANK PROTECTION TECHNIQUES FROM JAPAN

- Since 1996 the GOL has been introducing riverbank protection using local materials with the assistance

of the GOJ.

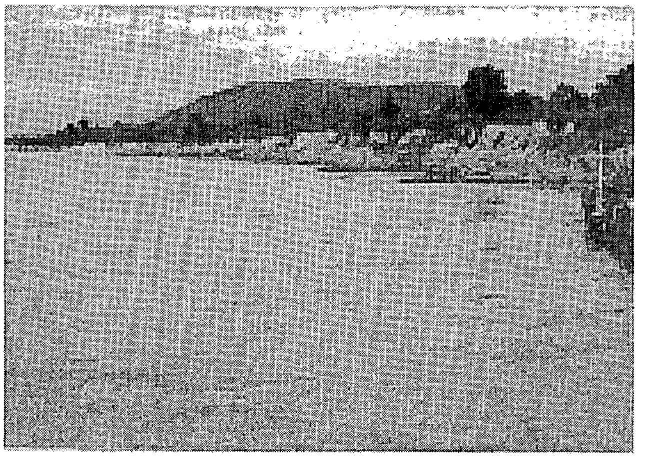
- These techniques are effective, environment-friendly and low cost, because the necessary materials can be secured in the country.

- Therefore the techniques can be sustainable for poor country such as the Lao PDR.

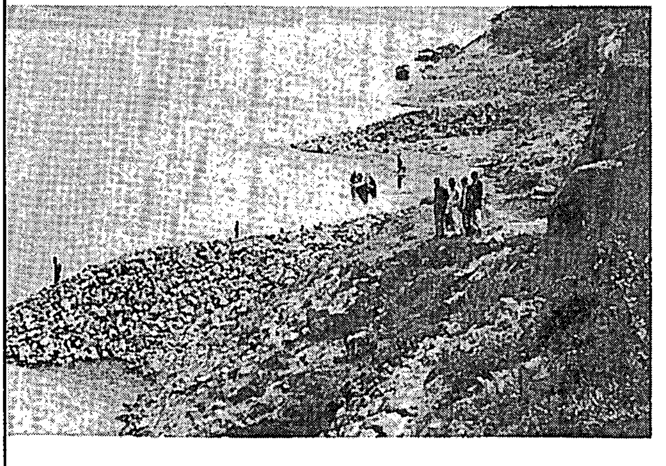
(1) Groynes construction in Bokeo Province

(Northern Part of Lao PDR)

Started from 1998



Groynes in Bokeo Province
(Northern Part of Lao PDR)



- Very effective for the riverbank protection.
- Promote sedimentation along the riverbank.
- Low cost.

(2) Experimental Work using "SODA"mattress (Fascine mattress).

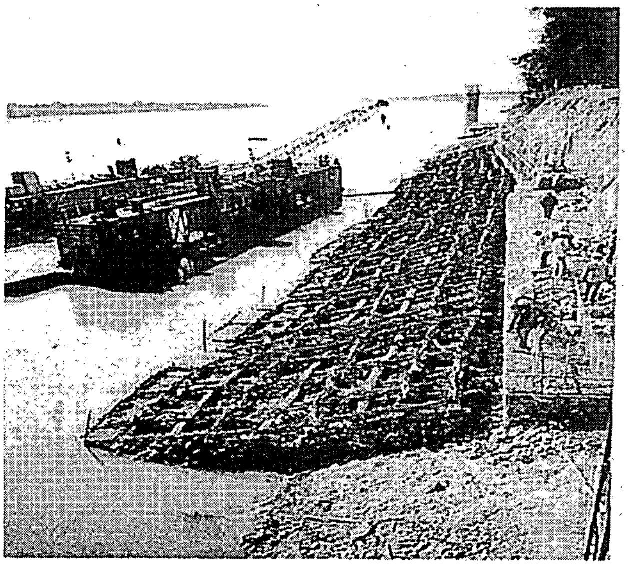
•MLIT and IDI of Japan experimentally protected 80m of a riverbank using "SODA" mattress that is a Japanese traditional riverbank protection technique was implemented in 2001.

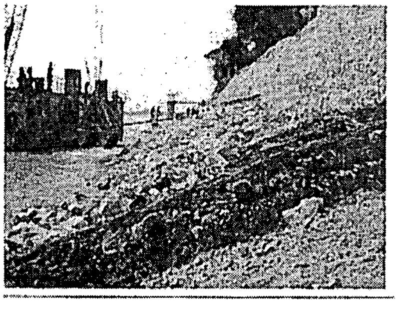
•This has proved the effectiveness of "SODA"mattress for the protection of the Mekong riverbank , in addition the cost is about 1000US$/ml which is almost haft of gabion works.

•The GOL is planning to practice the use of "SODA"mattress by itself in 2003 and 2004, and disseminate this technique to local government .

Training course on Soda mattress system at the MCTPC, March 2000 Organized by IDI, Japan.

Implementation of SODA Mattress System

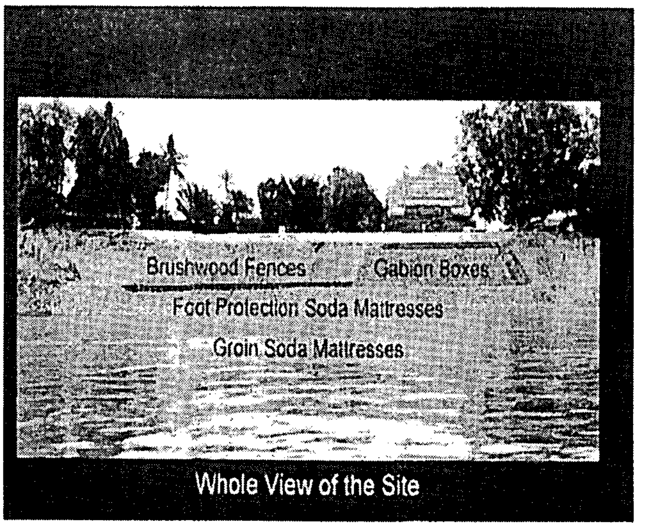




Installation of
SODA Mattress.

Assembly (Fabricate)
SODA Mattress.

Completion of SODA Mattress
(80 ml)



(3) JICA Development survey on Mekong riverbank protection around Vientiane Municipality.

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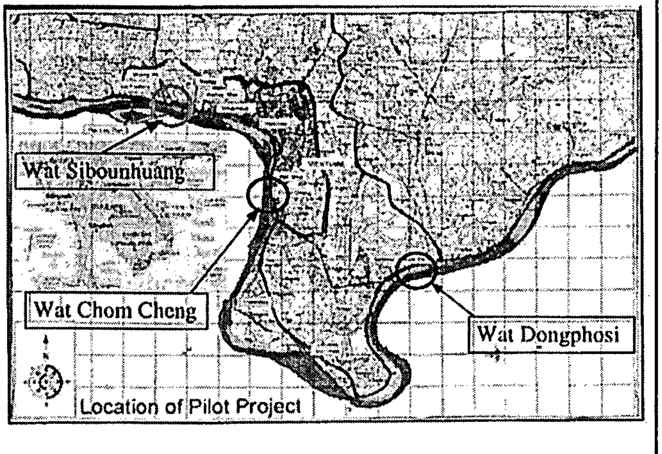

The Objectives of this survey are:

1. To study practical , low cost and sustainable riverbank protection works for the Lao PDR.
2. To Transfer technique concerned with the above mentioned works to the Lao PDR through pilot works.
3. To formulate a master plan for the Mekong riverbank protection around Vientiane Municipality, based on the monitoring of the pilot works.

In this dry season pilot work will start at 3 sites as follow:

Sites	Length	Techniques
Ban Dongphosi	648m	Coble stone with willow Branch work and"SODA"mattress
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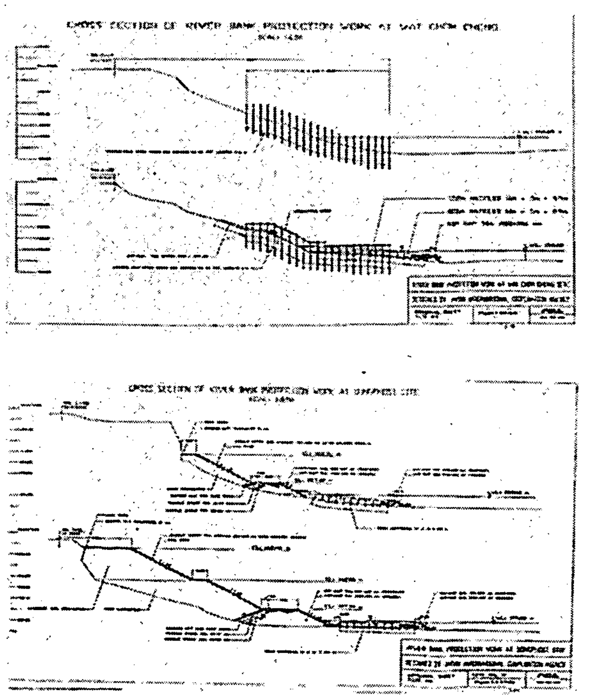

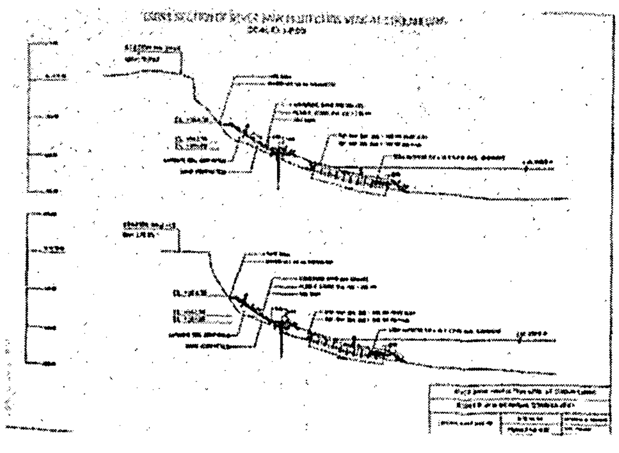

IV . CONCLUSION

•In poor countries such as the Lao PDR effective and low cost riverbank protection techniques are absolutely necessary to protect poor people's lives and property.

•After the on going JICA development survey has finished in march of 2005, The GOL will independently use and disseminate the transferred the techniques for poverty reduction and socio-economic development in the Lao PDR.


Thank you for your kind attention

MALAYSIA

Mr. MOBARAK Bin Hussein
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Mechanical & Electrical Services Division
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"WATER MANAGEMENT / MONITORING AND AUTOMATION SYSTEM - FOCUS – KRIAN IRRIGATION SCHEMES"

by

IR MOBARAK HUSSEIN

Introduction

Malaysia, which comprises Peninsular Malaysia, Sabah and Sarawak, is located between latitudes 1 degree and 7 degrees North and longitudes 100 degrees and 119 degrees East. It covers a total land area of over 330,000 sq km. The population is approximately 23 million with an estimated growth rate of 2.6 % per annum. The climate is equatorial with an average annual rainfall of 2000 - 2500 mm. The average temperature and relative humidity are around 26 degrees C and 80% respectively.

Approximately 80% of Malaysia is covered by tropical rainforest. About 22% of the land in Malaysia is utilized for agriculture. Townships, mining activities and other uses take up another 10%. Approximately 50% of the agricultural lands are cultivated with perennial crops such as rubber and oil palm. The other 50% is taken up for annual crops, mixed horticulture, shifting cultivation and fish ponds.

Presently, the agriculture sector contributes more than a quarter of the country's total export earnings, 20% of the Gross Domestic Product and nearly 33% of the total employment. However, value added earnings per worker in the agriculture sector is half that of the manufacturing sector.

1. Water Resources – Agriculture Sector

From a study conducted by the FAO it was found that the agricultural sector is presently the largest water consumer accounting for 85% of the country's water demand of irrigation purposes. This sector is also considered a comparatively low-economic-value, low efficiency and highly subsidized water user. It was found that most of the irrigation schemes have system efficiencies of less than 50% and water productivity index of less than 0.2 kg/m3. As the country is now having a fast economic growth and development towards industrialization in line with Vision 2020, there will definitely be an increase in water demand for other sectors such as industries and household consumers and coupled with the country's limited water resources, there is a need for a more efficient and responsive water allocation and distribution management system to be implemented. In line with the government's policy of having an electronic government, it is imperative that the department has to move towards paperless bureaucracy and also real time data access through computers and networking. For management to obtain accurate information timely and make good decisions, an integrated operations, control and management system that allows easy and rapid access of data for diverse purposes needs to be implemented.

2.0 Government Policy

2.1 Irrigation in Malaysia has been directly linked to the national rice industry. In the late 1980s, the rice industry in the country faced a number of problems arising from labour shortage and escalating production costs. The smaller irrigation schemes were quite severely effected with many left idle. The priority of irrigation development added a new dimension with the need to rationalize rice production costs and profit considerations. A policy was developed to confine irrigation development to eight large irrigated areas, which were designated as Granary Areas where economy of scaled could be practiced. The main thrust is to increase the productivity in these areas totaling some 220,000 ha. Currently, Malaysia produces 1.5 million tonnes of rice annually and imports 0.340 million tones. Granary areas contribute 72% of the total production.

2.2 The small irrigation schemes (in the Non-Granary Areas) were designated to be gradually changed from rice to diversified land use such as more remunerative cash crops. Existing rice irrigation schemes totaling 54,000 ha have been identified for conversion. An additional 70,000 ha of rain-fed rise areas have been also been targeted for conversion. Provision and management of suitable irrigation systems and related infrastructure will be required to maximize production. Modern irrigations methods such as micro-irrigation systems (drip and trickle) and overhead sprayers will be introduced.

3.0 Background – Kerian Irrigation Scheme

The Kerian Irrigation Scheme which covers an area of 23,359 hectares is located in the North West Corner of The State of Perak. It is the third largest granary area in Malaysia. The scheme I divided into eight compartments, i.e. A to H. The coastal compartments A to D are called Kerian Laut whereas the inland compartments E to H are referred to as Kerian Darat. Kerian Darat are supplied from the Bukit Merah Reservoir whereas Kerian Laut gets the supply from the same reservoir but are supplemented by Sungai Samagagah, a tributary of Sungai Kerian through the Bogak Pumping Station. Two primary canals namely Main Canal and Selinsing Canal convey water from the

Bukit Merah Reservoir to compartment A to F and compartments G and H respectively. A network of secondary and tertiary canals also serves the project area. The scheme has a network of primary, secondary and tertiary drains, which eventually drain either into Sungai Kurau in the South, or Sungai Kerian in the North or directly into the straits of Malacca in the West through tidal gates.

The Study On Modernization of Irrigation Water Management System In the Granary Areas of Peninsular Malaysia by JICA from February 97 to July 98, proposals were made to modernize the irrigation and drainage facilities as well as the current irrigation water , for the granary areas concerned.

4.0 Current Issues In Water Management

4.1 Low irrigation efficiency

Overall irrigated efficiency estimated to be below 50%, due to cultivating practices and related loss of water that flows over the field batases.

4.2 Inadequate Field Water Management due to:

i) Oversupply of water with the use of field siphon
ii) Cost saving for O & M (US100/ha/year)
iii) Continuous irrigation
iv) leaking of concrete irrigation canals
v) field leveling
vi) cropping intensity from 170%to 190%.

4.3 Head losses in main canal due to building of structures that need to be controlled water productivity index from 0.3 to 0.5 kg/m3.

4.4 Lack of beneficiary participation as distribution cannot be considered in solution.

4.5 Real time assessment and telemetry not available.

4.6 Government policy to increase yield from 4 ton/hectare to 10 ton /hectare by 2005. Rice production to increase from 1.5 million metric ton to 2.3 million metric ton.

5.0 Irrigation Objectives

5.1 To have an efficient water management system through real time and accurate data and information transfer using the latest information and automation technology.

5.2 To improve water use efficiency and productivity in the provision of irrigation for Kerian Irrigation Scheme.

5.3 To facilitate the provision of adequate, timely and equitable water supply for intensive paddy cultivation (double cropping).

5.4 To optimize water resource utilization and also implement flood monitoring/warning system by monitoring real time rainfall and water level data in the catchments area.

5.5 To provide telecontrol/automation for important structures in the schemes so as to improve the time lines and effectiveness of operation and to reduce O & M costs.

5.6 A saving of 15% in irrigated water can meet 15% of water demand for domestic and industrial sector.

6.0 Irrigation Modernization

Key areas for improvement :

* System infrastructure improvement
* Infield infrastructure improvement
* Water management improvement
* Land consolidation
* Acceleration of mechanized farming
* Improvement of agriculture (farming practices)
* Strengthening of farmers' organizations
* Environmental management.

The Proposed Telecontrol / Automation system of Kerian Irrigation Scheme :

6.1 Conversion of manually operated gate systems into motorized gate systems for main gated structures, and provision of battery backup system to enable automatic operation of diesel pump, if any. Damaged or old gates unsuitable for automation purpose should be replaced or upgraded.

6.2 Installation of remote control/automation system for selected gated structures and pump stations. The locations of structures and pump stations to be provided with telecontrol/automation system shall be as guided by JICA's proposal. However, additional structures that are found to be crucial in the operation of the scheme will be added. The existing automated system for Kerian Barrage is to be integrated into the new proposed automation system.

6.3 The supervisory control system to be installed at The Control Centre at JPS Bagan Serai should be able to provide both manual and automatic control capabilities for the water conveyance and delivery system. The primary objective is to met the delivery needs of the water users with a high efficiency. To achieve this purpose, the supervisory control system should be able to carry out regulation of the structures in the main canals (either automatic or supervisory) manual mode) so as to achieve target discharges and water levels within reasonable limits. The key structures as described in part (b) above should be able to be operated in three different control modes. In local control mode, the structures are operated from its individual control panel on site, independent of the supervisory control system. In supervisory manual mode, an operator at the master control station initiates remote control actions for gates or pumps. In supervisory automatic control mode, computer-generated control actions are initiated from the master control station. Setpoints and schedules are computed at the master station and transmitted to RTUs at check structure or pumps that execute local closed-loop position controls. The primary functions of the RTUs are a monitor system status and to telemeter these data to the master control station, to perform remote manual open-loop control on command from the master station, and to perform closed-loop functions (e.g. local auto automatic gate control). The software installed at each RTU provides interfacing between the master control station, the RTU, and the control equipment at each site. The software should incorporate suitable control algorithms (controllers) using local feedback data for dynamic automatic regulation and control of gate or pump.

6.4 Remote video monitoring of structures selected for automations at the central control station.

6.5 Upgraded/new telemetric rainfall, water level, and evaporation and gate opening gauging stations at the necessary remoter locations and the telemetric equipment at the control centre.

6.6 For monitoring of water levels and discharges at intake, diversion and regulation structures, the monitoring points should be guided by the points proposed by JICA. However, additional points can be added if found to be strategic and important.

6.7 For monitoring water resource and flood status of the Kerian Scheme, adequate and strategic rainfall and water level stations should be selected to cover the basins of Kerian Reiver and Kurau River, Bukit Merah Reservoir catchments as well the scheme area itself. The proposed telemetric stations for the Kerian River and Kurau River basins and Bukit Merah catchments area which are also required for The Proposed Flood Monitoring and Warning System as described under 4.3 below. The proposed system should be able to allow for safety control and early countermeasures for extraordinary conditions through warning system for flooding or critical low water levels at pumping/diversion points in rivers or at Bukit Merah Reservoir during drought periods.

6.8 Development of SCADA software to cater for scheduling of automatic polling of remote stations for data, data logging, database and file management

6.9 A computer network system is to be provided to handle, process and communicate data/information between the remote terminal units, central control station and workstations at the branch offices. The workstations/printers should be provided at branch offices at Farmers' Development Centers (FDC), pump houses and Bukit Merah site office. Communication of input/output data and information as well as video conferencing should be possible between the branch/site offices and the central control station.

7.0 DEMONSTRATION PROJECT

7.1 This primary objective of the Demonstration Project is to demonstrate the benefits of telemetry and automation. The experience gained in the demonstration projects can be used to fine – tune the design for the Kerian Water Management / monitoring and Automation System.

7.2 The objective of the system is to :

i) Remotely monitor the reservoir water level, gate position and canal water level.
ii) Remotely control the gate movement.

7.3 The works involved:

i) Installing and testing actuators on the two existing slide gates.
ii) Installing electronic water level sensors on the reservoir and canal.
iii) Installing and programming the RTU at the reservoir.
iv) Installing a pc with (SCADA) software at the JPS Kerian Office.

7.4 a) The demonstration Projects consists of two sites, the first being the reservoir located at Bukit Merah, and the control station located at master station in JPS Bagan Serai. The two sites were connected remotely via the GSM network. The major components used are :

i) Mantacom MC – 1000 Remote Terminal Unit RTU
ii) IBM Deskop PC
iii) Mantacom Scada software
iv) Rotork Gate Controller
v) Ultrasonic water level sensors
vi) Axis network camera
vii) Wavecom GSM modem
viii) Lighting protection system.

b) Issues with Demonstration projects :

i) Gates closes when power supply resumes after stoppage.
ii) Lighting strikes – ELCB trips.
iii) Variation in ultrasonic after level sensor.

iii) Sudden change in water level measuring reading.
iv) High cost of telephone bill for GSM link.

8.0 CONCLUSION

8.1 Information technology is one of the key success factors of an organization. In this department many systems which have been discussed above with the aim to improve operation and maintenance and also provide real-time accurate information for management decision making. It is now timely to expand such deployment into the various areas and also to integrate these systems into the department IT system to that rapid access to data from anywhere on the corporate network by a range of personnel for diverse purposes can be realized. An integrated SCADA system proposed shall be able to perform such task.

8.2 To implement such integrated system so that existing systems that have already been developed by the various divisions can be readily integrated without much hassle needs the careful and committed planning, co-ordination, implementing and monitoring by a special Steering Committee on IT and SCADA. Co-operation and help from the various divisions is needed.

8.3 To implement such a system allocation and funding is necessary and the unit that is entrusted with the implementation should be provided with the necessary funds to ensure successful implementation. Funds shall be channeled to the division that is most suited for the log-term development.

8.4 Implementation of the system requires the support and effort of all levels of personnel in the department especially the commitment of top level management in making a clear decision.

9.0 RECOMMENDATION

9.1 The provision of a modern computerized water management system coupled with a real time supervisory control and data acquisition system can ensure optimal distribution of irrigation water to the various areas in the scheme. The modern water management will be needed to be implemented to enhancing the irrigation efficiency of the scheme and minimizing inefficient use of water. Data requirement should cover :

i) Rainfall
ii) Evaporation
iii) Actual planting schedule and crop variety
iv) Infiltration rate
v) Other losses
iv) Irrigation supply
vi) Field water depth.

9.2 Research and development of appropriate technologies such as simple irrigation facility and the utilization of local content are needed for water management system.

9.3 It is vital for promoting research activities and methods used in other countries be used locally.

9.4 There is need for research into the applicability of technologies available internationally to suit Malaysia soil and water conditions assessment of low efficiency and water productivity, economic viability, effectiveness of the technology and its sustainable in case of poor maintenance standard .

9.5. Need to research adept local condition on integrated water management system.

9.6. Japan experience should come useful especially in trying to increase:

a) Low system efficiencies
b) Water productivity index
c) 4 ton/hectare to 10 tan/hectare.
d) ICT program
e) Infrastructure rehabilitation
f) maintenance strategy required sustain the system effectiveness.
g) Infrastructure and technology development that contribute to water conservation.

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6. Application of SCADA System in Support of the Main Functions of JPS by Ir Khor Kong Kee

APPENDIX

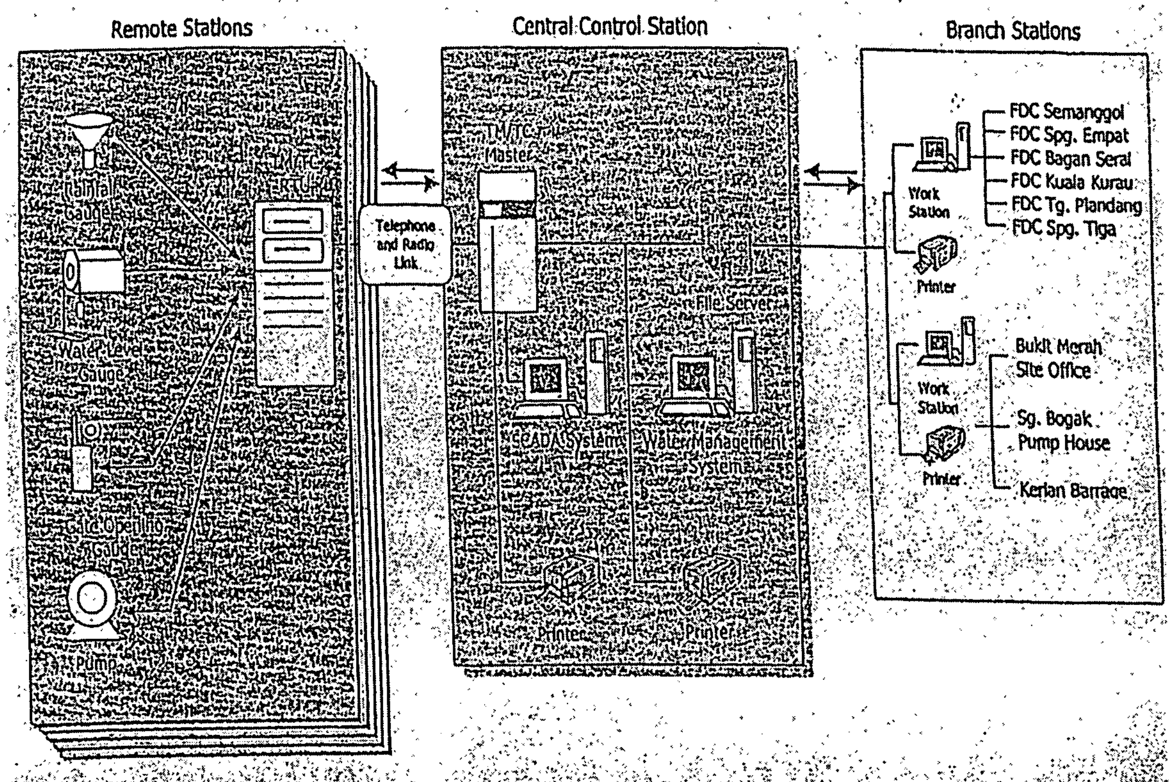
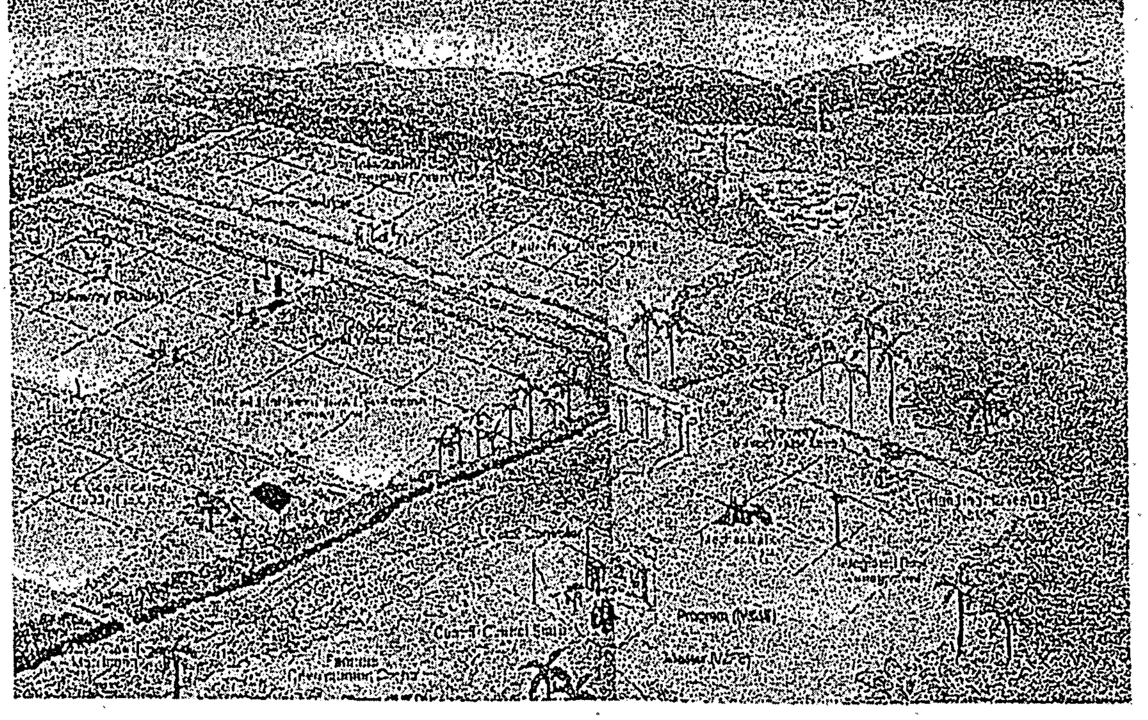
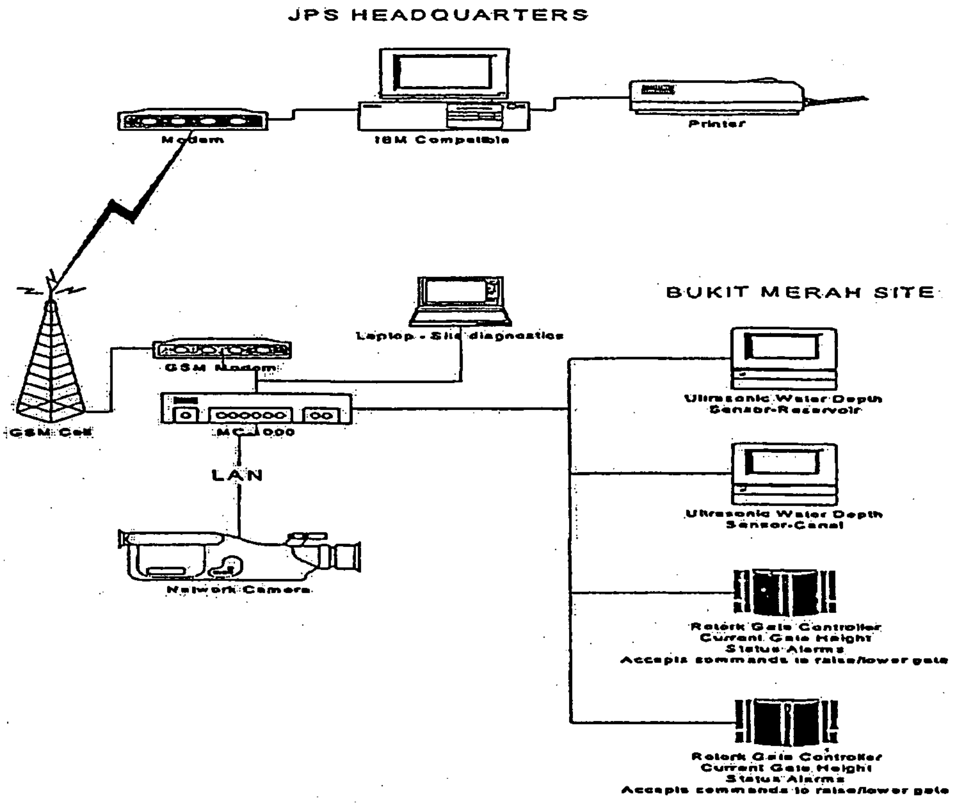


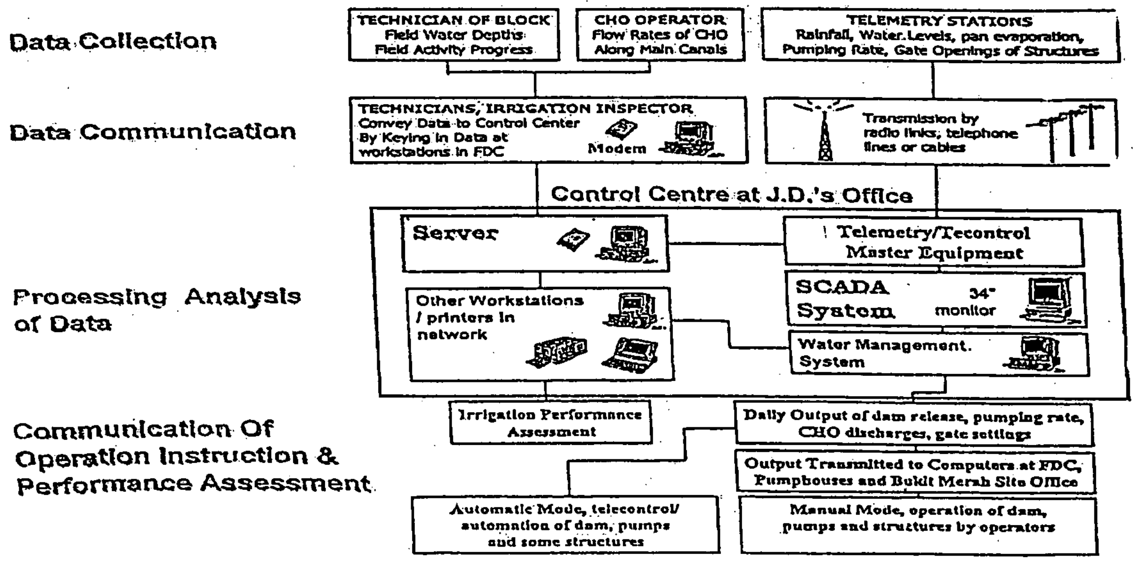
Fig. 3 - Schematic Diagram of Telemetry and Automation System



APPENDIX



Demonstration Project System Overview



Proposed Irrigation Water Management and Automaton System

PAKISTAN

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Communication & Works Department
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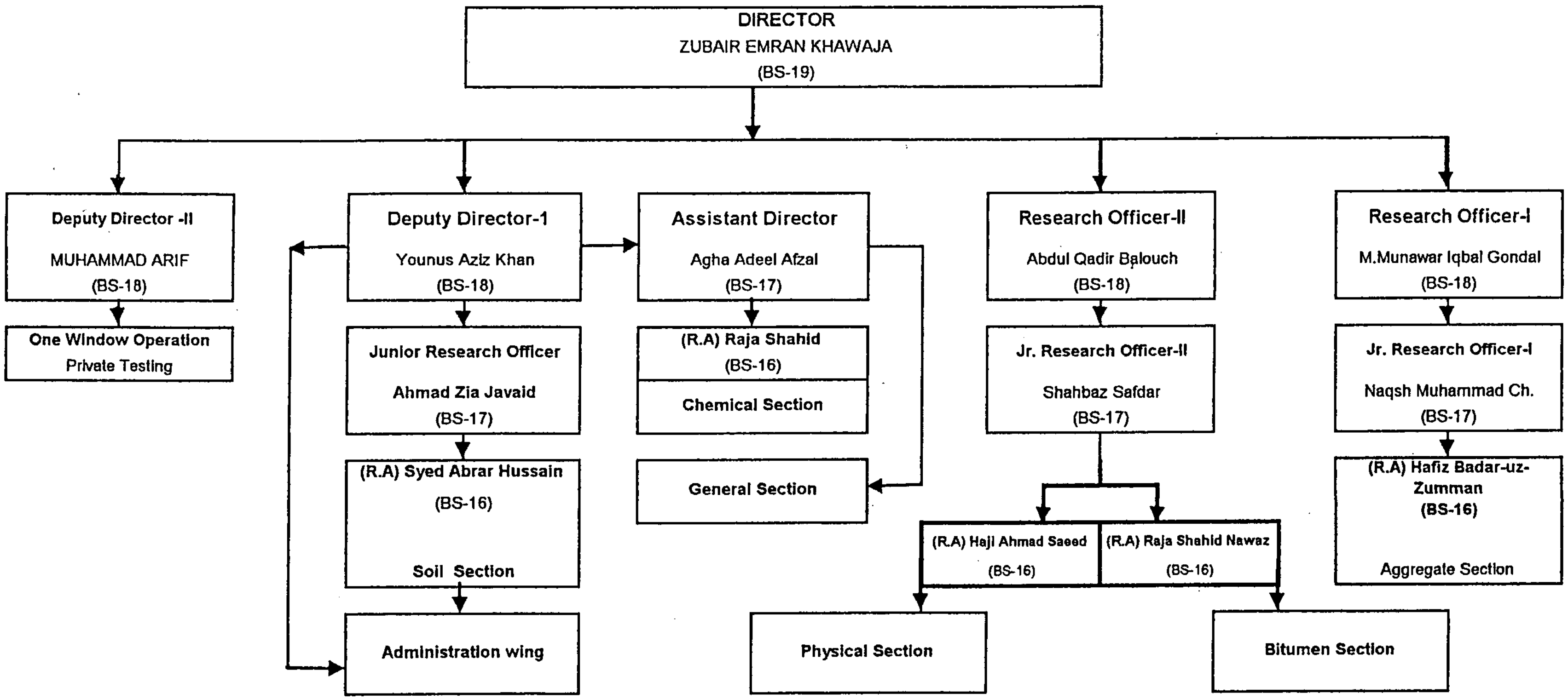
EXECUTIVES' SEMINAR
ON PUBLIC WORKS MANAGEMENT
JAPAN

COUNTRY REPORT
PAKISTAN

ROAD RESEARCH AND MATEIAL TESTING INSTITUTE/PRIVATE SECTOR PROJECTS INVESTMENT CELL. COMMUNICATION & WORKS DEPARTMENT GOVERNMENT OF THE PUNJAB, LAHORE

Zubar Emran SANTIAGO

ORGANOGRAM



TOTAL STRENGTH = 131
WORKING = 115

Subject of Common Interest

"Water Resources and River Management for Sustainable Development"

Pakistan's Economy by and large is agriculture based, and contributes 24.7% of GNP of 2000-2001 and accounts for more than 60% of foreign exchange earnings. About 68% of the rural population depends on agriculture as it employees over 46% of the labor force. Within the agriculture sector, the contribution from crop production is 52% while livestock contributes almost 44% the contribution from fishers and forestry are comparatively small, estimated at 3% and 1% respectively.

The principal objective of economic and financial policies of the Government of Pakistan is the achievement of sustained annual economic growth of around 6%, with agriculture making a significant contribution. Water has played a very significant role in the economic development of Pakistan and is likely to continue as such in future.

Total power generation capacity in Pakistan is of the order of 17,980 MW. This includes hydropower generation-capacity of 5,009 MW, thermal power generation capacity of 12,509 MW and nuclear power energy generated. The potential for hydropower generation is of the order of 40,000 MW. Cooling water requirements of the Chashma Nuclear Power Plant and several thermal power plants are also met from the river and canals.

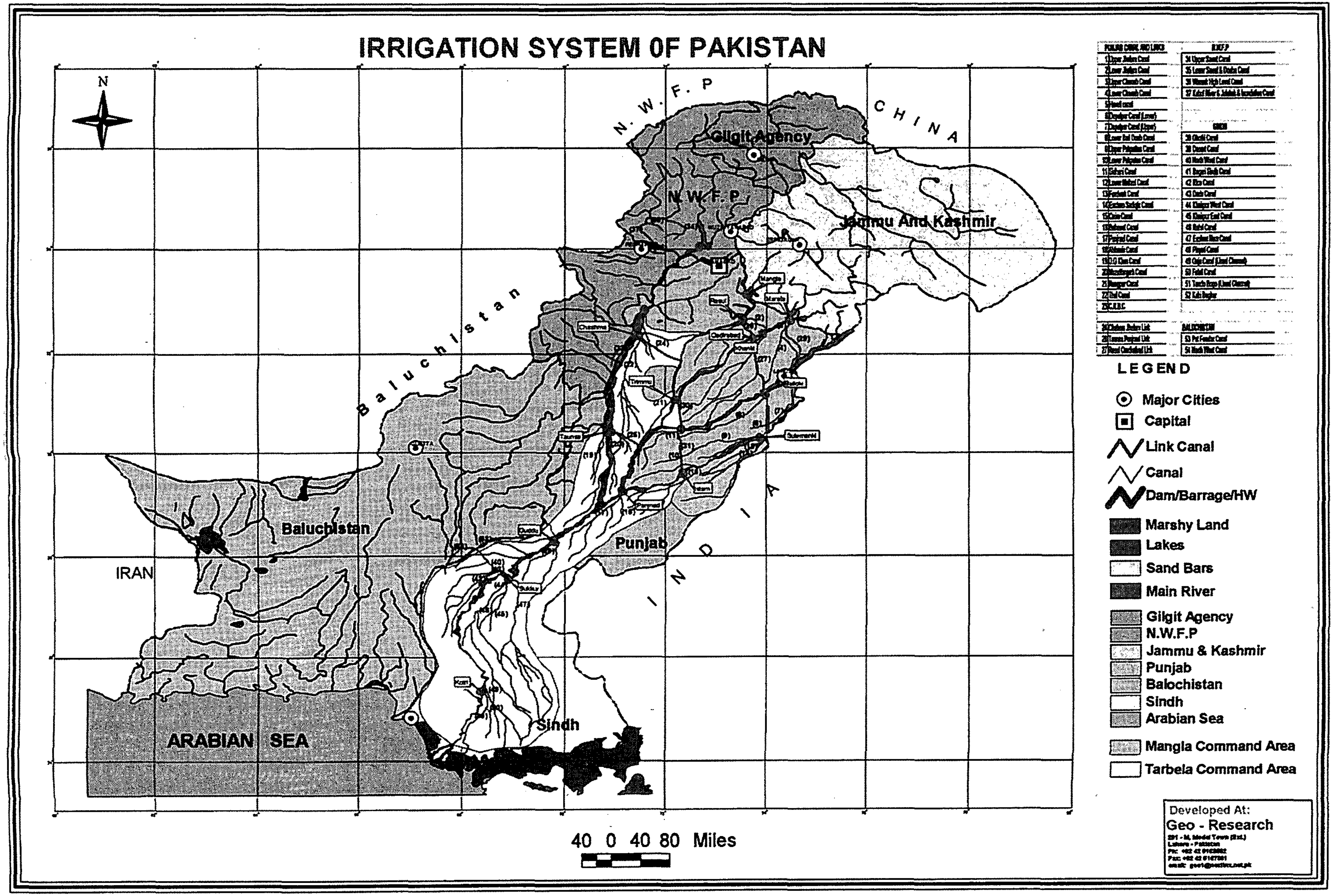
In addition to agriculture and hydropower, inland fisheries contribute reasonably to the national economy. Pakistan produced 665,000 metric tons (mt) of fish and related products in 2000 including 185,000 mt from inland water and 480,000 mt from marine fisheries. Although the share of fineries in the GDP is small, yet its contribution to national income through exports is sustainable. During the same period 84,693 mt were exported with a value of Rs.7.9 billion.

Water Resources: The total surface water available in the Indus Basin is estimated at 147.17 MAF (181.55 BCM). Additionally, in Balochistan the Makran Coastal basin has an average flow of about 3.0 MAF (3.69 BCM) and the Kharan Basin, has an average inflow of 0.79 MAF (0.97 BCM), both of which could be harnessed for use.

There is also groundwater. Recharge is from direct rainfall and infiltration through the alluvium from rivers, the irrigation system and from the irrigated fields. Estimates of groundwater recharge vary significantly but range from 40.5 to 52.7 MAF (50 to 65 BCM) annually. The groundwater supply is almost fully utilized and in some areas, notably in balochistan, groundwater tables are rapidly declining.

The water Apportionment Accord (1991) has allocated 114.35 MAF (141.1 BCM) to the provinces and another 3 MAF (3.7 BCM) for the Civil Canals in NWFP. Over the 11 years since the Accord it has never been possible to divert the full allocated amount despite above average inflows in several years. This is mainly a storage problem, as the most critical shortage occur in early Kharif when inflows are low, irrigation requirements are high and there is insufficient water in the storage reservoirs for release.

Average water abvailablity and hydropower generation from Mangla and Tarbela are declining as their combined live storage capacity reduced due to siltation. It has seen a 20% reduction in capacity to date and this will continue.



IRRIGATION SYSTEM 0F PAKISTAN
N
N. W. F. P
CHINA
Gilgit Agency
N.W.F.P
Jammu And Kashmir
Baluchistan
Baluchistan
IRAN
Punjab
INDIA
Sindh
ARABIAN SEA
LEGEND
Major Cities
Capital
Link Canal
Canal
Dam/Barrage/HW
Marshy Land
Lakes
Sand Bars
Main River
Gilgit Agency
N.W.F.P
Jammu & Kashmir
Punjab
Balochistan
Sindh
Arabian Sea
Mangla Command Area
Tarbela Command Area
40 0 40 80 Miles
Developed At:
Geo - Research

Potential for Additional Storage: There is reasonable potential for additional storage but, at present, lack of consensus among the provinces on the storage issue hampers its development. The storage option will require a strong national commitment, which satisfies the genuine concerns of the provinces and overcomes the objections of the provinces for the greater national good.

.Additional storage of 15 MAF (18.5 BCM) by 2025 is required to fulfill the water need of all sub-sectors, especially agriculture under the projected Low Demand Scenario, and to replace lost storage in the existing reservoirs. This is in addition to 6 MAF to be developed through efficiency increases in irrigation.

Recognizing the importance of water and power development in the national economy, the Pakistan Government through Water and Power Development Authority (WAPDA) has launched a water resource and hydropower development Mega-plan known as 'Vision-2025', which aims at the development of about 21 MAF (26 BCM) of new storage capacity between 2005 and 2025.

There are several possible storage sites, with a total volume of 22.5 MAF, as shown in Table 1.

Dam Site	**Storage Capacity (MAF)**	**Power Capacity (MW)**	**Status**	**Design & Construction Period (year)**	**Cost (m$US (2000)**
Gomal Zam Dam	1.14	17.4	OG	4	167
Mirani Dam	0.30	-	OG	4	118
Satpara Dam	0.02	0.20	OG	3	10
Munda Dam	0.68	740	FS	9	750
Kalabagh	6.10	3600	FS, DD, TD	8	5000
Sehwan Barrage	0.65	-	FS	7	610
Kurram Tangi Dam	1.20	1.20	FS	7	200
Raising Mangla Dam	3.10	180	FS	5	883
Basha Dam	5.70	3360	PF	12	6000
Sanjwal & Akhori	3.60	TBD	C	12	600
Total	**22.49**	**9498.8**	**N/A**	**N/A**	**14338**

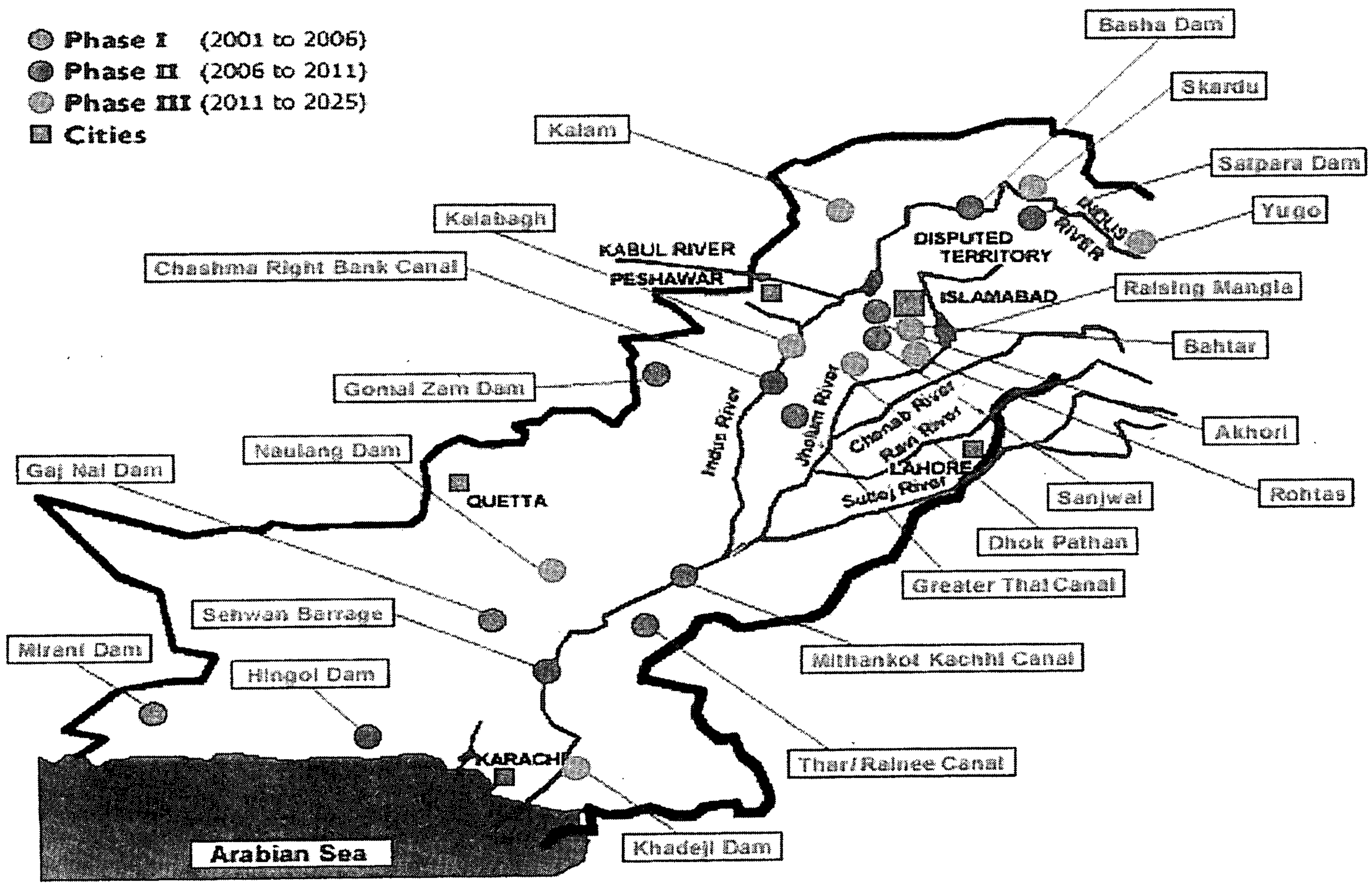
Table 1: Potential Storge Sites Presently Being Considered

Status:

OG	Construction started/likely to be stated shortly
FS	Feasibility Study ready
DD,TD	Detailed design and Tender Documents ready
PF	Pre-feasibility study ready. FS, DD& TD to be prepared
C	Concept exists, PF, FS, DD & TD to be prepared
TBD	To be determined
Costs	for most dams the costs are from the WAPDA Visions 2025 For Munda and Sewhan, costs were determined in this Study.

PAKISTAN WATER AND POWER DEVELOPMENT AUTHORITY
VISION 2025

Location Map of Water Sector Projects



Proposed Strategy for Water Resources: Population growth is the single most important driving force affecting the water sector, with the increasing demands, which it will place on irrigated agriculture production and non-agricultural water services. Pakistan's current population of 141 million people will grow to 221 million by 2025, with the resultant increased demands for water food and power.

Pakistan is now at the limit of its water resources. The long-term sustainable average annual surface water inflow is 144 MAF and there is limited potential for increasing the resources. There will be increasing competition among the various water sub-sectors as demands for non-agricultural uses increase and demands agricultural production increase. The main objective for the water resources sector is to provide sufficient water to meet the needs of the various sub sectors through several interventions, which include.

i). Water for the future will come from a combination of conservation and storage. Conservation will mainly come from the agriculture/irrigation sector through various interventions.

ii). Additional storage of 15 MAF is needed. The primary constraint in developing additional storage is the current lack of consensus between the provinces on the acceptability of such projects and the lack of national level commitment.

iii). A planning body must be instituted, which assesses overall water resources and has the authority to overcome the lack of cooperation between the provinces.

iv). A full Storage Master Plan should be undertaken with the objective of determining the best storage and, water management options. Included in this must be the assessment of the actual environmental water needs downstream of Kotri.

v). Implement a Public Awareness Programme to inform the public about the water resources isues and their responsibilities in conservation and other concerns.

vi). Develop a Management Information System (MIS) for all water information at athe national level, carried out in cooperation with the provinces and federally administered areas.

vii). Develop and implements a comprehensive Water Quality Improvement Programme to improve both surface water and groundwater quality.

Urban Water Supply and Sanitation

Water Supply: Public water supply in Pakistan represent a small component of total water use, currently estimated at around 3.16 MAF (3.9 BCM) per annum of 3% of total water use. Its relative importance to the population is, however recognized in current policies and plans and its need for priority acknowledged. For the urban sector alone, the estimate is 2.76 MAF (3.4 BCM) per annum.

In terms of proportion of the population with access to piped water supplies in cities, the estimate is 55% to 90% for the large cities with a weighted average around 71%. For smaller towns the average is nearer 50%. The overall average urban coverage for piped water supply is around 60%.

The reported quality of water entering the distribution systems is generally satisfactory. Conventional treatment is provided where the raw water comes from surface sources or where ground water quality is poor. Water quality deteriorates within the distributed system as a result of depressurization of the main. Under these conditions, chlorination cannot be effective in preventing bacterial contamination.

Sanitation: Present coverage of access to sewer connections for Karachi, Lahore and Faisalabad averages 56%. For the remainder of the urban population, the coverage is between 40% to 45%. Access to piped sewerage by the whole urban population may, therefore, be in the range 45-50.

The present total sewage treatment capacity is estimated at 339 Ml/d which represents less than 1% of total domestic sewage generated in urban areas. Some of this capacity is unused due to lack of sewerage infrastructure. Most of the sewage treatment plants in Pakistan are not in working order.

RIVER MANAGEMENT:

Incidence of Flooding: Rivers forming Indus basin in Pakistan has had a long history or repeated localized and widespread flooding that has caused loss of life, substantial damage to property and infrastructure and loss of agricultural crops and lands. Despite the construction of reservoirs and major investments in flood protection, there is still a considerable flood hazard. The barrages that occupy a key place in the irrigation economy are at risk when exposed to large floods, as some of the barrages do not have adequate capacity for the passage of major discharges. Also, there are some old structures such as bridges, which cannot pass high magnitude floods, thus raising the flood levels upstream and exacerbating damage. These constraints sometimes require breaching of flood protection bunds that cause flooding in downstream areas.

Much of Pakistan is a flood prone region, with steep upper catchments and the potential for high intensity rainfall. The flood problem has been exacerbated by the progressive denudation of river catchments and the general deterioration of river channels from significantly reduced flows during non-flood seasons because of increased diversion from the rivers. Major floods have occurred in 1950, 1956, 1957, 1973, 1976, 1978, 1988, 1992 and 1995. In 2001, though the country was passing a severe drought cycle, local flooding in the Leh Nullah caused extensive damage to life and properly in Rawalpindi. It is estimated that between 1995 and 2001 direct losses from floods have been of the order of US $ 10 billion and over 6,000 lives were lost.

Despite the construction of reservoirs and major investments in flood protection, there is still a considerable flood hazard. The capacities of the dams that attenuate flooding and regulate river flows are being reduced by situation. Uncompleted or poorly planned and constructed flood protection works are at risk, as well as the lands they are intended to serve.

Flooding mainly impacts on three areas of the country:

- The main riverine areas, adjacent to the Indus and its tributaries (the Jhelum, Chenab, Ravi, Sutlej, and Kabul), where annual floods are used for irrigation purposes and which are heavily populated and suffer catastrophic damage due to high intensity floods.;
- High torrent affected areas where intense local rainfall on steep, largely denuded mountainsides can cause major flash floods. Such floods cause immense damage

communications and urban infrastructures. Large and sudden deposits of sediment from hill torrents near the confluence with main river, adversely affecting flooding and erosion conditions.;

- Areas of poor drainage where water ponds in agricultural and urban areas as a result of heavy summer (monsoon) rainfall.

Flood Protection Works

Flood protection works in Pakistan usually take the form of:

- River training works and flood protection works for barrages and bridges that usually take the form of guide bunds and spurs;
- Breaching bunds which are utilized when the flood peak exceed the capacity of barrages;
- Bunds usually with spurs to constrain the river and prevent overall onto adjacent lands; and,
- Revetments on riverbanks to protect towns and villages.

The flood problem and the strategy for flood protection vary across Pakistan. Flood protection embankments are constructed where there is a problem of flooding, whereas spurs are constructed to arrest the problem of land erosion. The existing flood management facilities in Pakistan include about 3700 miles (5920 Km) length of embankment and nearly 800 spurs.

Flood Protection Plans and Projects

i) assess the flood problem;

ii) prepare an integrated and suitably phased flood control plan comprising short and long term measures; and

iii) recommend arrangements for efficient maintenance of flood control and protection works.

The Food Commission prepared a plan for flood protection in 1970. This central Commission was later replaced by two provincial commission; i) Punjab Province Flood Commission; and ii) Indus River Commission in Sind. Following the devastation during heavy floods in 1973 and 1976 the Federal Flood Commission (FFC) was constituted by the Government of Pakistan in 1976 with the main function of;

- preparing a National Flood Protection Plan for the country;
- approving flood protection schemes prepared by the provincial/federal agencies
- ensuring proper monitoring of flood works; and
- improving the performance of flood warning system.

A comprehensive National Flood Management Plan was prepared in 1978, which contained a phased implementation plan. Phase I under this Plan was implanted during the period 1978-88. During this period 350 flood protection schemes were implemented at a cost of Rs. 1.73 billion.

The Flood Management Plan was updated and the National Flood Protection Plan-II (NDPP-II) was implemented during the period 1988-98 where in 170 schemes were completed at a cost of Rs. 2.542 billion. During the same period several foreign funded projects. Both for flood damage restoration and flood protection, where also implemented which included:

- 1988 Flood/Rain Damage Restoration Project where 2065 schemes were completed at a cost of Rs. 2.3 billion including US$ 200 million provided by ADB.
- Flood Protection Sector Project-I (FPSP-I) – 257 schemes were implemented at a cost of Rs. 4.86 billion including US $ 131 million provided by ADB.
- 1992-94 Flood/Rain Damages Restoration Project – 1980 schemes were completed at a cost of Rs. 6.67 billion including US $ 193 provided by IDA, EU, KFW and ADB.

Several facilities and services were procured under FPSP-I to improve the flood forecasting and warning capability. As a floow-up, FPSP-II is currently being implemented with the assistance of ADB in order to complete the remaining activities to strengthen the Flood Forecasting and Warning System, undertake left over sub-projects and develop certain new flood protectin schemes. The FPSPII has encountered major delay of about 55%. AS of end 2001, physical progress is 3% cumulative contracts awards 14%, and cumulative disbursement only one %. The Chief Executive of Pakistan constituted a Special Committee (namely the Flood Protection Committee) on 19 June 2001 to review the flood sector, and specifically FPSP-II. The review of FPSP-II was carried out over a four month period. The Committee completed its findings and recommendations in November 2001. The total cost of the project is proposed to be reduced from Rs. 8 billion to Rs. 4.342 billion for the reformulated Project which is designated as Phase I components of FPSP-II. The remaining sum of Rs. 3931.235 million is proposed as Unallocated Sum for Phase II of FPSP-II. After approval of the reformulation proposals by ADB the Project is likely to recommence.

FCC has also completed several feasibility studies through consultants to address the problem of flood damage caused by hill torrents in various parts of the country. The proposals from these studies are in the process of approval at the federal government level for arranging financing.

For each of the %-ages indicate whether stable, increasing or decreasing	Severe Impact	Moderate Impact	Slight impact	No impact
Area of rural floodplains in which flooding adversely affects people and/or agricultural activities.	20%	50%	20%	10%
Area of urbanized floodplains in which flooding adversely affects people, properly and/or industry.	15%	35%	30%	20%
Area of settled floodplains that has integrated structural and nonstructural flood mitigation				30%
Area of settled floodplains that has effective nonstructural flood mitigation				Negligible

PHILIPPINES

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Assistant Director
Bureau of Design, Department of
Public Works and Highways

REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BUREAU OF DESIGN

COUNTRY REPORT

Water Resources and River Management for Sustainable Development

OCTOBER 2002

Sofia T. Santiago
OIC, Director III
Bureau of Design

PART I : GENERAL SITUATION

1.1 Geographical and Meteorological Characteristics

1.1.1 Geography

The Philippines is an archipelago composed of about 7,100 islands and islets with an aggregate area of approximately 300,000 km2. It is bounded by the South China Sea on the west, by the Pacific Ocean on the east, by the Sulu and Celebes Sea on the South and by the Balintang Channel on the north. The country is divided into three major island groups, namely: Luzon, the largest, with an area of 141,000 km2, Mindanao, the southernmost major island, with 102,000 km2 and Visayas with 57,000 km2. The entire island group is closely scattered within the tropical belt and southeast of Asian mainland.

1.1.2 Topography

The topographical features of the country varies from the low marsh, which is about one foot above high water at the head of Manila Bay in the Luzon island to 2,954m above mean sea level, the height of the country's highest peak, Mt. Apo in the Mindanao island. The largest mountain areas and the most extensive plains are founding in the island of Luzon. The country has few inland lakes but many semi-enclosed bays. There are four large marshes – two in Luzon and two in Mindanao.

1.1.3 Geology

The following variety of rocks exist in the country: igneous, sedimentary and metamorphic. Basement complex is generally made up of gabbro, andesites, agglomerates, serpentine, greisses, schist, volcanic breccias, volcanic tuff, quartzite and basalt flows.

On the other hand, Philippine soils have considerable depth even on relatively steep slopes due to rapid chemical weathering and slow physical weathering of rocks. Hence, organic matter in the country is very small. Plant material in the tropical forest is about 2 to 3 times that in the temperate forest, but because of rapid chemical decomposition, very little humus is found. Carbon dioxide and organic acids provided by this plant material through attack the rocks, causing its rapid chemical weathering.

1.1.4 Climate

The Philippines is located in the tropics and the climate prevailing in any particular place in the country is influenced by its geographical position and wind system prevalent in different locations at certain times of the year. The classification of climatic conditions is based more on the type of rainfall than on slight differences in temperature. Four types of climate are adopted and are categorized as dry season and wet season induced by minimum or maximum rain period, as indicated below:

i) Type I : Two pronounced seasons, dry from November to April, wet during the rest of the year

ii) Type II : No dry season with a very pronounced maximum rainfall period from November to January

iii) Type III : Seasons are not very pronounced with relatively dry season from November to April and wet season during the rest of the year

iv) Type IV : Rainfall more or less distributed throughout the year

Figure 1.1.4 shows the distribution of climate regions in the Philippines.

Rainfall intensities range from very light to heavy and may occur as continuous, intermittent, or showery. Precipitation is influenced by prevailing air streams or monsoons, tropical typhoons, the Inter-tropical Convergence Zone, topography, fronts, easterly waves, and local thunderstorms.

The country has a wide range of precipitation with the highest intensity of 9,006mm recorded in 1910 in Baguio City and lowest of 94mm in Ilocos Sur in 1948, both places in Luzon. The average yearly precipitation is 2,360mm over the numerous rain gauging stations in the islands.

1.1.5 Typhoons

The Philippines is located along the path of tropical cyclones generated in the Pacific Ocean. About twenty (20) tropical cyclones a year originates from this area out of which nine (9) affect the country. From 1948 to 1999, the Philippines experienced a total of five hundred thirty seven (537) tropical cyclone passages. The graphical distribution of these passages is shown in Figure 1.1.5.

1.2 Population and Land Use

1.2.1 Population

The Philippines has a total population as of 76.5 million, that corresponds to a population density of 228 persons/km^2. Out of the total, about 13% lives in the Metropolitan Manila Area (15,690 persons/km^2), the political and economic/trade center of the country. Population growth peaked in 1970 at 3.08%/year but decreased through the years recording 2.32%/year in 1990-1995.

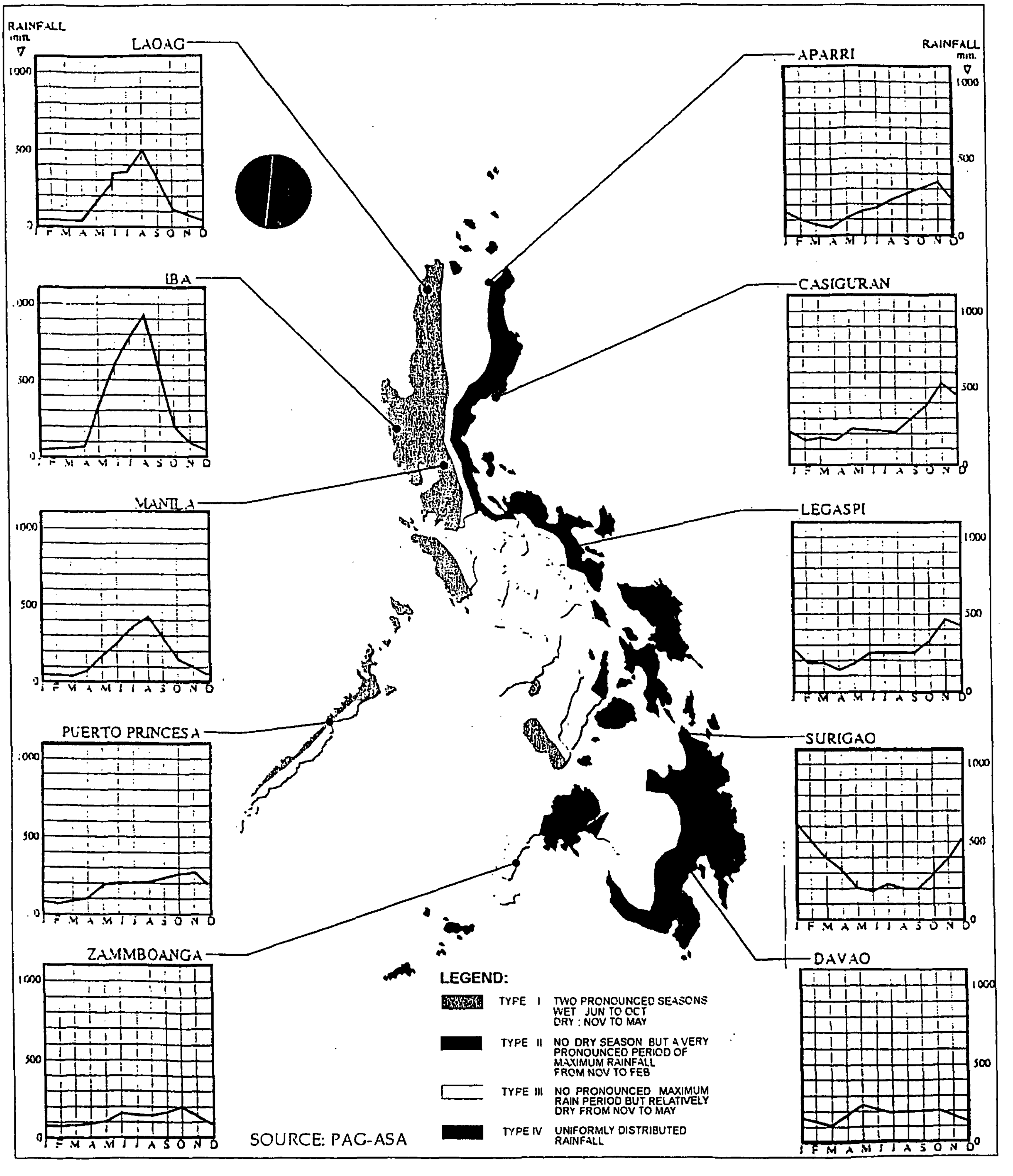


Figure 1.1.4

Climate Regions of the Philippines

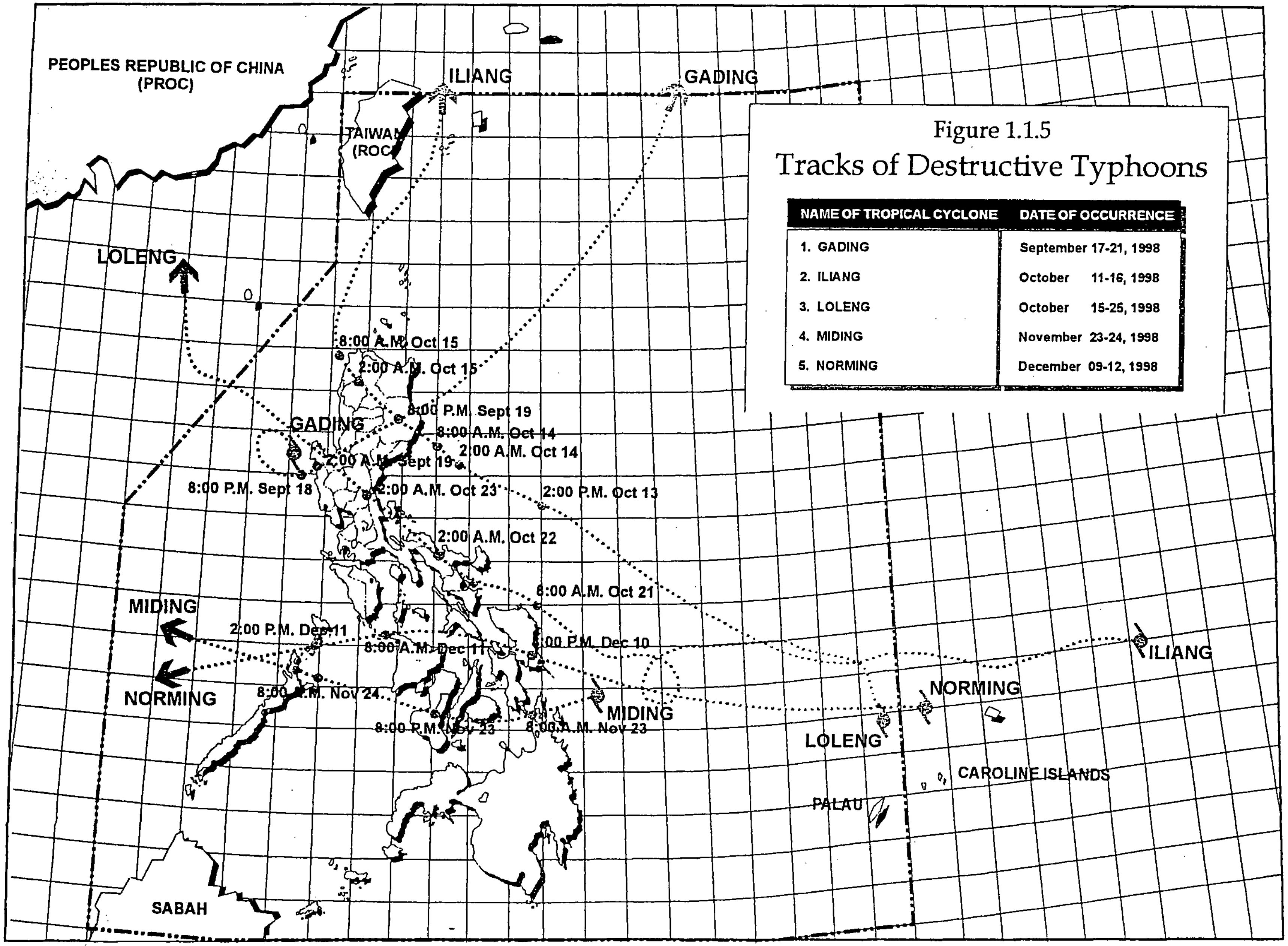


Figure 1.1.5
Tracks of Destructive Typhoons

NAME OF TROPICAL CYCLONE	DATE OF OCCURRENCE
1. GADING	September 17-21, 1998
2. ILIANG	October 11-16, 1998
3. LOLENG	October 15-25, 1998
4. MIDING	November 23-24, 1998
5. NORMING	December 09-12, 1998

Table 1.2.1
Population and Density by Region, as of 2000

Region	Population (thousands)	Density (person/km^2)
NCR (National Capital Region)	9,932	15,690.00
CAR	1,365	70.56
Region 1	4,200	333.40
Region 2	2,813	90.28
Region 3	8,030	438.00
Region 4	11,794	239.70
Region 5	4,674	258.00
Region 6	6,208	303.72
Region 7	5,701	363.16
Region 8	3,610	155.33
Region 9	2,831	167.44
Region 10	3,505	174.86
Region 11	3,676	173.10
Region 12	3,222	143.36
Region 13	2,095	98.46
ARMM	2,803	116.90
Total	**74,498**	**228.00**

1.2.2 Land Use

The Philippines has a territory of 300,000 km^2, classified into forest land of 158,883 km^2 and alienable/disposable land of 141,117 km^2 as of December 1995. The alienable/disposable land covers the urban area, the industrial areas and all other alienable and disposable land, while the forest land includes residential area of 32, 729 km^2 (23.1%), timberland of 101,159 km^2 (71.7%), national parks of 13,411 km^2 (9.4%), military & naval reservation of 1,303 km^2 (0.9%), civil reservation of 1,660 km^2 (1.2%) and fishpond of 756 km^2 (0.5%). Land Classification by region is shown in Table 1.2.2.

Table 1.2.2
Land Classification by Region, as of 2000

(Unit: Km^2)

Region	Total Land	Alienable and Disposable Land	Forest Land
NCR	636	482	154
CAR	18,293	3,407	14,887
Region 1	12,840	8,101	4,740
Region 2	26,838	9,601	17,237
Region 3	18,231	10,519	7,712
Region 4	46,924	21,613	25,312
Region 5	17,632	12,221	5,412
Region 6	20,223	14,088	6,135
Region 7	14,951	9,592	5,359
Region 8	21,432	10,237	11,195
Region 9	15,997	7,623	8,375
Region 10	28,328	10,669	17,658
Region 11	31,693	12,124	19,568
Region 12	14,373	5,468	8,904
ARMM	11,608	5,428	6,180
Total	**300,000**	**141,172**	**158,828**

PART 2: RIVERS IN THE PHILIPPINES

2.1 Principal / Major River Basins

There are 421 principal river basins in the country with drainage areas ranging from 41 km^2 to 25,649 km^2. About 60% of these river basins have drainage areas ranging from 100 km^2 to 500 km^2, as listed below.

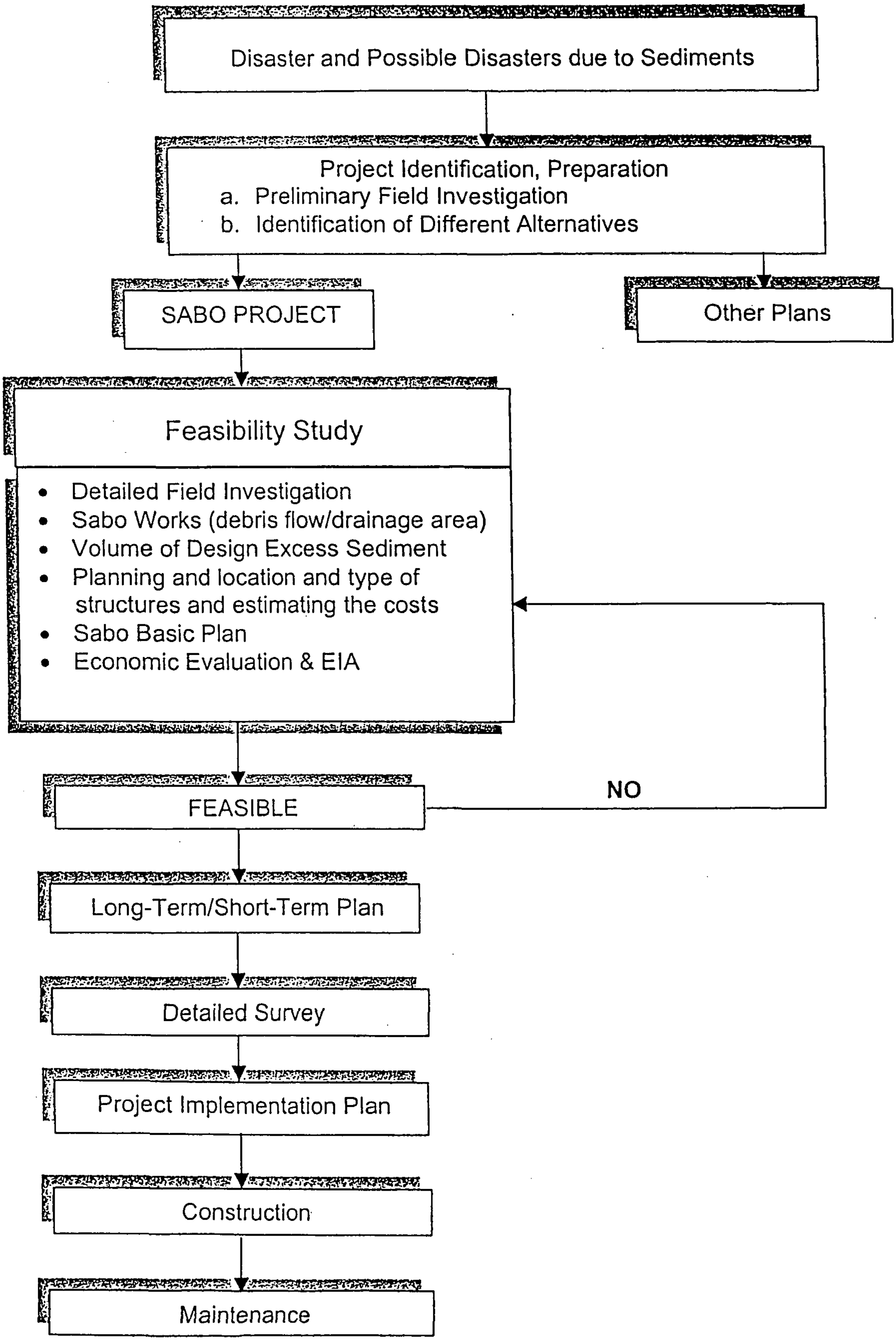
Drainage Area (km^2)	Number of River Basins
50-100	51
101-200	113
201-500	155
501-1,000	63
1,001-2,000	22
2,001-5,000	9
5,001-10,000	5
>10,000	3

Of the 421 principal river basins, 20 are considered major rivers with catchment areas of more than 1,000 km^2. The largest river basin in the country is the Cagayan River basin with a catchment area of 25,649 km^2 located in the Cagayan Valley Region. Figure 2.1 shows the major rivers while Table 2.1 below lists the major rivers and catchment areas.

Table 2.1
Major River Basins

No.	River System	Region	Catchment Area (km^2)	River Length (km)
1	Cagayan	Cagayan Valley	25,649	505
2	Mindanao	Southern Mindanao	23,169	373
3	Agusan	CARAGA	10,921	350
4	Pampanga	Central Luzon	9,759	260
5	Agno	Central Luzon	5,952	206
6	Abra	Ilocos	5,125	178
7	Pasig-Marikina-Laguna de Bay	NCR, Southern Tagalog	4,678	78
8	Bicol	Bicol	3,771	136
9	Abulug	Cagayan Valley	3,372	175
10	Tagum-Libuganon	Southeastern Mindanao	3,064	89
11	Ilog-Hilabangan	Western Visayas	1,945	124
12	Panay	Western Visayas	1,843	132
13	Tagoloan	Northern Mindanao	1,704	106
14	Agus	Southern Mindanao	1,645	36
15	Davao	Southeastern Mindanao	1,623	150
16	Cagayan de Oro	Northern Mindanao	1,521	90
17	Jalaur	Western Visayas	1,503	123
18	Buayan-Malungun	Southeastern Mindanao	1,434	60
19	Laoag	Ilocos	1,353	73
20	Amnay-Patrick	Southern Tagalog	993	58

PROCEDURE ON SABO WORKS



DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS

MAJOR RIVER BASINS IN THE PHILIPPINES

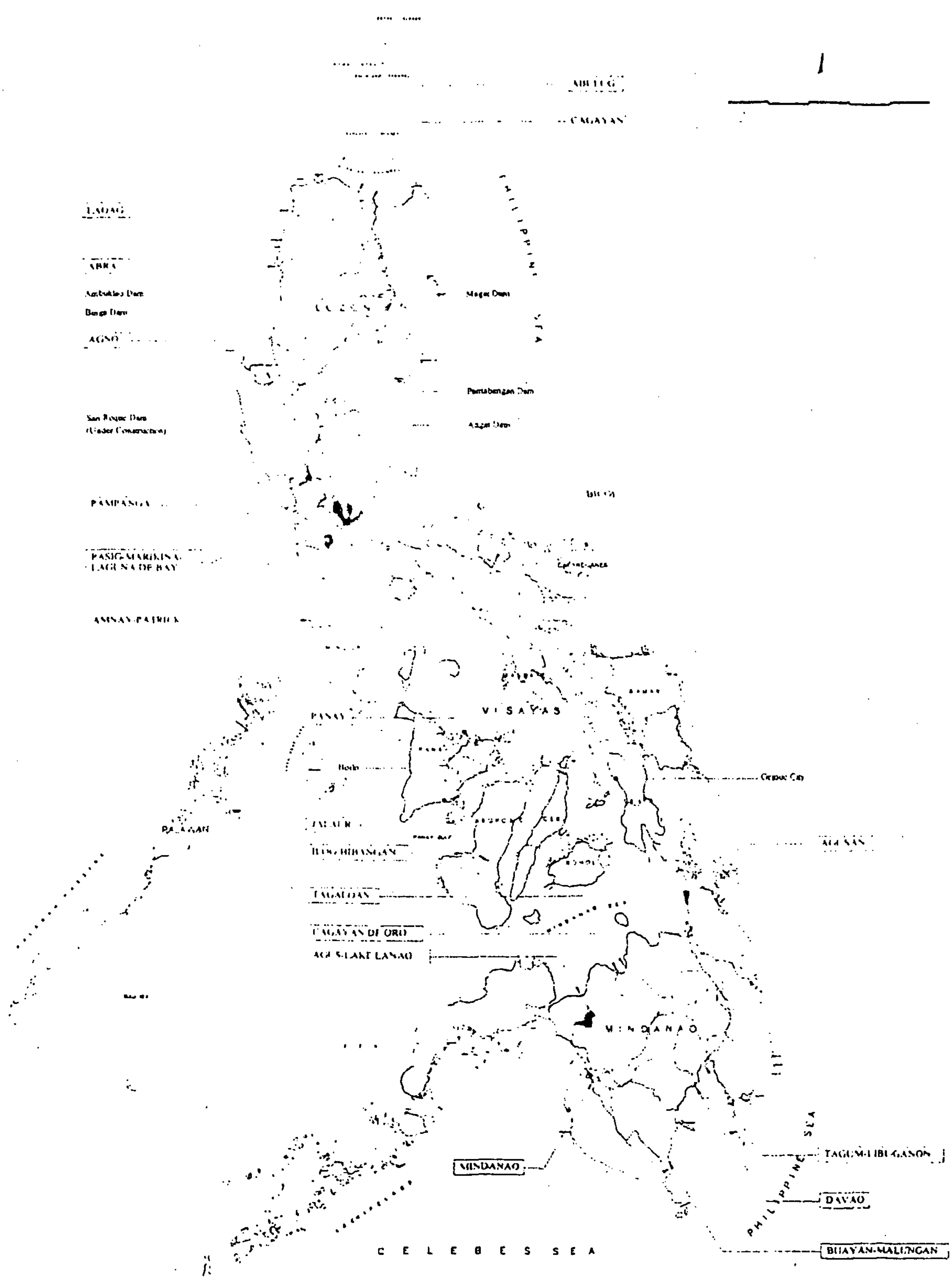


Figure 2.1

PMO - Major Flood Control Projects
PMO - Flood Control and Sabo Engineering Center

2.2 Conditions of River Systems

Rivers in the Philippines are characteristically short and steep. Most of the rivers flow directly from mountain headwaters to the sea. The aforementioned major river basins, however, have river delta ranging from 50 kms. to 280 kms.

In comparison with rivers in other parts of the world, most of major Philippines rivers are short and steep with channel gradients ranging from 0.40% - 0.70%. However, the two largest Philippines rivers, i.e., Cagayan and Cotabato rivers, have channel gradients of 0.08% and 0.13%, respectively.

Cagayan River which is the largest, has relatively gentle slope with a length of approximately 475 km and elevation of about 4000 m. It traverses the entire length of the Cagayan Valley flowing in a northerly direction from its headwaters in Quirino Province to its mouth in the Babuyan Channel.

Mindanao River is the second largest, having an approximate length of 405 km and headwater elevation of 550 m located in Bukidnon. At the convergence point of major tributaries of the river about 200 km from the river mouth, the Liguasan Marsh is formed by overflowing. The marsh covers an area of approximately 280,000 hectares cutting across the tree provinces in North Cotabato, Sultan Kudarat and Maguindanao.

Common to all major river systems in the Philippines is the inadequacy of the existing river channel carrying capacity which generally corresponds to only about 2.0 yr. probable flood.

2.3 Problems and Issues

2.3.1 Flood Disaster

The Philippines due to its geographical location is one of the most disaster-prone countries in the world. It lies along the path of about 20 tropical cyclones a year, about 9 of which directly affect the mainland and cause enormous damage to lives and properties. These cyclones are often accompanied with destructive wind forces that cause storm surges and heavy rainfall which result in inundation in river basins and low-lying areas.

Total cumulative damage for the last 20 years had reached approximately ₱124 Billion and has caused loss of lives of 27,000 casualties. Damaged to houses affects as average of 502,000 families annually.

Damages caused by typhoons experienced in the Philippines from 1970-1999, including their dates of occurrences, areas affected and corresponding damages, are shown in Table 2.3.1 below.

Table 2.3.1
Damages of Destructive Typhoons
1970-1999

Year	Casualties			Population Affected		Houses Damaged		Value of Damages
	Dead	Missing	Injured	Families	Persons	Totally	Partially	(Million Peso)
1970	1,328	494	1,917	18,370	109,980	-	-	501
1971	89	110	72	-	-	-	-	40
1972	298	5	33	-	-	-	-	178
1973	74	89	24	2,024	12,144	-	-	250
1974	153	89	118	97,085	444,330	1,441	4,589	365
1975	39	8	8	4,518	26,523	698	1,547	19
1976	313	185	37	504,510	2,744,379	3,917	4,912	725
1977	99	23	118	137,411	821,638	15,679	16,115	335
1978	663	395	834	520,405	2,853,104	68,376	94,147	1,575
1979	69	68	79	155,919	924,326	54,283	58,649	415
1980	143	29	55	306,895	1,666,498	16,510	47,573	1,465
1981	484	264	1,922	250,965	1,472,417	93,965	159,251	1,275
1982	337	223	347	266,476	1,569,022	84,042	97,485	1,659
1983	126	28	168	140,604	747,155	29,682	85,072	522
1984	1,979	732	4,426	741,510	4,048,805	310,646	313,391	5,869
1985	211	300	17	318,106	1,643,142	8,204	211,151	2,725
1986	171	43	151	287,140	1,414,188	7,106	36,357	1,777
1987	*1,020*	*213*	*1,455*	*668,628*	*3,882,534*	*242,336*	*345,370*	*4,083*
1988	429	195	468	1,173,994	6,081,566	134,344	355,459	8,676
1989	382	89	1,087	502,600	2,582,822	56,473	184,584	4,494
1990	670	262	1,392	1,265,652	6,661,474	223,525	636,742	12,678
1991	5,199	4,281	355	150,894	759,335	15,458	83,664	4,187
1992	117	95	53	352,944	1,755,811	3,314	8,006	5,071
1993	794	200	1,634	1,446,031	7,465,711	164,174	444,909	19,987
1994	242	48	247	617,228	3,056,232	58,567	223,358	6,381
1995	1,204	642	3,025	1,561,334	7,693,526	294,147	719,124	15,256
1996	124	50	90	260,581	1,255,289	2,690	17,559	2,834
1997	91	8	44	442,298	2,204,761	2,325	20,546	1,046
1998	498	106	873	1,590,905	7,197,953	137,020	406,438	17,822
1999	56	3	25	270,424	1,281,194	144	687	1,555
TOTAL	17,402	9,277	21,074	14,055,451	72,375,859	2,029,066	4,576,685	123,765
AVERAGE	580	309	702	501,980	2,584,852	78,041	176,026	4,126

Source : National Disaster Coordinating Council (NDCC)

• : Based on Current Prices

2.3.2 Key Problems in Philippine Rivers

2.3.2.1 Urban development within the confines of river waterway and flood plain.

- Restricts flood flows resulting in increased localized riverbed aggradation/degradation, localized bank erosion and damage to existing flood control facilities

- Loss of life and property from severe floods

- Restricts access to existing flood control facilities for maintenance works

- Delays new flood control project implementation

2.3.2.2 Deafforestation and resulting increased sediment runoff into river systems

- Increased sediment runoff into river systems result in localized bank erosion, localized riverbed aggradation and degradation and reduced storage capacity to water impounding structures

2.3.2.3 The Philippines is in a volcanic/earthquake region hence volcanic eruptions and earthquakes impacts on river systems

- Volcanic eruption (Mt. Pinatubo-1991) resulting in substantial effusion of lahar into river systems leading to significantly increased riverbed aggradation and damage to existing facilities such as bridges, dikes, etc.

- Earthquake damage to existing facilities is always significant like the Luzon 1990 earthquake – magnitude 7.8

2.3.2.4 Compared to other infrastructure sectors like roads, bridges, flood control sector is in a lower priority which results to less allocation than necessary, hence, staged implementation

2.3.2.5 Reliance on ODA/Foreign Assistance. Like other developing countries, the Philippines relies on ODA / Foreign assistance for major flood control projects

PART 3: RIVER IMPROVEMENT ACTIVITIES

3.1 Development Policies

The Department of Public Works and Highways (DPWH) is the government agency responsible for the planning, design, construction and maintenance of flood control projects in all major river basins. It has developed policies and strategies which addresses issues, structural and non-structural, related to river improvement works as follows:

a) Mitigate flooding to tolerable levels in Metro Manila and major river basins with the additional construction/installation of flood control facilities such as dikes, river walls, levees, cut-off channels, diversion floodways, revetments and installation of pumping stations, dredging and related works.

b) Provide adequate flood control and facilities in all flood prone areas that need protection as determined under the national land use plan.

c) Coordinate the development of flood control projects with the implementation of irrigation projects.

d) Pursue comprehensive planning of major river basins and implementation of flood control structures on identified flood prone areas including proper river management.

e) Pursue the installation of flood forecasting and warning system in all river basins.

f) Relocate squatters living along the banks of rivers/esteros/creeks in coordination with other concerned government agencies.

g) Pursue maintenance of facilities against lahar and dredging/desilting activities to increase flood conveyance capacities of river channels.

h) Put up viable and effective garbage collection and disposal systems for areas near rivers/esteros/waterways used for drainage.

i) Pursue proper maintenance and up-keep of existing drainage system through the concerted efforts by the national government and LGUs.

j) Organize flood reaction teams and Bantay Estero/Ilog brigades among LGUs in coordination with the tri-media.

k) Put-up an effective flood monitoring system.

l) Establish the Flood Control and Sabo Center to conduct applied research and development and human resource development.

3.2 Flood Control Projects in Major River Basins and Urban Centers

In line with the foregoing policies, the DPWH is currently implementing major river improvement works listed in Table 3.2. Due, however, to fund limitations, the DPWH is able to implement only a few of its major flood control works with emphasis on major river basins having completed the Master Plan/Feasibility Study status, with assistance from foreign lending institution notably from the Japan Bank for International Corporation and the Japan International Cooperation Agency.

Table 3.2
FEATURES AND FLOOD CONTROL PROGRAMS OF MAJOR RIVER BASINS
As of May 2002

GENERAL INFORMATION							COMPLETED / ON-GOING PROGRAMS									FUTURE PROGRAMS		
					RIVER DESCRIPTION		STUDY					IMPLEMENTATION						
Code No.	Name of River Basin	Region	Province	Catch. A. (sq. km.)	Section	Feature	Agency	Year	Type	Title/Scope	Status	Agency	Year	Project Description	Status	Study/ Agency	Implementation Phase/Package	Priority
1	Laoag	I	Ilocos Norte	1,353		Sedimentation Problem	JICA	1996-97	MP/FS	Sabo/Flood Control	Completed	JBIC	2001	Sabo Dams River Improvement	On-going	D/D OECF	24-YL	A
2	Abra	I CAR	Abra	5,125		Sedimentation Problem												C
3	Cagayan	II	Cagayan Isabela Quirino Nueva Vizcaya	25,649	Whole	Largest River	JICA	1985-87	M / P	Water Res. Dev.	Completed							-
					Lower	Flooding Due to Narrow Sections	JICA	2000-02	F / S	Flood Control	On-going					D/D OECF	27-YL	A
					Upper											FS/DD		B
4	Abulug	II CAR	Cagayan Apayao	3,372														C
5	Agno	CAR I II	Benguet Pangasinan Tarlac	5,952	Whole	Flooding/Sedim.	JICA	1988-91	F / S	Flood Control	Completed							-
					Lower				D / D			OECF	1995	PH-I	On-going			-
					Middle	Poponto Swamp			D / D			OECF	1998	PH-2A	On-going		PH-2B / 24-YL	A
					Upper												PH-3 / 26-YL	A
					Lower-Sinocalan											FS/DD JICA		A
					Tarlac River	Lahar										PH-2B	PH-3	A
6	Pampanga	III	N. Vizcaya Pampanga Bulacan	9,759	Delta	Delta-Development w/ Opposition	JICA	1979-82	M / P	Flood Control	Completed	16-YL	1990	PH-I	Completed		PH-2 / 26-YL	A
							13-YL	1986-89	D / D	Flood Control	Completed							
					Upper											MP / FS		B
7	Pasig-Marikina Laguna Lake	NCR IV-A	Metro Manila Rizal Laguna	4,678	Metro Manila	Pumping Stations						1-YL	1973-83	10 Pumping Sta.	Completed		Rehabilitation	B
												12-YL	1984-87	2 Pumping Sta.	Completed			
												14-YL	1988-98	3 Pumping Sta.	Completed			
						Mangahan FW						4-YL	1975-88	Floodway	Completed			-
						EFCOS						11-YL	1983-93	FC Operation	Completed			-
												GOJ/GA	2000-	Rehabilitation	On-going			A
						West of Mangahan Floodway	JICA	1987-90	F/S	Flood Control	Completed	21-YL	1996	North Laguna Flood Control	On-going			-
							16-YL	1990-96	D/D	Flood Control	Completed							
						KAMANAVA	JICA	1987-90	F/S	Flood Control	Completed	SYL	2000	Flood Control	On-going		Special-YL	A
							DPWH	1998	Re-FS	Flood Control	Completed							
						Drainage Main/Laterals						GOJ/GA	1989	Retrieval	Completed			-
												GOJ/GA	1992	Retrieval 2	Completed			-
						Esteros	JICA	2000	Pre-FS	Flood Control	Completed					F/S		A
					Pasig-Marikina River	Channel Improvement	JICA	1987-90	F/S	Flood Control	Completed						25-YL	A
							SAPROF	1997-98	F/S	Flood Control	Completed							
							23-YL	1999	D/D	Channel Improv.	On-going							
					Pasig River	Dredging						Belgium	2000-	Dredging	On-going			-
					San Juan R.	Dredging						GOP	2000-	Dredging	On-going			-

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As of May 2002

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8	Amnay-Patrick	IV-B	Occidental Mindoro	1,353		Sedimentation & Flooding	7-YL	1996-97	MP/FS	NFCPRDP	Completed						FCSEC - Pilot Area for FC/Sabo	A
							DPWH	1984	Pre-FS	Multi-purpose	Completed							
9	Bicol	V	Camarines Sur Albay	3,771		Flooding in Urban Area	7-YL	1978-82	M/P	NFCPRDP	Completed							B
							BRBDP	1983	F/S	Flood Control Component	Completed	DPWH	1973-91	Cut-off/Diversion Channels	Completed			
							BRBDP (ADB)	1992	D/D	& Irrigation Flood Control	Completed							
10	Panay	VI	Capiz, Iloilo	1,843		Flooding	7-YL	1978-82	M/P	NFCPRDP	Completed					FS		B
11	Jalaur	VI	Iloilo, Antique Capiz	1,503			7-YL	1978-82	M/P	NFCPRDP	Completed							C
12	Ilog-Hilabangan		Negros Occidental Negros Oriental	1,945		Flooding at Lower Reaches	7-YL	1978-82	M/P	NFCPRDP	Completed							B
							JICA	1989-91	M/P	Flood Control								
13	Agusan	CARAGA	Agusan del Norte Agusan del Sur Surigao del Sur Surigao del Norte	10,921	Lower	Flooding in Urban Area	7-YL	1978-82	M/P	NFCPRDP	Completed							-
							10-YL	1982-85	D/D	Flood control	Completed	14-YL	88-99	PH-1, West Bank	Completed			-
												21-YL	1996	PH-2, East Bank	On-going			-
					Whole	Bunawan Marsh	7-YL	1978-82	M/P	NFCPRDP	Completed					FS/JICA		A
14	Tagoloan	X	Misamis Oriental Bukidnon	1,704		Sedimentation & Flooding	7-YL	1978-82	M/P	NFCPRDP	Completed							C
15	Cagayan de Oro	X	Misamis Oriental Bukidnon	1,521		Flooding in Urban Area	LGU	1999	M/P	Flood Control & Env'l Improvt.								B
16	Tagum-Libuganon	XI	Davao	3,064		Flooding in Urban Area	NIA-DPWH		F/S	Flood Control & Irrigation	Completed	NIA		Diking-Left Bank	Completed			C
												DPWH		Diking-Right Bank	On-going			
17	Davao	XI	Davao	1,623		Flooding in Urban Area	Davao City	1998	M/P, F/S	Drainage	Completed							C
18	Buayan-Malingan	XI	South Cotabato Davao del Sur	1,434														C
19	Agus	XII	Lanao del Norte	1,645														C
20	Mindanao	XII ARMM	Maguindanao Sultan Kudarat South Cotabato North Cotabato Bukidnon	23,169	Whole	Constricted Sec. causes the flood at midstream Liguasan Marsh	7-YL	1978-82	M/P	MFCPRDP	Completed							-
							NEDA	1997	M/P	Liguasan M. Development	Completed							
							PHRD WB	1999-	M/P	Watershed Management	On-going							

Note: NFCPRDP - National Flood Control Project and River Dredging Program

Table 3.2
FEATURES AND FLOOD CONTROL PROGRAMS OF MAJOR RIVER BASINS
As of May 2002

GENERAL INFORMATION							COMPLETED / ON-GOING PROGRAMS									FUTURE PROGRAMS		
Code No.	Name of River Basin	Region	Province	Catch. A. (sq. km.)	RIVER DESCRIPTION		STUDY					IMPLEMENTATION				Study/ Agency	Implementation Phase/Package	Priority
					Section	Feature	Agency	Year	Type	Title/Scope	Status	Agency	Year	Project Description	Status			
1	Mt. Pinatubo	III	Zambales		Pasig-Potrero	Lahar	1976-78	M/P	MP/FS		Completed	T.S.-YL	1997-		On-going			-
			Pampanga		Sacobia-Bamban		1992-95	F/S			Completed	23-YL	2000-		On-going			
			Tarlac		West Side	Lahar										JICA-FS		A
2	Dalton Pass	II, III	Abra														FSEC Pilot Area	A
3	Mayon	V	Camarines Sur		Mt. Mayon	mudflow lavaflow	JICA	1978-81	M/P	Sabo-FC	Completed						25-YL	A
							JICA	1982-83	M/P	Updating	Completed							
							JICA	1998-00	F/S	Comp. Disas. Prevention	On-going							
4	Ormoc City FC Project	VII	Ormoc City	25.2	anilao River		JICA	1993-95	MP/FS	Flood Control	Completed	GOJ/GA	1998-	River Improvement slit dams, bridges	Completed			-
				11.1	Malbasag River													
5	Iloilo City FC Project	VI	Iloilo City	412	Jaro River	Flooding in Urban Area	JICA	1993-95	MP/FS	Flood Control	Completed	25-YL	2002	River Input Flood Control	On-going		25-YL	A
				106	Iloilo River		22-YL	1999-	D/D	Jaro FW	Completed							

3.3 Solutions implemented / to be implemented :

The following are being pursued to address the key problems identified, to wit :

- Urban development within confines of river waterway and flood plain (both LWC & HWC).

    - Establishment and strict enforcement of local Government zoning regulations

- Deafforestation and resulting increased sediment runoff into river system.

    - Strict enforcement of logging bans through appropriate regulatory agencies – DENR, Police, etc.

    - Implementation of tree planting programs in river watershed areas.

- Philippine is a Volcanic region and the associated impacts of eruptions on river system.

    - Difficult to prepare for in terms of river system due to the magnitude of the event.

    - Post eruption activities very important such as :

        * Dike heightening
        * River channel dredging
        * Sabo dam construction
        * Replacement of damaged infrastructure e.g. bridges

- Philippine is in an earthquake region and the impacts of earthquakes on existing flood control.

    - Ensuring earthquake resistant designs are prepared for new / or replacement river flood control facilities.

- Lower prioritization of flood control projects in the Philippines compared to projects in other sectors.

    - Upgrade priority level of flood control.

    - Enhance in-house capability of DPWH through training and transfer of technology.

Sri Lanka

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EXECUTIVES SEMINAR ON
PUBLIC WORKS MANAGEMENT
JAPAN

COUNTRY REPORT
SRI LANKA

MINISTRY OF HIGHWAYS

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WATER RESOURSES AND RIVER MANGEMENT FOR SUSTAINABLE DEVELOPMENT

BACKGROUND

Even through three forth of the earth surface is carried by water only as little as 2.5 % of this is pure and fresh. Much of the worlds water resources are in the form of icebergs in the arctics and other regions of extreme cold. As such, less than one per cent of the total volume of the water available is sustainable for human consumption.

A thousand cubic meters of water per year is the minimum need of each human. The UNDP says anything less is "are acute shortage of water". Already 20% of the population is without pure drinking water. Scarcity of portable water has been identified as one of the major areas, the world will face in the 21st century.

In the year 2025 according to scientists 66% of the world population would find it difficult to meet minimum water requirements. This situation will seriously affect the third world Countries like ours. In this situation several countries will have to face storage of good water as early as in 2005. Sri Lanka is one of them.

22nd of March was declared as World Water Day by the United Nations in 1990. Water for health is the theme for the future. Because average 30,000 children die daily of water related diseases. The Scarcity also affects agriculture. About 70% of the water available for human consumption is utilized for agriculture particularly in Asia and Africa.

PRESENT SITUATION

According to surveys carried in Sri Lanka it has been revealed that the proportion of households with access to safe drinking water is about 67% and that only about 35% has access to pipe born water. By 2005 Sri Lanka has planned to expand the water supply to 80% and achieve total coverage by 2010. The requirements of funds for this is around Rs. 85 billion. 50% of this have to be from alternative sources. In order to achieve the targets the management of available water resources is important. As an initial step institutional arrangement with private sector partnership has been planned for the future.

WATER QUALITY

Maintaining a appropriate balance between environmental quality and long term sustainable economic development has been recognized as the basic environment policy in the country. This requires the use of natural resources for the benefit of mankind with out disturbing the environmental balance with taking measures for the conservation of same. In line with this basic policy the Ministry of Environment and National Resources (MENR) the Central Environment Authority (CEA) and other relevant Government institution continued their activities in relation to environment conservation monitoring management of regulation in the water sector.

RIVERS IN SRI LANKA

Sri Lanka is an island surrounded by sea. The water received is only by rain received during the monsoon period from May to July and September to December annually. The rainfall provides more water to the wet zone than the dry zone see map. All the water collected part is used in precipitation. Run off from catchments of Forest, Agricultural and urban sector areas are collected by the Natural Drainage systems up to the canals. The canals in tern are connected with the major rivers which will collect such water and discharge to the sea. Due to the geographical situation high percentage of water is wasted with sediment transport to sea out of the Island. Collected water part is evaporated from the reservoirs. However it is to be noted that from ancient times Sri Lanka has a large network of man made and natural tanks, lakes reservoirs distributed within the Island.

The three major rivers starting from Samanala Kanda in Sabaragamuwa Province is a unique place where the Sri Pada of Lord Buddha has been placed. This Mahaweli, Kalani and Kalu Ganga. The two rivers flow though Sabaragamuwa, Western Province are Kalu and Kelani. These two rivers floods during the heavy monsoons. The Banks are Natural and the water is used for Bathing, Consumption and Industry. Certain section of the river are used for transport of people and goods. However the major use of the water is for drinking purposes. The National Water Supply and Drainage Board is operating and supply of safe drinking water from these two rivers. However sand mining has become a problem in these rivers causing damage to river banks and erosion of river bed. This has caused salinity in the domestic supply of water by the National Water Supply and Drainage Board.

The largest river is the Mahaweli which cover Sabaragamuwa Central, North Central and North East of Sri Lanka. This river is 331Km long. In 1970 this Government embanked upon a programme of the development of Mahaweli programme implemented to provide 671 Megawatts of power and 53500 Hectare agriculture lands. 175,000 families were resettled in theses areas A to H. This projects helped to control the water and reuse for obtaining power, Agriculture Industrial and Domestic purposes by constructing Series of Reservoirs.

The annual capacity of Mahaweli is 8.4 billion cum out of this it was planned to use 60%. The Project was executed by the Mahaweli Development Authority under the Ministry of Irrigation of Sri Lanka.

URBAN WATER SUPPLY

This mainly from rivers and reservoirs. Treated and supplied to households. The problems are encountered due to wastage in transmission, distribution due to poor infrastructure maintenance.

RURAL WATER SUPPLY

Tanks, wells, deep wells, miner water supply schemes are method of provision of water to rural poor. Covered wells are tested and provides goods quality water, but, deep wells does not provide a continuous supply due to poor maintenance. The supply of tanks are stagnant water naturally cleaned but, contaminated due to discharge of waste water and bathing and using by animals. However the water supply is in progress by NWDB with treatment supplied from such tanks. The rural supply water project has provided water for 182,392 by end of 1998 with their participation in providing labour. This project will be extended to cover other districts too.

SHORTAGE OF WATER

From several years now there is water shortage in several areas in Sri Lanka. Namely North Western and Southern, parts of Sri Lanka. Greater Colombo area daily need is around 13 million gallons. This service the grater Colombo area and a floating population of 400,000 per day with an uninterrupted supply for a period of 24 hours.

POPULATION

Water resources are diminishing due to population growth, environmental degradation and soil erosion. Another factor which has are effected on water resources is the lack of proper management in the disposal of household garbage.

WASTE

Waste disposing measures has also aggravated the problem of water storage. According to surveys the urban population, around 40-50% of the total supply of water to urban areas are wasted. In Germany and Singapore the wastage is 3-8%. In Sri Lanka the daily per capita Consumption should be 100-115litres but, it is in the region of 180-200 liters. In countries like South Africa per capita consumption is restricted to 45 liters.

FUTURE PLANS

With a view to keeping inland water bodies clean pilot projects called "Pavithra Ganga" project was launched to protect the Kalani river and Kaluganga. This was carried out with the assistance of public and local authorities. Under this project priority was given to tree planting, mitigating the effect of sand mining, controlling urban waste, controlling discharge of sewage and industrial effluent. Ministry of Environment and Natural Resources is coordinating matters with all other organizations

CONCLUSIONS

Water is abundant but, mankind has to manage it properly. River environment have to be protected to keep clean water flowing and strategies have to be developed to control flow and stock the water in reservoirs and tanks much as possible. The maintenance of the BOD values within the required limits and quality of water. Market Instruments have to be used in the management of water for agriculture and industrial sector. Soil Erosion Control methods have to be adapted and soil conservation and protection of river catchments is important in arresting the silting of river beds and reservoirs. In formulating projects the environmental aspects have to be adapted for sustainable development.

<u>SPECIFIC SUBJECT I</u>

RIVER ENVIRONMENT

Sri Lanka has 4 large rivers which start from Adamspeak and flow to the sea. Namely Kalani, Kalu, Mahaweli, Walawe. The map shows the rivers and their basins. The rivers provides the water necessary for the energy production and further the agriculture requirements. Most of the rivers are used for drinking water and supply of industrial water. During the monsoons the water discharged into the rivers and fill the reservoirs and tanks and the balance flows to the sea.

The environment of the rivers contains the river banks, flood retention areas reservations, and bunds. Most of the rivers with rime has changed their flow paths carrying deposits of clay. In rainy season the river water carries material in suspension, solution and bed load. The river water is not possible to be used by people during this period due to speed of flow and impurities.

<u>RIVER WATER</u>

The water in other times are used for Agricultural Industrial / Domestic purposes specially Mahaweli river produce the majority of the hydropower in Sri Lanka with its reservoirs Network. Domestic supply by treatment is supplied to most of the Colombo metropolitan and suburbs by using river water.

<u>RIVER BANKS</u>

Naturally made other than places used by people for domestic, and public purposes. The banks are naturally covered with vegetation. Changes occurs during flood times due to speed of flow and alignment. Banks are eroded and the other sides are silted during flood times. River Banks of Sri Lanka are damaged by transporting logs in rivers and disposing and collecting at banks of such materials. Speed boats which develop wave action also erodes unprotected river banks. This cause collapse of river banks causing change in cross section. The change in cross section causes change in river geometry and flow direction and speed. The natural Bamboo cover is protecting river banks during flood times.

FLOOD BUNDS / RETENTION AREAS

The rivers are protected by statute by the Irrigation Department and local authorities, but however it is observed in Government / Private properties mining clay is a business for industries like, Bricks Pottery, tiles ect. for the Construction Industry. There are sometime uncontrolled excavation where reclamation is not carried out after extraction. This has caused environmental hazards producing stagnant water pools etc.

However the Government has launched in urban areas clean environment programmes on rivers like "Pavithra Ganaga" in the past few year with the assistance of non governmental organization, environmental groups and public to protect the river environments.

However it is becoming evident that the river environment are becoming polluted in urban and industrial areas due to discharge of waste and polluted waste water to rivers without proper treatment. Action is taken by the Central Environmental Authority to arrest this situation.

SPECIFIC SUBJECT II

TRAFFIC MANAGEMENT AND SAFETY

BACKGROUND

The road densily of Sri Lanka is very high with a length of 100,000 Km of roads within a 60,000sqr.Km area. However only 11460 Km of these are National Highways which are all paved. 16,000 Km of minor roads belongs to the Provincial Councils and majority of these are feeder roads. All other roads are urban and rural access roads.

PRESENT SITUATION

The National Network carries traffic volumes from 250 to 65,000 vpd. Urban roads carry heavy traffic and are mostly congested at peak hours. However the rural areas the traffic is low and speeds up to 40 - 70 Km / hour can be maintained . The urban roads are mostly asphalt paved and supported with constructed drains and paved footwalks. In dry weather most of the roads condition deteriorate due to bad drainage. Lack of proper maintenance is the cause for the poor condition of roads. Recent Survey conducted by ADB has shown that the maintenance cost/Km used by Sri Lanka is low compared to India and other developed countries.

The traffic is mixed and contains a majority of slow moving vehicles. Traffic composition in developing countries are different to the situation in a developed country. The roads are narrow and needs widening to provide facility for increasing traffic and growing pedestrian volumes. However the widening of the existing roads are not possible due to ribbon development and protest by urban population for land acquisition. Due to this the changes are always compromised for public requests and political aspirations. Long term objectives are not taken to consideration. Therefore existing roads on the other hand are fully occupied by traffic and foot walks by venders and for other activities of people causing damage to road fittings and furniture and hardship to pedestrians. Provision for individual benefits on roads carrying greater risk on road users.

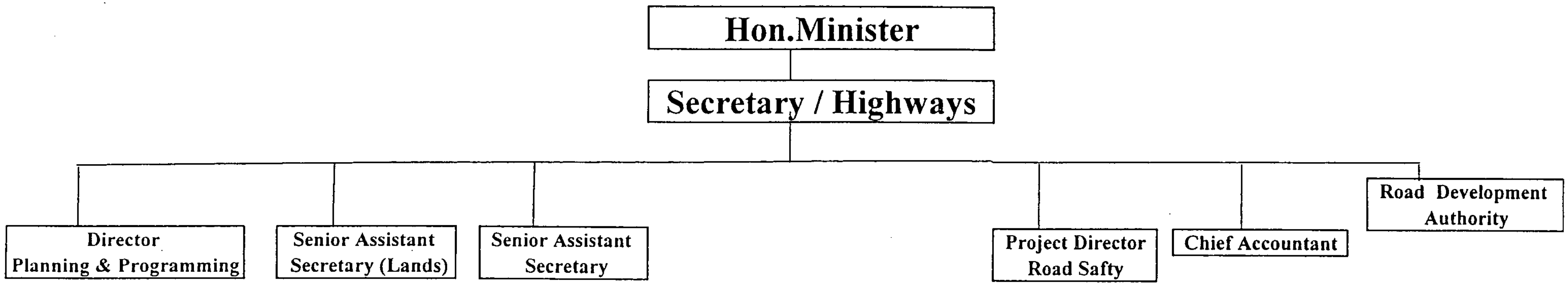
FUTURE

At present there is a programme for improving junctions, inter section and urban areas by widening of roads installing traffic signals, traffic signs and constructing of overpasses and underpasses. There is a programme to clear road reservations from unauthorized structures.

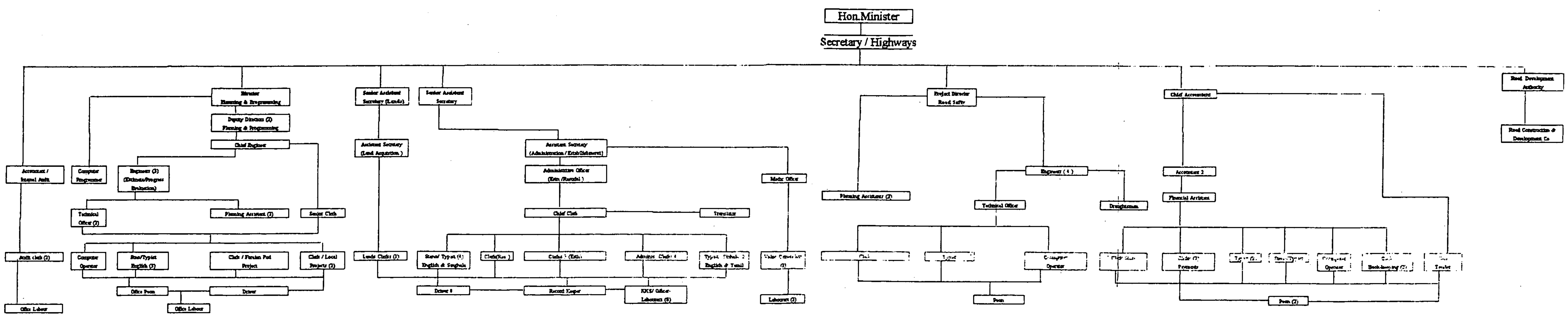
However we have to note that with present fuel price fluctuations and energy crisis, the non motorized traffic also making prominence on the roads and will be a cause of more concern in the future for road designers. The roads safety is becoming more important today than any other time. Accident rate are increasing. Drivers discipline and low enforcement is deteriorating.

The Ministry of Highways has proposed the Expressway Network to reduce congestion and increase mobility and reduce congestion on the other roads. This total Network of about 380 Kms of Expressway will help to improve the total Network condition and improve traffic management. The present safety programme embarked includes, blackspot improvement, driver training, vehicle licensing, vehicles inspection, emergency and rescue operations, safety auditing of roads, vehicles over lording checks, will span for a period of 05 years and will definitely produce an impact on road safety in Sri Lanka.

MINISTRY OF HIGHWAYS ORGANIZATION



<u>MINISTRY OF HIGHWAYS</u>
<u>ORGANIZATION</u>



MINISTRY OF HIGHWAYS ORGANIZATION

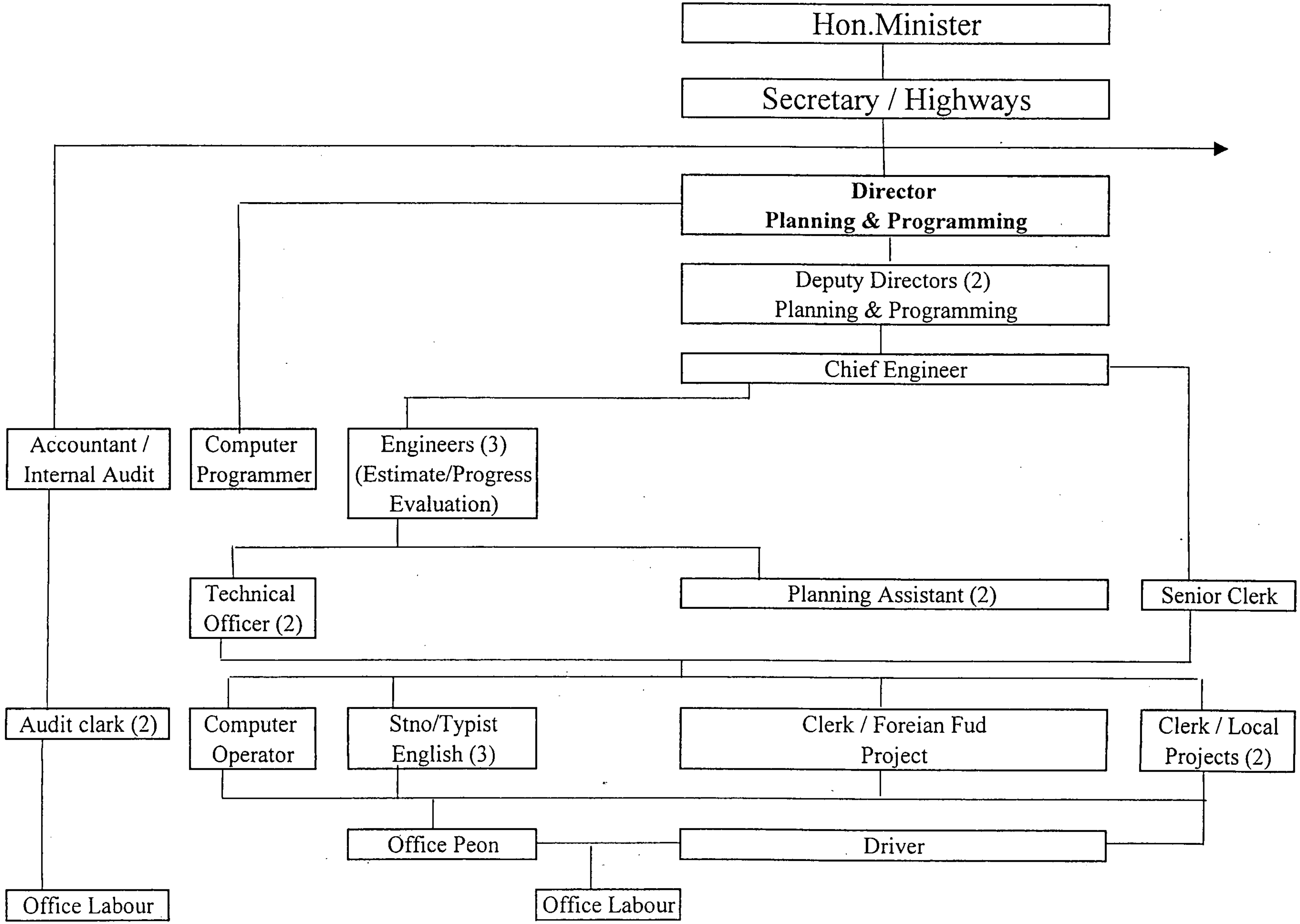


Table 4 : Water Supply Schemes ADB Project

District	No of Benificiaries	Allocation Rs. Mn
Kalutara	281,476.00	124.00
Hambantota	141,185.00	234.50
Kegalle	326,550.00	187.80
Moneragala	129,077.00	249.00
Puttlam	400,000.00	358.30
Anuradhapura	186,146.00	270.80
Total	**1,464,434.00**	**1424.40**

(Source : National Water Supply & Drainage Board)

Table 5 : Annual Expenditure on Water supply (%) (In addition to the projects)

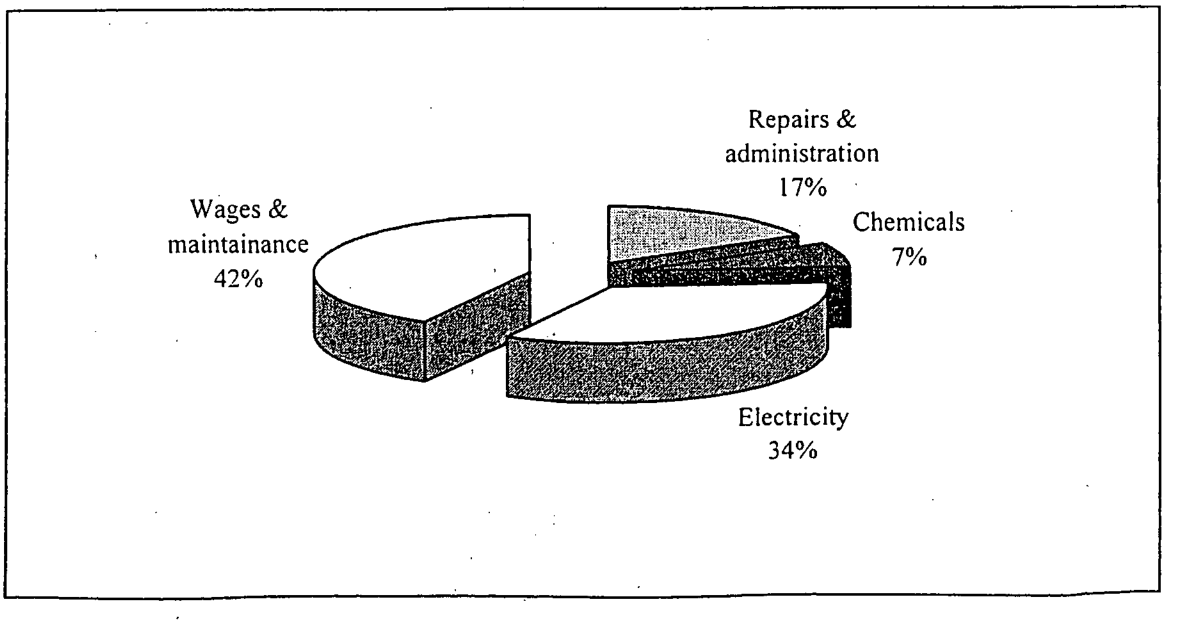


Table 2 : Urban Water Supply Schemes

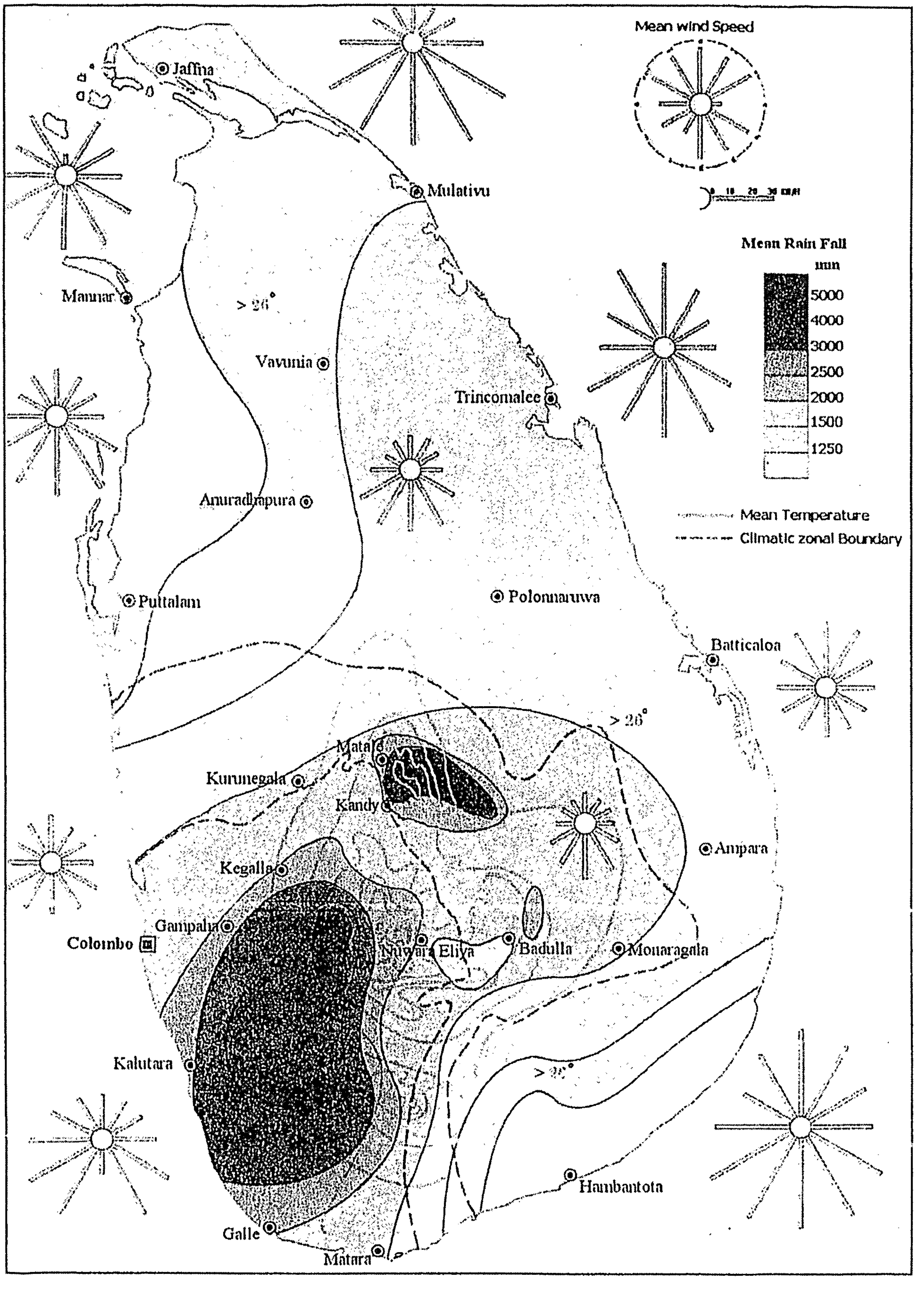
	No of Beneficiaries	Allocated funds for 1999 Rs. Mn
Colombo South	260,000	2,423
Avissawella	100,000.00	31
Hambantota - Muruthawela	16,000.00	120
Galle (Improvement)	40,000.00	130
Kundasale U.W.S.S	56,000.00	110
Ambalangoda (Improvement)	73,000.00	103
Anuradhapura	120,000.00	200

(Source : National Water Supply & Drainage Board)

Table 3 : Community Water Supply and Sanitary Projects Targets of next 6 years Under Phase II

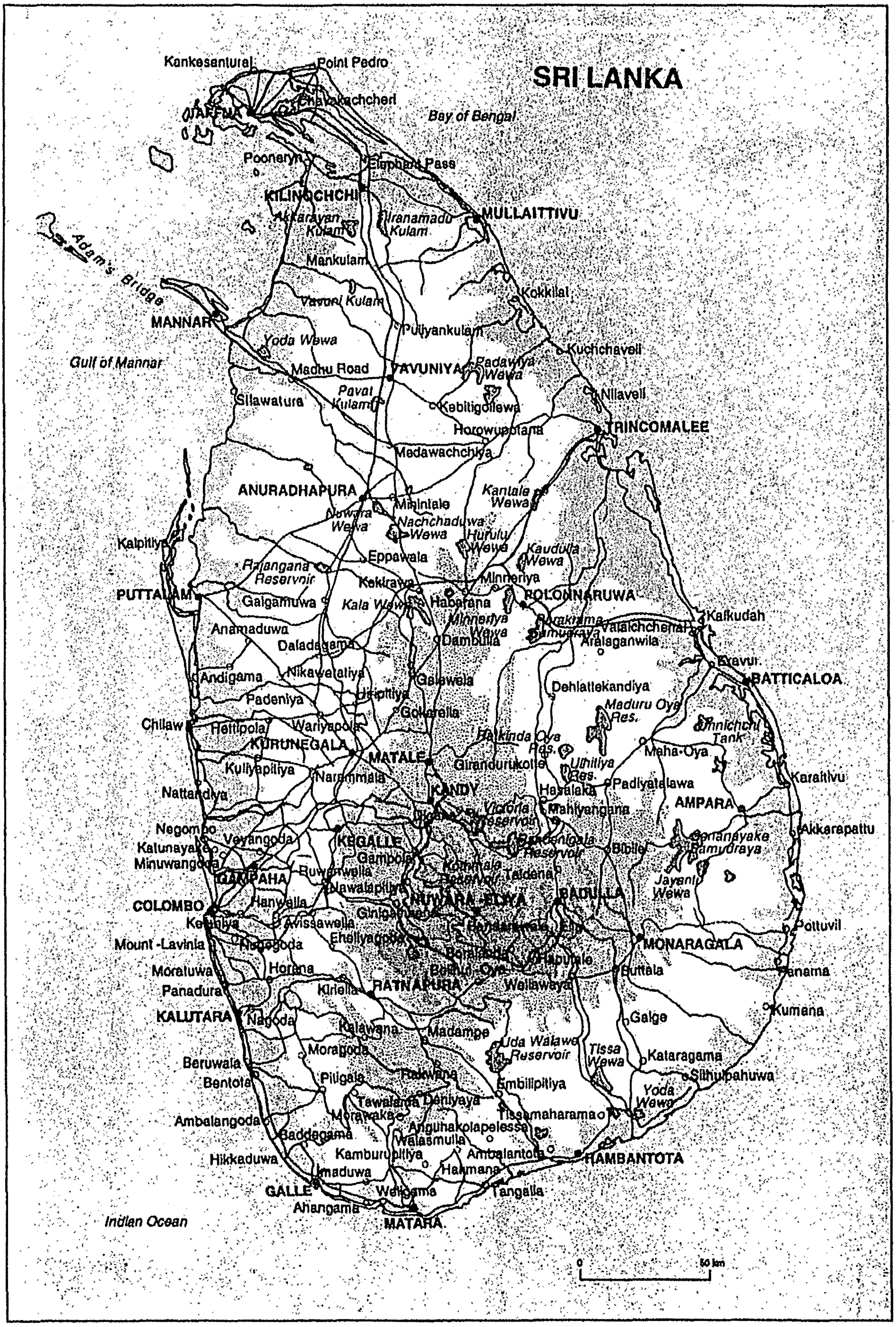
District	Rural	Townships	Schools	Expected cost Rs.Mn.
Colombo	80	6	30	441
Gampaha	190	6	35	1036
Galle	165	6	30	903
Matara	100	-	36	539
Matale	85	3	17	476
N'Elliya	85	2	18	469
Ratnapura	95	-	34	518
Badulla	80	-	30	434
Kurunegala	220	7	70	1204
Total	1100	30	300	6020

(Source : National Water Supply & Drainage Board)



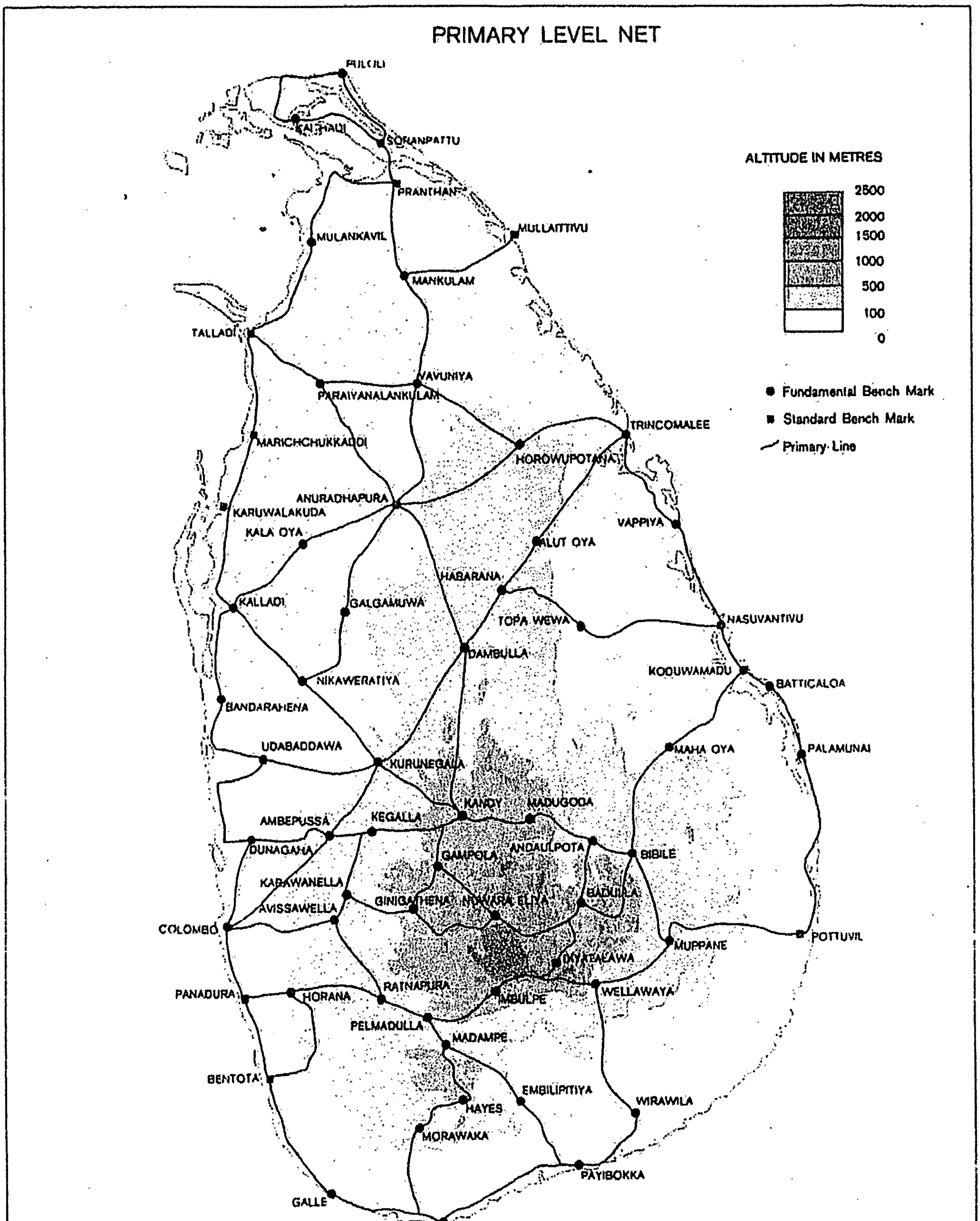
Map - 1

Climatic Zones



Map - 2

Road Network in the country (National Highways)



Map - 3

Topographical Map

MAIN CONSTRUCTIONS IN MAHAWELI PROJECT

Reservoir	Height of Dam metres	Length of Dam meters	Type of Dam	Gross Capacity cu.m. mill.	Permanent Capacity cu.m. mill.	Potential capacity M.watts	Annual units G.watt hrs.
Victoria	122	520	Concrete arch	721	688	70x3 = 210	605
Kothmale	87	600	Earth core rockfill	172	150	67x3 = 201	396
Randenigala	94	485	Concrete gravity	861	558	63x2 = 126	274
Rantambe	41.5	420	Concrete	22	18	25x2 = 50	103
Ulahitiya / Rathkinda	25	4960	Earth fill	145	82	-	-
Maduru Oya	41	1090	Earthfill	597	478	-	-
Bowathenna	29.8	226	Concrete	52	35	40x1= 40	83
Udawalawa	36	4000	Earth fill	268	240	RB2X1+LB4X1 = 6	21
Ukuwela			Only Electricity Generation Plant			19X2 = 38	173
Polgolla	14.6	144	Concrete with gates	4.1	2.1	-	-
			Total	**2842.1**	**1563.1**	**671**	**1655**

Note: Wastages in power generation not considered.

INTER BASIN DIVERSIONS AND CANALS

Type	Capacity cu.m per sec.	length(km) Tunnel	Cannal	Development Zones
Diversion				
Polgolla	56	8.06		'H', 'G, 'I' / 'H' and 'M' / 'H'
Bowathenna	28	6.85		'H', 'G, 'I' / 'H' and 'M' / 'H'
Right bank canal, Minipe	64			
Inter Bazin canal			30.90	'C' and 'B'
Rathkinda-Maduruoya tunnel	34	5.72		
Main Canals				
Zone 'H'			44.80	
Zone 'C'			28.30	
Zone 'B' (Left bank)			52.90	
Zone 'M' / 'H'			24.00	
Upper Walwa			72.80	
Total		**20.63**	**253.70**	

THAILAND

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Ministry of Agriculture and Cooperatives

Course No. : J – 02 - 00587

Country Report

for

Executives' Seminar on Public Works and Management

JFY 2002

October 14,2002 – October 25, 2002

MICRO IRRIGATION DEVELOPMENT WORK IN TFY 2003

prepared by

Mr. Jirachai SUTHASSANAJINDA

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Ministry of Agriculture and Cooperatives (MOAC)

Bangkok, THAILAND

August, 2002

Agricultural Land Reform Office (ALRO)

The Agricultural Land Reform Office (ALRO) was established in 1975 to undertake the land reform programme in accordance with the Agricultural Land Reform Act B.E. 2518 (1975). The ALRO is a political agency under the Ministry of Agriculture and Cooperatives (MOAC) equivalent to a Department headed by a Secretary – General.

Implementation of the land reform programme entails two major sets of activities :

1. Improvement of land tenure and land rights in public and private lands.
2. Agricultural and rural development in the land reform areas.

The first set of activities involves land distribution to the landless, marginal farmers , and tenants. The second set involves development of rural infrastructures , provision of production , agricultural land reform cooperatives , marketing , and other supporting services, etc.

The ALRO has been divided into the central and the regional administration. At present , there are 8 divisions and 69 provincial land reform offices. The organization chart is attached herewith.

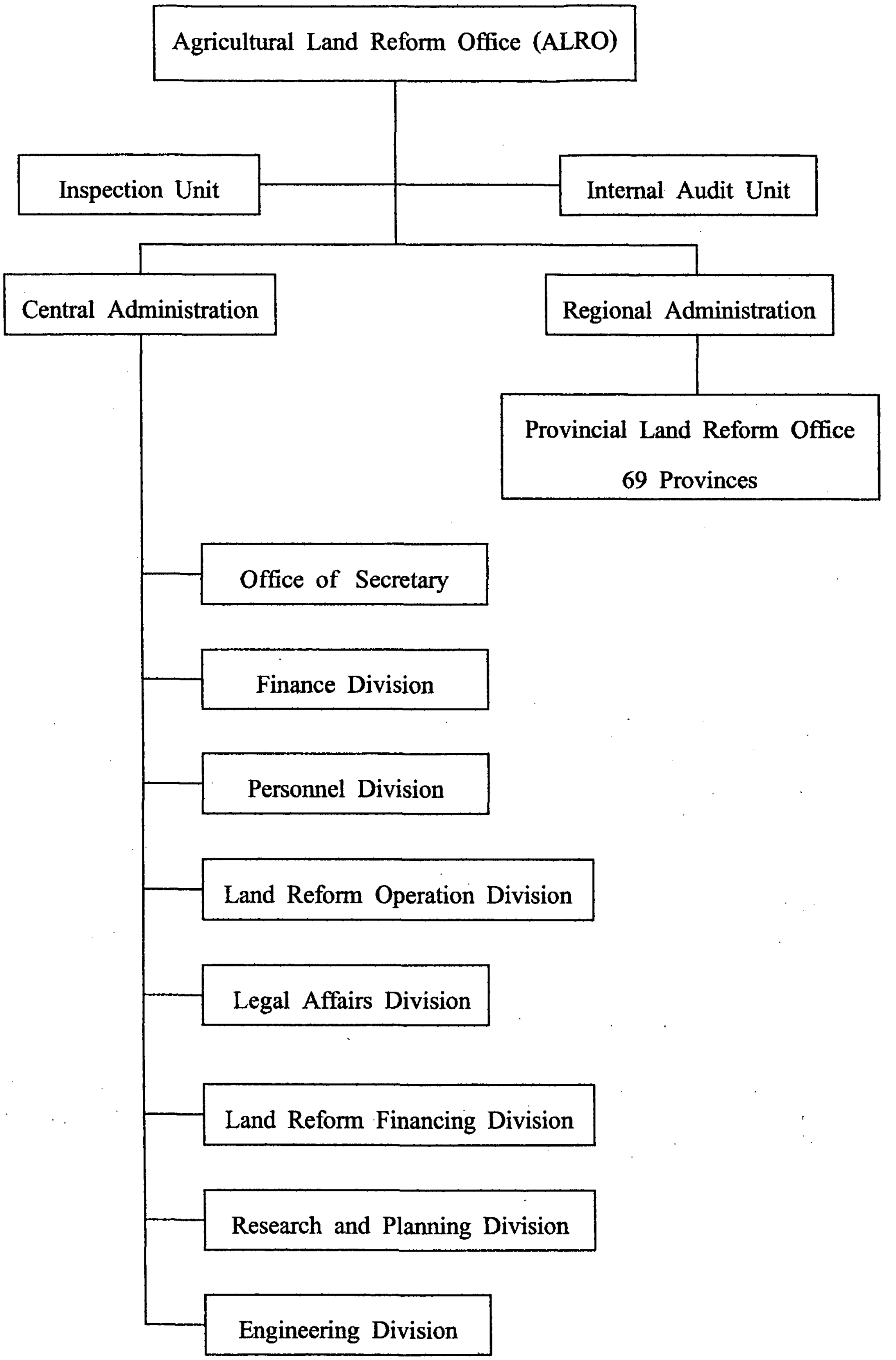
The nominee , Mr. Jirachai SUTHASSANAJINDA , is presently an agricultural engineer at Engineering Division , ALRO. His duties are concerned with planning and design of the rural infrastructure development in land reform areas. Because of more experience in planing and management of the rural infrastructure development, during the pass a few years, he has been responsible for the micro – irrigation development project. The project is implemented for farmers' quality of life.

The accessible numbers to contact :

Tel. No. 0-2279-7275

Fax No. 0-2278-0780

Organization Chart



THE INCREASE OF WATER USE EFFICIENCY FOR AGRICULTURE BY MICRO IRRIGATION SYSTEM PROJECT THAI FISCAL YEAR 2003

1 Executing Agency

Agricultural Land Reform Office (ALRO)

2 Principle and Rationale

Agricultural Land Reform Office (ALRO) has promulgated a total of 51.20 million rai* of the land reform area, both the state and private lands, in 69 provinces. A total of 21.43 million rai were allocated to 1.331 farm households. More than 95% of the allocated land was deteriorated forest, public land, and idle land. The encountered development constraints are the fact that these lands are rainfed area with poor soil, lack of water resources, and poverty of the local farmers.

In addition to the land allocation to farmers, ALRO takes responsibility in infrastructure development, especially water resource, which is the most important natural resource and input for farming. The ambitious goal of the land reform is *" security and sustainability of farmers in the land reform area to farm their own land and to have better income and quality of life."*

ALRO realizes that with constraints relating to the land reform area, it is very important to promote and support poor farmers in the land reform area to learn water-efficient farming method so as to achieve such goal. As a result, ALRO has initiated a project focusing on the increase of water use efficiency for agriculture by micro irrigation system or water-efficient farming method or frequent localized watering to plant base. This is another significant alternative of development process. ALRO envisions that in spite of many constraints, the efficient use of land and water-efficient farming method can adequately generate farm income, thus eventually leading to a close-knit family, love of land, no abandonment of land, and decline in social problems, especially labour migration to urban communities.

3 Compliance with Plan and Policy

The Increase of Water Use Efficiency for Agriculture by Micro Irrigation System Project is in line with the 9th National Economic and Social Development Plan (2002-2006), and the current and urgent government policies.

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* 6.25 rai = 1 hectar

4 Project Objective

4.1 To promote understanding of water-efficient farming method among farmers in the land reform areas;

4.2 To promote efficient utilization of land and family labour among farmers in the land reform areas, as well as increase of farm income; and

4.3 To promote and build grass-roots economic strength by aiming at sustainable agricultural development.

5 Project Target

5.1 **Micro Irrigation System Installation**: To install necessary equipment on the lands of 7,500 participating farm households. All installed equipment will be transferred to the farmers.

5.2 **Increase of the Participating Farmers' Income**: An incremental income of about 28,000-40,000 baht/household/year is expected for the equipped farms.

6 Project Period

The project period is one year, in Thai fiscal year 2003 (October 2002-September 2003). Figure 1 presents the project action plan.

7 Project Cost

A budget of 270.375 million baht of Thai fiscal year 2003 is allocated for the project implementation (Baht: Two hundred and seventy million three hundred and seventy-five thousand only). The allocated budget is divided as follows:

		Million Baht
(1)	**Project Management Cost** *(3% of the construction cost)*	**7.875**
	▪ Temporary wages	1.834
	▪ Remuneration, services, and supplies	3.416
	▪ Construction supervision	2.625
(2)	**Construction Cost**	**262.500**
	▪ System installation and equipment of micro irrigation system	262.500

Figure 2 shows the disbursement plan of the project.

8 Project Area

The project will be implemented in 39 provinces scattering in all regions as follows:

(1) **Northern Region**: 13 provinces, i.e. Chiang Rai, Chiang Mai, Tak, Nakhon Sawan, Nan, Phichit, Phitsanulok, Phrae, Mae Hong Son, Lampang, Lamphun, Sukhothai, and Uttaradit;
(2) **Central Region**: 6 provinces, i.e. Chanthaburi, Trat, Prachuap Khiri Khan, Phetchaburi, Ratchaburi, and Lop Buri;
(3) **Northeastern Region**: 11 provinces, i.e. Kalasin, Chaiyaphum, Nakhon Phanom, Nakhon Ratchasima, Loei, Si Sa Ket, Sakon Nakhon, Surin, Nong Khai, Udon Thani, and Ubon Ratchathani;
(4) **Southern Region**: 9 provinces, i.e. Krabi, Chumphon, Nakhon Si Thammarat, Phatthalung, Yala, Ranong, Songkhla, Satun, and Surat Thani.

9 Project Approach

9.1 Criteria for consideration of participating areas are as follows:

(1) A land use certificate (Sor Por Kor 4-01) was issued to the farm plot to be equipped with micro irrigation system or the participating farmer has already passed a land right investigation and been selected or the relevant farm plot was purchased by ALRO for the purpose of land reform.
(2) The land capability and soils should be suitable for crop cultivation.
(3) There should be no inundation problem.
(4) There is sufficient water availability for all year round.
(5) The farm plot should be not more than 20 metres far from the available water source. Priority will be given to the farm plot close to farmer's house or community.

9.2 Criteria for consideration of participating farmers are as follows:

(1) The farmer has to own the farm plot where the equipment will be installed.
(2) The farmer must be well disciplined, diligent, and patient.
(3) The participating farmer should have an adequate number of family members in working age to work on the equipped farm plot.
(4) The farmer is well prepared and accepts the project conditions and must voluntarily join the project.

9.3 Guidelines for selection of participating farmers and areas are as follows:

(1) Each Provincial Land Reform Office (PLRO) will consider and select the participating farmers and areas. This project aims to select 7,500 farmers from land reform areas in 39 provinces.
(2) For the above selection, first priority will be given to the criteria for consideration of potential areas, followed by the criteria for consideration of farmers to select farmers who own the selected farm plots.

(3) Quantity will not be emphasized. Each PLRO will focus on potential of the relevant area and the preparedness of farmers who voluntarily participate in the project and accept the conditions set forth.

(4) In the project area selection, emphasis will be given to nearness or grouping of the participating lands for the convenience of installation works and setting up of production group.

(5) Project details and conditions should be clearly explained to farmers for making their own decision to join the project.

(6) Prior to the project implementation, the land and farmers' preparedness will be rechecked.

9.4 Farmers' participation is the key condition of the project, i.e. ***think, do and pay together.***

(1) **Think Together:** Farmers will decide on the crop pattern between vegetables and fruit trees. This will help identify the required model of equipment installation. Additionally, farmers will select the location where equipment will be installed under ALRO's advice.

(2) **Do Together:** Farmers will join in the installation works to build up their skills and experience. They will be provided with training so as to learn how to operate and maintain the equipment properly, Farming technique suitable for the equipped farm plots is also introduced for the purpose of income generation.

(3) **Pay Together**: Farmers will partially pay for the pump, which is the indispensable equipment of the system. The payment will 50% of the pump cost, but not more than 4,000 baht.

9.5 Emphasis will be put on the system installation and equipment of farm plots or individual farmers. The participating farmers will determine their own crop pattern and choose an appropriate model of equipment installation. One of the following two standard models will be chosen by the participating farmers.

(1) V3 model for vegetable or flower growing, one rai of installation area;

(2) F2 model for fruit tree growing, two rai of installation area.

10 Expected Project Benefit

10.1 In terms of agricultural development process, this project is another alternative for rainfed area which often face water shortage. By this way, learning process is created for farmers to learn the principle and method of optimizing the limited water resources.

10.2 The above learning process will help increase farm income for farmers who are the grass-roots people of the country, specifically the poor, and upgrade their quality of life in consistence with the concept of sufficiency economy.

10.3 The construction works under this project will directly create rural employment of about 60,000 man-days, which will generate 7.80 million baht of income, and 39 million baht of cash flow. It is estimated that jobs will be created for about 7,500 people.

10.4 After project completion, the farmers will be able to use the facilities for farm production. It is expected that the participating farmers will achieve an incremental income of 28,000-40,000 baht/year or gross domestic product of 210-300 million baht/year.

11 Project Monitoring and Evaluation

11.1 To ensure the effective project implementation, monitoring and evaluation will be carried out in 2 phases as follows:

(1) During the construction, to report work progress and problems encountered;

(2) After the construction or completion of project implementation, to monitor the construction works to meet the target, and to monitor the use of the completed facilities.

11.2 The evaluation is to measure the project success and will be conducted after the project completion and use of the facilities for a certain period. The following key indicators will be determined.

(1) Use of the installed equipment

(2) Income of the participating farmers

(3) Understanding and learning of operations and maintenance of the equipment

(4) Improvement of farm practice

(5) Farmers' capability in payment of their debt

(6) Increase of farmers' investment in expanding the equipped area.

Figure 1 : Action Plan for the Increase of Water Use Efficiency for Agriculture by Micro Irrigation System Project

in Thai Fiscal Year 2003

Agricultural Land Reform Office (ALRO)

Ministry of Agriculture and Cooperatives (MOAC)

Activity	Quantity	Thai Fiscal Year 2003											
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.
1. Project Management	1 Project												
2. Installation of Eguipment and Micro Irrigation System													
(1) Preparatory Work	39 Provinces												
(2) Contracting Work	7,500 Farmers												
(3) Construction Work	7,500 Farmers												
(4) Contruction Supervision Work	39 Provinces												
(5) Monitoring of Construction and Use of Project Facilities	1 Project												

Figure 2 : Disbursement Plan for the Increase of Water Use Efficient for Agriculture by Micro Irrigation System Project

in Thai Fiscal Year 2003

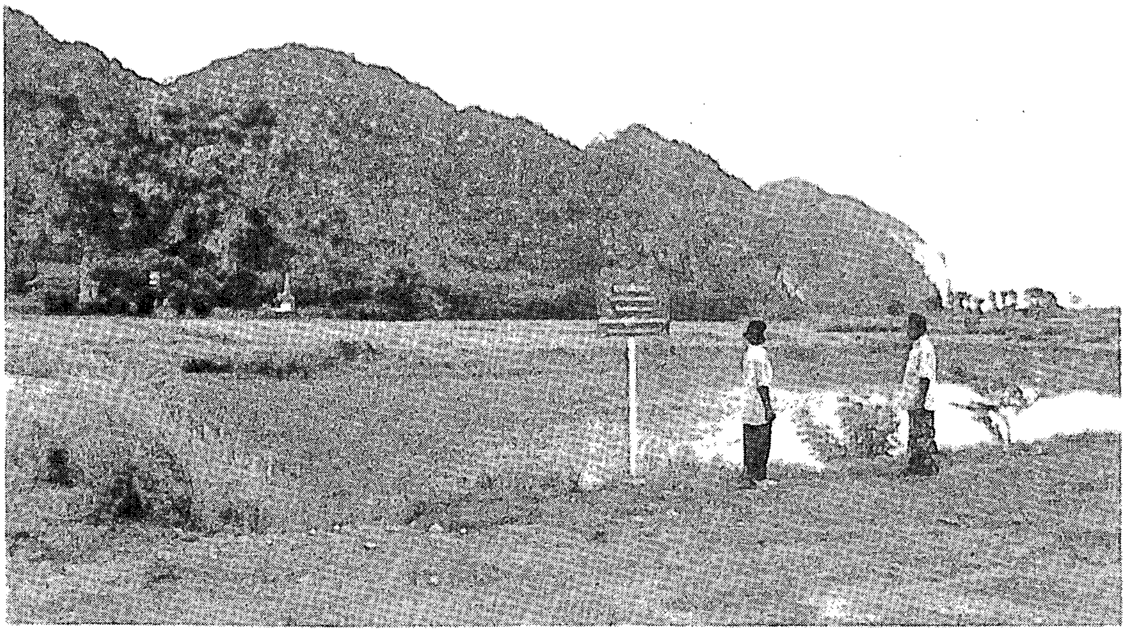
Agricultural Land Reform Office (ALRO)

Ministry of Agriculture and Cooperatives (MOAC)

Unit : mil. Baht

Items	Quantity	Thai Fiscal Year 2003												Total
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	
1. Project Management Cost	1 Project	0.438	0.438	0.438	0.438	0.875	0.875	0.875	0.875	0.875	0.875	0.438	0.438	7.875
1.1 Temporary Wages	1 Project	0.153	0.153	0.153	0.153	0.153	0.153	0.153	0.153	0.153	0.153	0.153	0.153	1.834
1.2 Remuneration, Services and Supplies	1 Project	0.285	0.285	0.285	0.285	0.285	0.285	0.285	0.285	0.285	0.285	0.285	0.285	3.416
1.3 Construction Supervision	39 Provinces	0.000	0.000	0.000	0.000	0.438	0.438	0.438	0.438	0.438	0.438	0.000	0.000	2.625
2. Construction Cost	7,500 Farmers	0.000	0.000	0.000	0.000	0.000	0.000	65.625	65.625	65.625	65.625	0.000	0.000	262.500
Total		0.438	0.438	0.438	0.438	0.875	0.875	66.500	66.500	66.500	66.500	0.438	0.438	270.375

Photos of the previous project

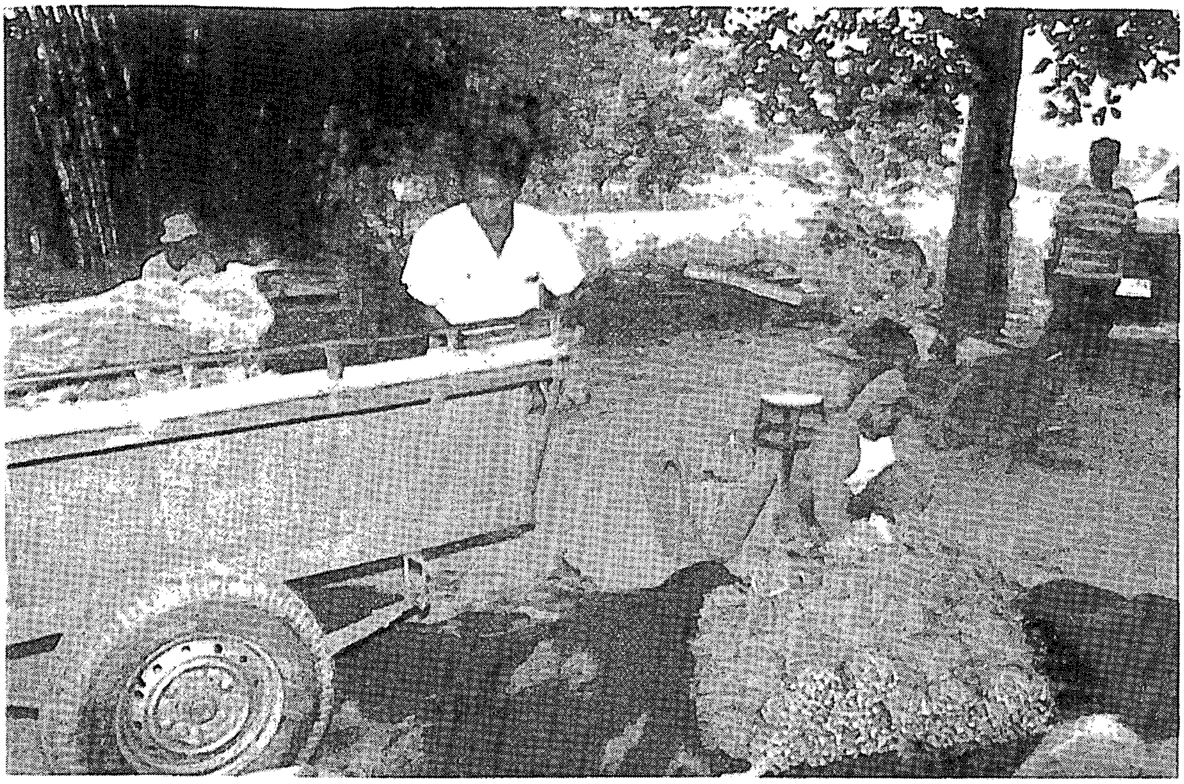


1. Farm pond, provided by ALRO, is used for water resource of micro – irrigation work.

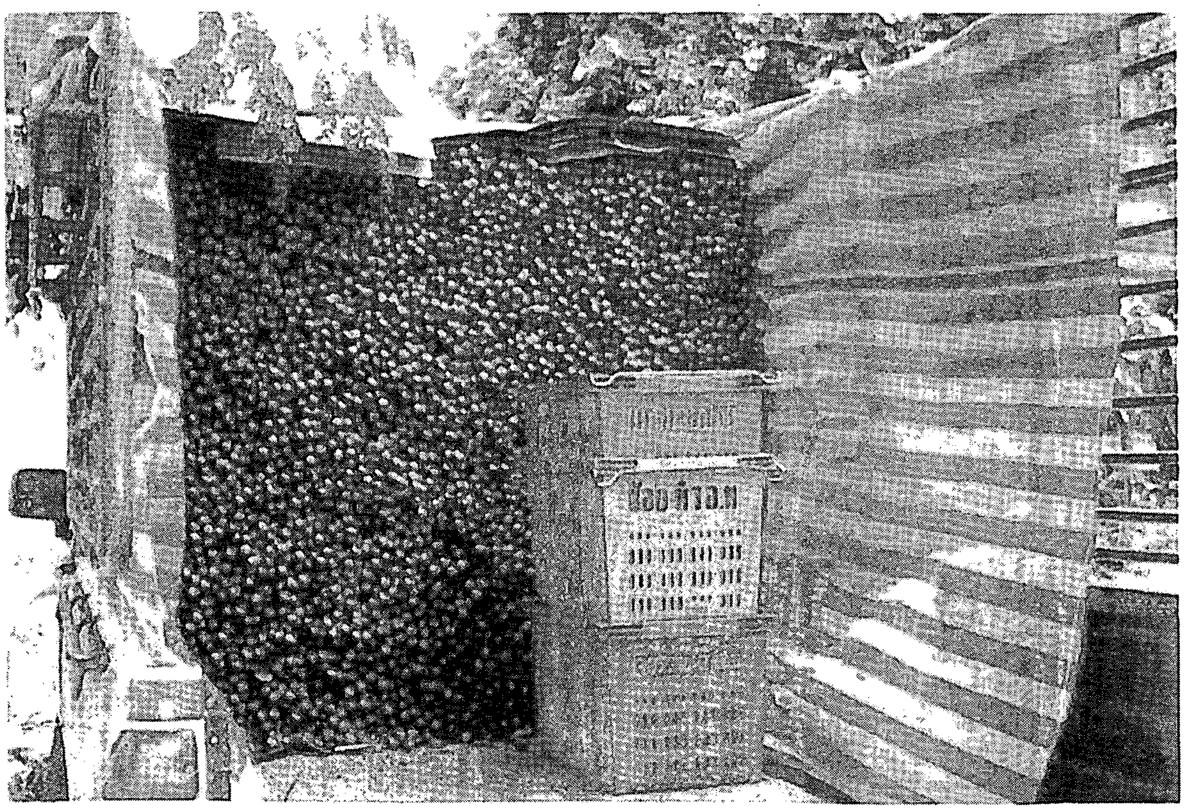
2. A set of high pressure pump installed for micro – irrigation development work.

3. A set of micro sprinkler installed in the vegetable plot.

4. A set of micro sprinkler installed in the orchard plot.



5. Vegetable product, Chinese kale, prepared to market delivery.



6. Orchard product, Longan, prepared to market delivery.

MICRO IRRIGATION WORK.... AN ALTERNATIVE OF AGRICULTURAL DEVELOPMENT IN LAND REFORM AREA

BACKGROUND OF LAND REFORM PROGRAM

- Agricultural Land Reform Office (ALRO) has been established to implement the land reform program since 1975.
- The promulgated land reform area cover a total of 8.2 million hectars in 69 provinces.
- At present, ALRO has allocated land in a total of 3.43 million hectars to 1.33 million farmers.

GOAL OF LAND REFORM

" security and sustainability of farmers in the land reform areas to farm their own land and to have better income and quality of life "

THREE OBLIGATIONS SET FORTH TO SUCH GOAL

- **Allocation of land to farmers;**
- **Infrastructure development; and**
- **Farmers' income and quality of life.**

EXISTING PROBLEMS OF LAND REFORM AREAS

- Low Soil Fertility;
- Lack of water sources for farming;
- Farmers' poverty; and
- Farmers' debt.

SOLUTIONS OF SUCH PROBLEMS

- Low soil fertility : to adopting appropriate technology and local wisdom.
- Lack of water sources for farming : to promote farmers' awareness of the importance of water security by storing rainwater for dry-season use and to create learning process regarding water efficient agriculture for value-added production and high return.

SOLUTIONS OF SUCH PROBLEMS

- **Farmers' poverty : to enable farmers to generate continuous farm income.**
- **Farmers' debt : to create learning process for farmers to be able to classify their debts, and then promote reduction and elimination of borrowing for family subsistence.**

CONCEPT OF DEVELOPMENT

Micro Irrigation Work ...

an Alternative of Agricultural

Development in Land Reform Area

WHAT IS MICRO IRRIGATION ?

- An irrigation system where water efficiency is adopted;
- Water is limitedly and frequently brought of only root zone of plant;
- Emitters may be drip or micro sprinkler; and
- To efficiently use the limited water sources for maximum benefit.

ESTIMATE OF INCOME

- To generate a net income of 28,000-40,000 Baht per year per household while the investment cost is approximate 38,000 Baht per farm plot.

IMPLEMENTATION GUIDELINE

- Establishment of criteria for selection of land plots and participating farmers;
- Investigation and selection by Provincial Land Reform Office (PLRO) ;

IMPLEMENTATION GUIDELINE

- The first selection of land plot prior to consideration of participating farmers;
- Emphasis on area potential and preparedness of farmers;
- Equipment installation on individual land plot or for individual farmer;

CRITERIA FOR SELECTION OF PARTICIPATING LAND PLOT

- Land right certificate;
- suitable soil for crop cultivation.
- No inundation problem;
- Availability of sufficient water for all year round; and
- Not more than 20 metres of distance between land plot and water source.

CRITERIA FOR SELECTION OF PARTICIPATING FARMER

- Owner of the land plot;
- To be well disciplined, diligent, and persevering;
- An adequate number of farm labor; and
- Acceptance of project conditions.

CONDITIONS OF PROJECT PARTICIPATION

- Think Together : to decide on cropping pattern;
- Do Together : to join in equipment installation works; and
- Pay Together : to partially pay for equipment cost.

STANDARD MODELS OF EQUIPMENT INSTALLATION

A total of 8 standard models of equipment installation are divided into 2 parts.

- Three standard models for vegetable or flower plot;
- Five standard models for fruit tree plot.

THREE STANDARD MODELS FOR VEGETABLE OR FLOWER PLOT.

- **Model V1** : dripping system
- **Model V2** : micro sprinkler with watering radius of 4.00 X 4.00 m.
- **Model V3** : micro sprinkler with watering radius of 6.00 X 6.00 m.

FIVE STANDARD MODELS FOR FRUIT TREE PLOT

- **Model F1** : micro sprinkler for planting space of **3.00** x **3.00** m
- **Model F2** : micro sprinkler for planting space of **4.00** x **4.00** m
- **Model F3** : micro sprinkler for planting space of **6.00** x **6.00** m
- **Model F4** : micro sprinkler for planting space of **8.00** x **8.00** m
- **Model F5** : micro sprinkler for planting space of **10.00** x **10.00** m

WATER SOURCES FOR MICRO IRRIGATION SYSTEM

- Canal / natural canal
- Natural pond / farm pond
- Shallow well
- others

THE PRINCIPLES OF MICRO IRRIGATION DEVELOPMENT WORK

- **The key element of work is " water availability "**
- **The target of work is " farmers "**
- **The successfulness of work is " Joining Hands of ALRO "**

E. SYMPOSIUM

The 11th International Symposium on National Land Development and Civil Engineering in Asia

Date : October 22, 2002 (Tue)

Time : 14:20 to 18:00

Place : Bankoku Shinryokan

Sponsor : National Institute for Land and Infrastructure Management, Ministry of Land, Infrastructure and Transport

Co-sponsors : Okinawa General Bureau
Okinawa Prefectural Government

PROGRAM

14:20～18:00 The 11th International Symposium on
National Land Development and Civil Engineering in Asia
－Water Resources and River Management for Sustainable Development－

14:20～14:50 Lecture 1 "Case of JAPAN"
-Comprehensive Water-Resource Issues of Island Communities-
by Dr. Housei UEHARA, Honorary Professor, University of the Ryukyus

14:50～15:20 Lecture 2 "Case of JAPAN"
-Tokyo Metropolitan Region and Tonegawa-
by Mr. Haruhiko OKUNO, Director General
National Institute for Land and Infrastructure Management
Ministry of Land, Infrastructure and Transport

15:20～15:30 Break

15:30～16:00 Lecture 3 "Case of KOREA"
by Dr. LEE Jang-Hwa
Senior Research Fellow
Korea Institute of Construction Technology

16:00～16:30 Lecture 4 "Case of INDIA"
by Mr. Kaushal N. AGRAWAL, Additional Director General
Central Public Works Department
Ministry of Urban Development

16:30～17:00 Lecture 5 "Case of PHILIPPINES"
by Ms. Sofia Torio SANTIAGO
Project Manager, and OIC
Assistant Director
Bureau of Design Department of Public Works & Highways

17:00～17:30 Lecture 6 "Case of PAKISTAN"
by Mr. Zubair Emran KHAWAJA
Director
Road Research and Material Testing Institute/
Private Sector Project Investment Cell
Communication & Works Department
Government of Punjab, Lahore

17:30～18:00 Lecture 7 "Case of OKINAWA"
-Integrated Dam Management and the Development of Okinawa's Water Resources-
by Mr. Tamio SHIMOGAMI
Deputy Director, Okinawa General Bureau

Lecture 1

Case of JAPAN Ⅰ

—Comprehensive Water-Resource Issues of Island Communities—

Dr. Housei UEHARA

Honorary Professor

University of the Ryukyus

OVERVIEW: WATER RESOURCE ISSUES OF ISLAND COMMUNITIES – CASE STUDY FOR SUSTAINABLE DEVELOPMENT IN OKINAWA PREFECTURE

Hosei Uehara,
Engineering PhD,
Professor Emeritus, University of the Ryukyus
Director, Uehara GeoTec Research Center

1. INTRODUCTORY REMARKS

As the era in which we confront the issues of water (resources), the 21st Century is, in other words, also the time for us to develop our know-how in the Sustainable Development of global environmental resources. However, in contrast to other non-renewable resources, the processes of water recycling and re-use all too often severely lack proper risk management principles. As evident in the many recent water-related emergencies (floods, droughts, etc.) resulting from global warming and other causes, it is imperative for us to act now to deal with the issues (including impacts on food production et al) threatening Man's very survival.

While these issues are of grave import on the continents, they are and have been of perennial concern in island communities. Today, I will introduce an example of integrated development and usage of island water resources through a case study of Okinawa Prefecture.

The (supply & demand plans and project) development of Okinawa Prefecture's water resources has come through three consecutive (10-year) development and promotion plans. While these have contributed greatly to underlying basic infrastructure and industrial development, the benefits are yet inadequate. As such, the new national program starting this fiscal year (2002) outlines new promotion and development measures that position energy and water resources as integral to securing foundations for economic self-sufficiency and stable social environments.

At this point, to provide an introductory understanding of conditions in Okinawa today, I will outline the strategies and water resources problems that face our island communities. (REF: PowerPoint Slide #2)

- Basic Precepts: Peace, Comfort, Vigor
- GOALS:
    - Sustainable Development for Self-Sufficiency: Open Contact with the World, Establishment as a Hub of (Asia-Pacific) Cooperation
    - Communicating Regional Aspects in tune with 21^{st} C Trends and Currents: Participatory Planning, Responsibility vs. Choice, Stationary vs. Mobility/Interaction
    - Balancing Nature and Man's Habitats; Conservation & Preservation: Providing for the Talent and Skills Diversity to Support Sustainable Development
    - Developing Stable Logistics/Transport, IT, Energy and Water Resource Capabilities to Support Social Infrastructure and the Economy.

Next, I would like to consider the issues of water and water resources within the context of Okinawa's natural environment, that of an island prefecture at the southernmost end of the Japanese Archipelago, as a lead-in to the potential for geotechnology solutions.

- Unique Characteristics of the Southwest Islands (Ryukyu Archipelago): 4 Controlling Factors (Climate, oceanic properties, and geophysical factors)

Natural Disasters, Environmental & Pollution Strategies: Issues and Countermeasures

- Long Term Water Supply Strategies for Okinawa Prefecture:
  - ➢ Fundamental Concepts and the Evolution of Water Conservation
  - ➢ Water Supply Strategies and Policies of Resource Development
  - ➢ Rethinking Water Usage/Supply Systems
  - ➢ Drought Controls and Measures Taken at Source (Water sources are recharged by the forest! Community Support Essential!)
- Okinawa's Strategies as an Archipelago with Remote Islands: Case Studies of Diverse Water Resource Usage
- Building Dams on Small, Remote Islands, Underground Dams for Agricultural and Residential Water
- Alternate water sources:
  - ➢ Springs, Small Scale Waterworks, Rainwater, Wells, Groundwater
  - ➢ Redevelopment and Use of Idle Water Sources; Development of Seawater Desalination Plants
  - ➢ Recycling and Treating Sewage and Wastewater

2. REGIONAL STRATEGIES FOR THE OKINAWA ISLAND GROUP

Okinawa's strategies for economic self-sufficiency in the 21st Century are based on interaction and interaction with those parts of the Asia-Pacific region within a 3,000-kilometer radius of these islands. (REF: Power Point 3)

The national government followed the 1st Okinawa Promotion and Development Plan (1972-1981) and the 2nd Okinawa Promotion and Development Plan (1982-1991), with a 3rd Okinawa Promotion and Development Plan (1992-2001). A comprehensive review of these plans was compiled (May, 2002) which summarized Okinawa's current level of development and its remaining issues, as well as its potentials. These findings were incorporated into the new development program for Okinawa.

Presented here (Figure 1) for reference are the guiding policies of the promotion and development programs as well as Okinawa Prefecture's environmental management program as examples of the methods of pursuing sustainable development in island environments. Also, to introduce the concepts underlying Okinawa's future plans, here are: a) Okinawa's socio-economic issues and conditions, the trends of the day, Okinawa's unique aspects, and the perspectives on which Okinawa's vision of the future is based; b) in pursuit of development, providing the fundamentals that allow sustainable development, such as a vigorous industrial base, greater exchange and cooperation with the Asia Pacific region, balance between the natural environment and Man's habitats, a healthy, orderly society, the nurture of diverse talents and skills, and invigoration of the remote and isolated areas, and, c) adopting development and promotion measures for each island region; developing support systems and taking special action to advance these development and promotion measures; giving full play to Okinawa's characteristics; overcoming disadvantages; requesting the National Government provide special support measures for improvement of military base issues and other problems. In this light, in July of 2002, the Cabinet Office promulgated the Okinawa Development and Promotion Plan with its four sections of: (1) General Remarks, (2) Basic Direction for Development and Promotion, (3) Development and Promotion Measures, and (4) Development and Promotion Measures by Region.

3. Unique Aspects of Okinawa's Natural Environment

Among the island communities of the Asia-Pacific, the Southwest Islands, a.k.a. the Ryukyu Archipelago, have a unique position in terms of island studies perspectives. I have summarized below, some of the unique environmental aspects, and methods and technologies of community development.

The four facets having with the greatest impact on natural conditions in the Ryukyu Archipelago are:

1) latitude (sub-tropical);
2) aberrant weather patterns (typhoons, tropical depressions);
3) ocean currents (the Black Current, warm water flows); and
4) the Chinese mainland (the Eurasia continent).

The world has numerous island communities, each with its own unique aspects. Okinawa is notable for characteristics unique from other areas of Southeast Asia, or the island nations of the South Pacific. (REF: Power Point 4)

Okinawa Prefecture consists of some 160 small islands (40 of which are inhabited) scattered across a broad expanse of the East China Sea and the Pacific Ocean. They reach 1,000 kilometers east to west, 400 north to south.

The ancient connection between the Ryukyu Archipelago and the continent is evident not only in the geology and landscape, but in anthropological, ethnic and biological aspects. (Figure 2) (REF: Power Point 5)

The mission of civil engineers is securing happiness and the greater good of mankind. This can only be achieved through deep understanding of, and dialogue with, nature. Project implementation, from planning to maintenance, must be based on comprehensive understanding and evaluation of natural phenomena, while always focusing on safety, disaster prevention, health and security. At the same time, continual progress is essential to conservation of land and the natural environment, and protection of our living environment.

At this point, for reference, I will explain the phenomenon of natural disasters. First, the principle guiding disaster prevention is full consideration of the interaction between natural phenomena and human activities: how they interact determines the potential for disasters. I will clarify how knowing the (both direct and indirect) causes of aberrant weather patterns, et al, is useful in evaluating disaster prevention and recovery methods. Additionally, the potential to avert disaster is determined by the involvement of the ordinary citizen, government authorities, and disaster control experts. When the various natural forces are input into a black box of local factors, we see that various types and scopes of disasters appear as the output. (Figures 3 - 4)

Next, as an example of the regional advantages and disadvantages to Okinawa Prefecture, I will introduce the movements of last month's Typhoon No. 16. In a typical year with the usual typhoon paths, the Ryukyu Archipelago is in the midst of the Typhoon Corridor. Around June, typhoons move off the north coast of Taiwan, before heading for the Chinese mainland. Later months are marked by a more easterly path which leads northward to Kyushu, Shikoku and the main island of Honshu, while come October, the path starts far east of the Ryukyus and moves due north. In recent years, these usual paths have given way to irregular pathways (Figure 5), reportedly due to changes in the global environment (changes in the ocean current patterns). These bring droughts or other natural disasters to Okinawa Prefecture. These disasters include heavy rainfalls (Note: water resources – the rains also have the benefit of bringing water) for which prediction and countermeasures are a problem of growing difficulty. Okinawa Prefecture has overcome its cruel destiny replete with natural disasters (heavy rain or low rainfall/water rationing) that are brought about by its island environment. It takes advantage of its geographical location, as well as its history of friendship and exchange with the southern reaches and the world, to achieve self-sustained development (international exchange; technology transfer to other subtropical island regions).

Incidentally, Typhoon 16 was a strong typhoon, remained stationary for an extended period, and marked historic highs for wind velocities and total precipitation. (REF: Power Point 7)

4. RELATIONSHIP OF GLOBAL ENVIRONMENTAL ISSUES WITH GEOTECHNOLOGY

First, to provide an awareness of environmental science and environmental engineering, I will present the (1987) proposals of the Science Council of Japan on the relationship of Environmental Science, a comprehensive interdisciplinary field of study, and Environmental Engineering, a practical science. (Figure 6)

Next, let us look at two systems to serve as references in considering global environmental issues (Figure 7 & 8). The first figure categorizes environmental problems into those of natural causes and human causes. The second figure looks at global environmental issues as a problem for geotechnology.

Next, I will briefly go over the role of geotechnical engineering in island environments. In 1981, Sembenelli and Ueshita defined Geotechnical Engineering as a prospective, comprehensive and interdisciplinary approach to environmental issues as opposed to the conventional Soil Mechanics/Soil Engineering which are academic, technical and symptomatic approaches (Figure 9). Environmental geotechnical engineering sessions were early recognized in international conferences. The discipline covers the atmosphere, hydrosphere, geosphere, biosphere, and the microbiosphere, as summarized in the diagram (REF: Power Point 8 9). In April 2000, the Science Council of Japan Specialized Field Liaison Committee suggested Geotechnical and Geoenvironmental Engineering as a new field of study that incorporates a broader scope of phenomena to meet the needs of the 21st Century. Based on this trend, I have proposed and promoted the application of Insular Environmental Geotechnical Engineering that links civil engineering, environmental engineering, and geotechnical engineering with island studies. (REF: Power Point 10-12)

5. AN OVERVIEW OF WATER RESOURCE ISSUES IN OKINAWA

- Concept of the Hydrological Cycle in an Island Environment, and Water Uses in Hawaii and Okinawa

Water resource is one of the most important natural resource of a nation. In Okinawa, the lack of water resources has impeded industrial growth. Since the postwar U.S. military plan in 1962, there has been over 30 water supply and demand studies and plans for Okinawa. The island's water issues must be understood in connection with the island community, meteorology, hydrology, and geology. It is also important to understand the relationship between water volume, quality, and flow, as well as the north-south conflict between the water sources versus the (urban) water consumers in Okinawa. (Figure 10)

I have joined with others in bilateral water issues and resource studies conducted between Hawaii and Okinawa. The findings have been published in "Island Regions' Water Resource Issues and Prospects", covering the differences between Hawaii's natural underground dams and Okinawa's surface dams and manmade underground dams, as well as water sources, volume and quality (REF: Power Point Slides 13-16).

Next, I will discuss systems of water usage and water resource development vis-à-vis consumption, in Okinawa Prefecture. I will outline this using a figure to show the water resource development projects under the 3rd Okinawa Development and Promotion Plan as well as the Long Term Water Supply Draft Proposal (2002-2003). (REF: Power Point slides 19–26) Figure 11 shows how water demand for daily use is projected; Figure 12 summarizes the rivers and surface water tapping facilities in Okinawa, and Figure 13 details the Water Source Fund projects and the submarine water transmission pipes.

The following recommendations are made on Okinawa Prefecture's long-term water supply and demand plan:

(1) Develop water resources such as rivers, dams, groundwater, and seawater desalination
(2) Diversify water sources (rainwater, recycled water) that can be diverted among different uses
(3) Promote a water-conservation conscious society; streamline water use
(4) Measures at the water source, including the Water Source Fund and various forms of exchange and cooperation between the water source areas and consumption areas.

In addition, there is a requirement for follow-ups to the plan. (The national dams in northern Okinawa offer a good example of follow-up in development, use and management.)

6. APPENDIX

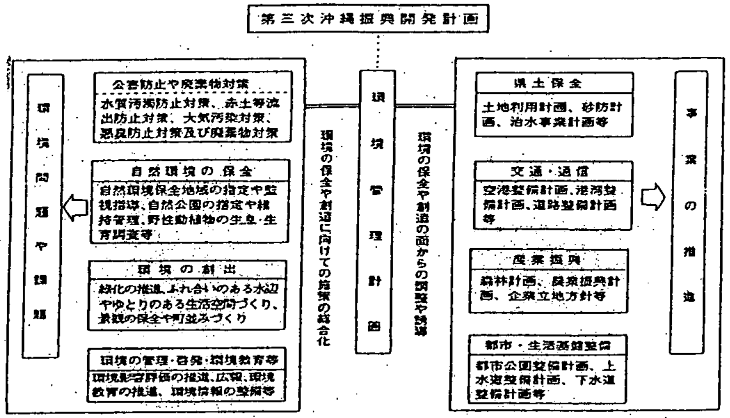
I will introduce the diverse water sources and water resource development and usages via pictures and charts. (REF: Power Point Slides 27-38)

- Small scale dams for small islands
- Springs, wells, and small-scale waterworks: uses and sanitation issues
- Rainwater tanks in individual homes and apartment complexes: equipment, water quality issues
- Merits of seawater desalination in remote islands: abundant seawater, plant construction period, area, ease of feeding water
- Underground dams (Miyako, Itoman area, remote islands): Pollution and threat of cave-in's
- Sewage and wastewater treatment and recycling: offices, hotels, resort facilities, water used by public facilities of all types; Ecology and Amenities (The Ota Riverfront project, Aqua Park, et al); Agricultural and Industrial Water Use (Figure 14)

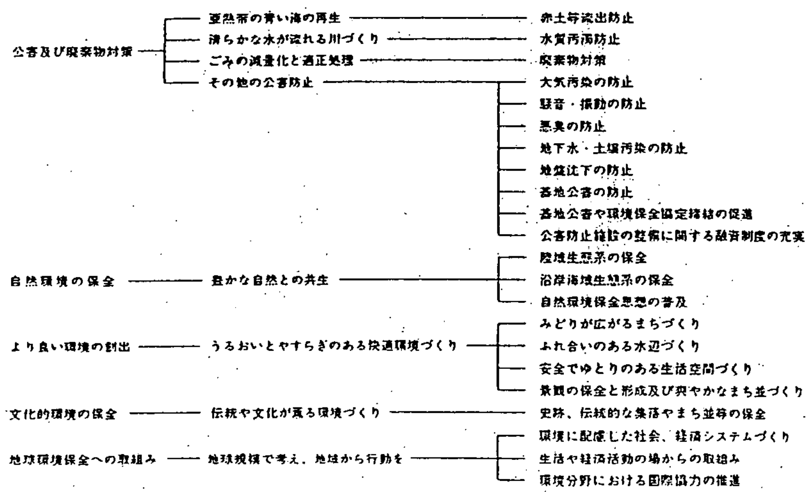
7. CONCLUSION

Key Words: Island Studies, Environmental Engineering, Practical Bio-engineering, disaster, disaster prevention

SUSTAINABLE DEVELOPMENT
Think Globally. Act Locally
The 3R's: Reduce, Reuse, and Recycle
Create, Sustain, Renew
Accolades to Civil and Environmental Engineering!!, Act Locally!

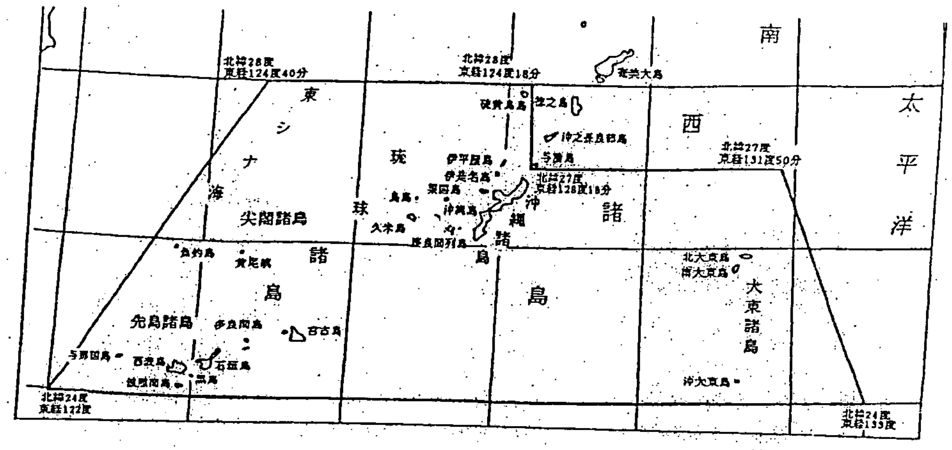


環境管理計画の位置付け



施策の体系

Figure 1: Environmental Management Scheme in the 3rd Development and Promotion Plan



島嶼県沖縄の圏域図

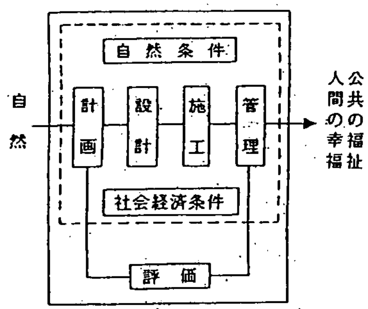
(「土地対策の概要 '95」沖縄県企画開発部, 1995 年による)

高島と低島の自然環境

	高島	低島
1. 地形的特徴 (1) 山地及び丘陵 (2) 台地 (3) 低地	山地が存在し、山地周辺には、比較的起伏の丘陵地が発達する。 海成の砂礫台地が発達する。 谷が発達し、谷地低地が見られる。	山地は存在しない。尾根が定高性をもつ丘陵とそれを取り巻く台地が発生する。場所によっては、台地より低地に小起伏の丘陵が発生する。 琉球石灰岩から構成された石灰岩台地が発達する。 谷の発生が少なく、断片的な海岸低地が見られる。
2. 地質的特徴	a 離島 古期岩類、深成岩類が主である。 b 火山島 火山岩、噴出岩が主である。	a 陸地 古期岩類、深成岩類が主である。 b サンゴ礁 琉球石灰岩が主である。
3. 土壌的特徴	成帯性の赤黄色土および火山灰土壌が主である。	石灰岩土壌（テラロッサ）が主である。
4. 水文的特徴	河川水系	地下水水系

(目崎茂和:島の生態基盤——琉球列島の分類1978)

Figure 2: Geography and Geology of Okinawa Prefecture

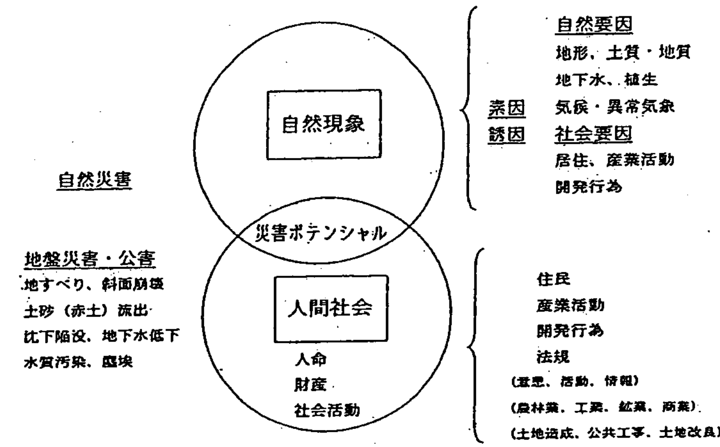


土木技術のシステム（長尾義三）

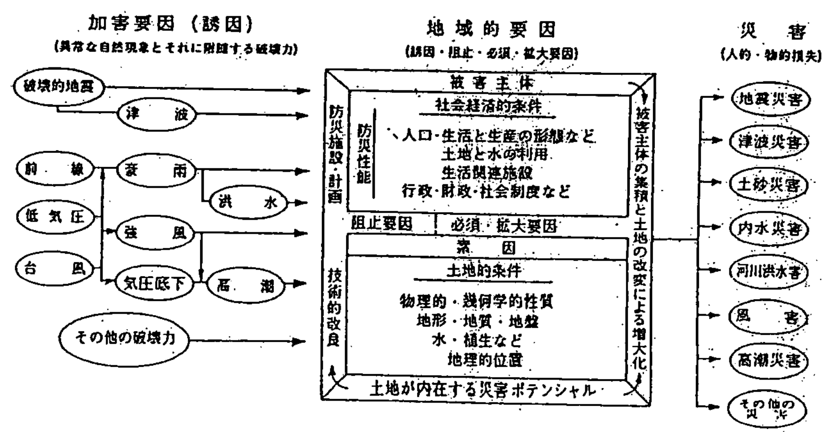
環境／国土保全と災害・公害防止事業

	施設／事業内容
自然環境	保全・回復・自然公園保護・管理、保護センター等、緑化
災害防止	治水、すべり・崩壊対策、海岸保全対策、治山対策、防災体制
公害防止	7公害対策、環境資源保全活用、管理計画、環境影響評価、赤土等流出防止対策等

Figure 3: Civil Engineering Technology: Disaster Prevention and Countering Pollution

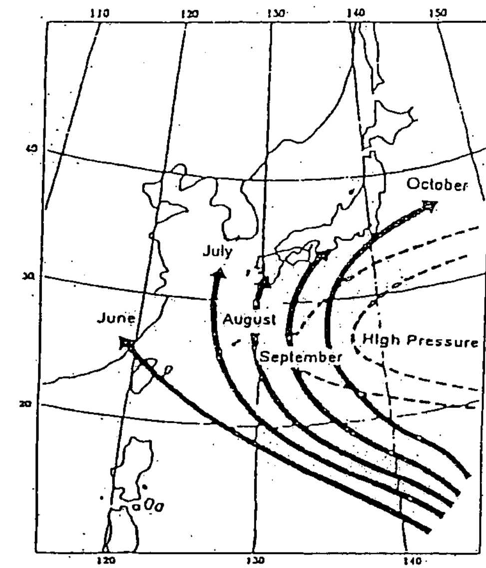


災害ポテンシャル



自然災害の基本構造（門村 浩，1972）

Figure 4: How Natural Disasters Occur



Normal Monthly Courses of Typhoon

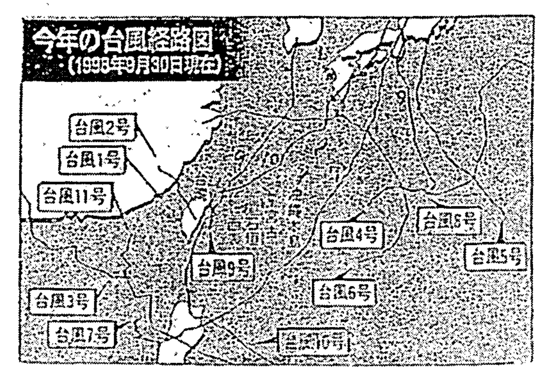
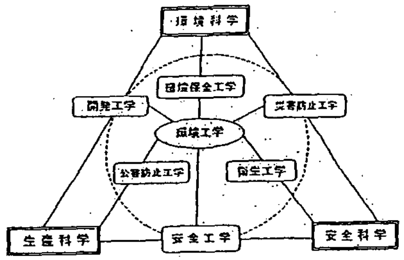


Figure 5: Typhoon Routes



(○は広義の環境工学の領域を示す。)

環境工学の位置

(「現代環境工学概論」：オーム社，1978)

Figure 6: Environmental Science and Environmental Engineering

環境悪化事象の分類（天野，1971）出典「環境科学」：技報堂

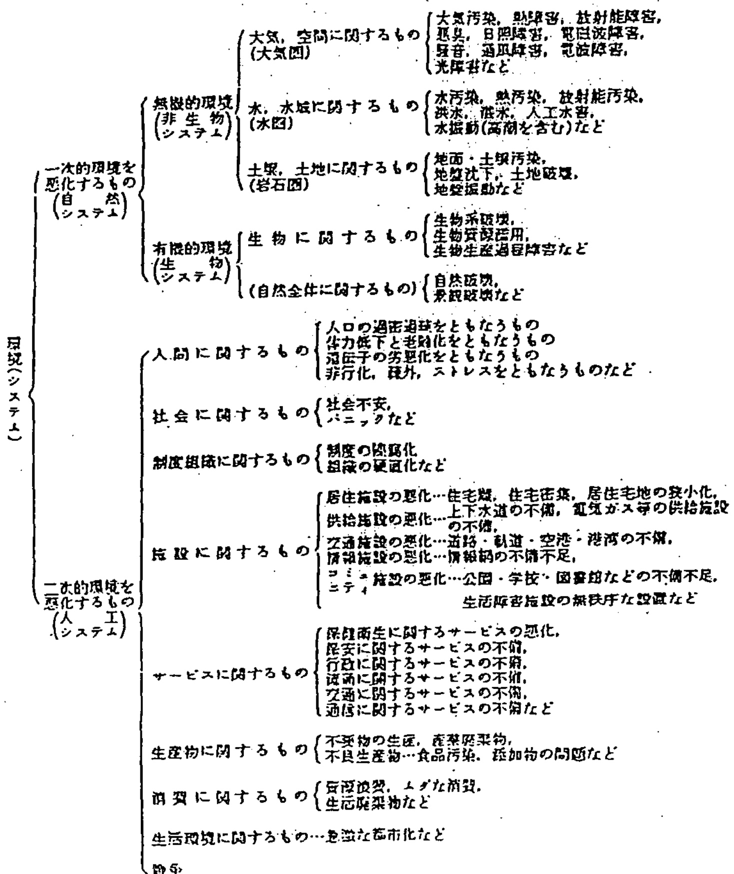


Figure 7: Environmental Deterioration

地球環境問題と地盤との関係（地球環境悪化の構図，石 弘之より）

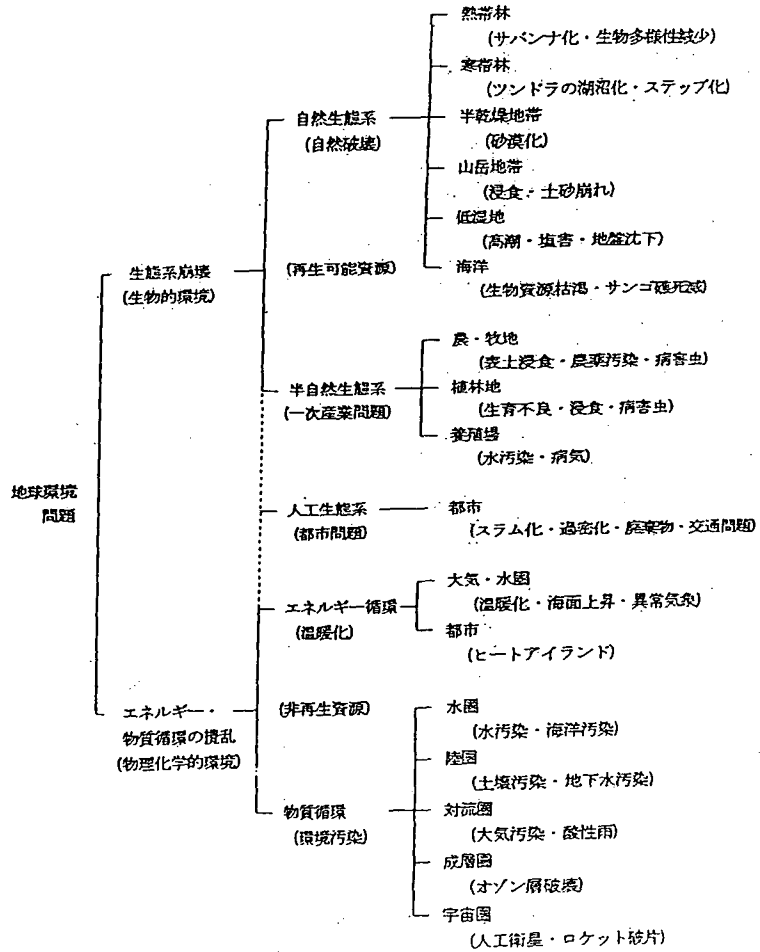
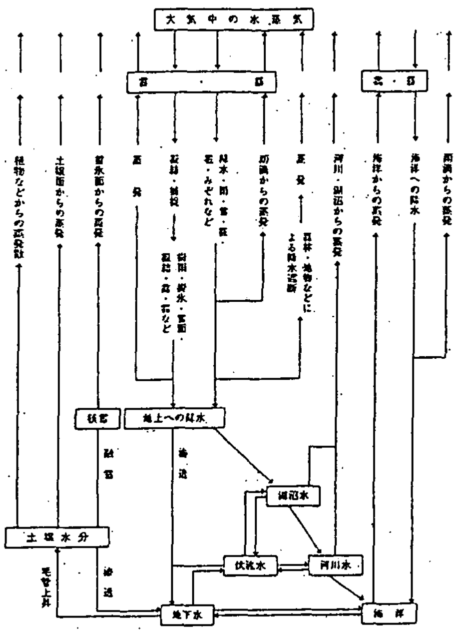


Figure 8: Global Environmental Issues

Recognition to environmental geotechnics vs. conventional geotechnical engineering (Sembenelli and Ueshita, 1981)

Conventional Geotechnical Engineering	Environmental Geotechnics
1) Solution for accidental problems/hazards	Predictable/forecasting engineering to protect environment impact
2) Limited to special cases and responsibility	Comprehensive, interdisciplinary based on soil mechanics, soil engineering rock engineering, engineering geology, groundwater engineering etc.
3) Academic, theoretical contribution	Engineering, practical contribution to regional geotechnical problems. Ultimates comprehensive responsibility
4) Contribution to local, limited field	Positive contribution to environment impact assessment and control at initial regional development project

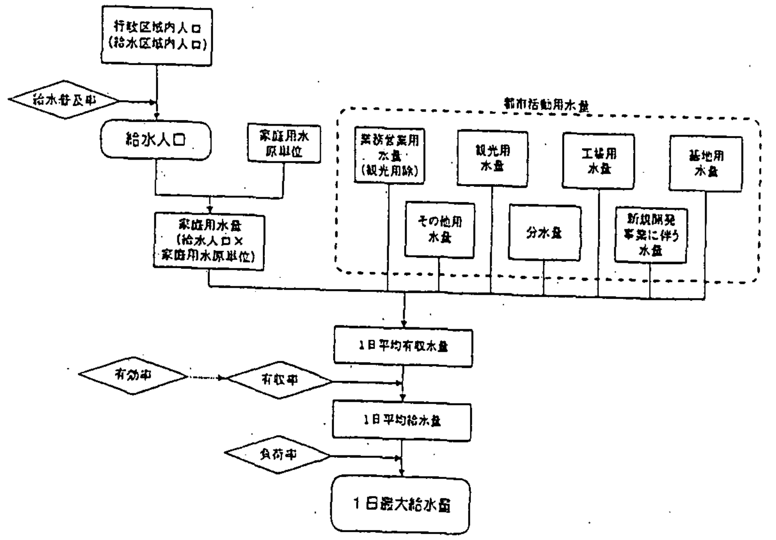
Figure 9: Soil Mechanics/Soil Engineering vs. Environmental Geotechnical Engineering



（資料） 資源調査会編「日本の資源問題」(上)

水の循環

Figure 10: The Hydrological Cycle



生活用水の予測手順

Figure 11: Flow Chart: Water Supply & Demand Planning

沖縄県の主要ダム施設一覧(平成 12 年度末現在)

No.	ダム名	河川名	目的	貯水池の規模(千m3) 総貯水容量	有効貯水容量	開発水量 上水(m3/日)	工水(m3/日)	かんがい(m3/sec)	事業者	備考
[多目的ダム]										
1	福地ダム	福地川	FNWI	55,000	52,000	86,800	31,200		沖縄総合事務局	
2	新川ダム	新川川	FNWI	1,650	1,250	13,200	4,800		沖縄総合事務局	
3	安波ダム	安波川	FNWI	18,600	17,400	55,200	19,800		沖縄総合事務局	
4	普久川ダム	普久川	FNWI	3,050	2,550	19,900	7,100		沖縄総合事務局	
5	辺野喜ダム	辺野喜川	FNWI	4,500	4,000	15,500	5,500		沖縄総合事務局	
6	漢那ダム	漢那福地川	FNAW	8,200	7,800	11,500		12,000	沖縄総合事務局	(水量:m3/日)
7	倉敷ダム	与那原川	FNW	7,100	6,900	28,800			沖縄県	
8	金城ダム	安里川	FN	510	470				沖縄県	
9	座間味ダム	内川	FNW	66	56	45			沖縄県	
10	真栄里ダム	宮良川	FNA	2,300	2,100			注1	沖縄県・沖縄総合事務局(共同事業者)	
[都市用水]										
11	金武ダム	億首川	W	820	660	19,000			沖縄県企業局	
12	山城ダム	天願川	W	1,250	1,190	7,600			沖縄県企業局	注2
13	屋嘉ダム	前田川	W	83	60	326			金武町	
[かんがい用水]										
14	底原ダム	底原川	A	13,000	12,850			2.201※	沖縄総合事務局	
15	石垣ダム	宮良川	A	420	400			0.938※	沖縄総合事務局	
16	名蔵ダム	名蔵川	A	3,970	3,820			0.761※	沖縄総合事務局	
17	大浦ダム	大浦川	A	1,190	1,170			0.187※	沖縄県	
18	喜瀬武原ダム	億首川	A		300			6,221	金武町(防衛施設庁	(水量:m3/日)
19	当袋ダム	グガチャ川	A		423			1,996	恩納村(防衛施設庁	(水量:m3/日)
20	儀原ダム	慶武原川	A		267	180		2,696	宜野座村(防衛施設	(水量:m3/日)
21	鍋川ダム	松田鍋川	A	375	333			0.073※	宜野座村	
22	長浜ダム	長浜川	A	1,600	1,430			0.225※	沖縄県	
23	石川ダム	石川川	A	230	216			0.130※	沖縄県	改修中
24	砂川地下ダム	—	A	9,500	6,800			1.46※	沖縄総合事務局	
25	福里地下ダム	—	A	10,500	7,600			1.83※	沖縄総合事務局	

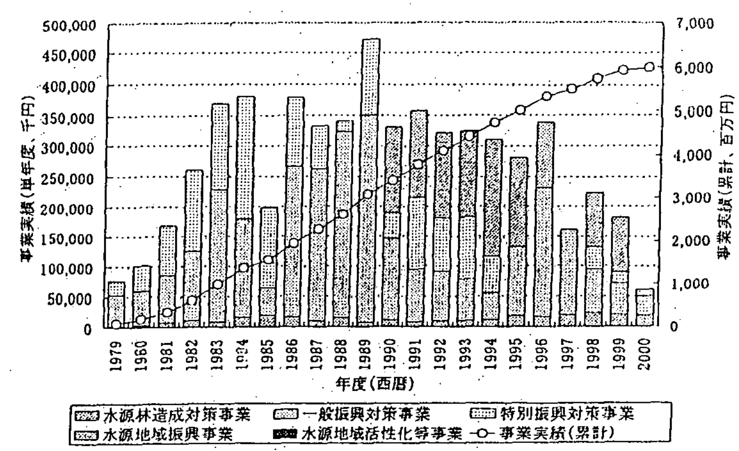
目的(F:洪水調節、N:流水の正常な機能の維持、A:かんがい用水、W:水道用水)
※最大取水量
注1)1日最大 146,620m3/日
注2)山城ダムは石川浄水調整池と合わせて46,200m3/日の開発水量

出典)沖縄県土木建築部:平成11年度版土木建築部要覧、沖縄県土木建築部河川課:沖縄県のダム概要、
内閣府沖縄総合事務局北部ダム事務所:平成12年度事業概要、
沖縄県農林水産部農地水利課:平成12年度沖縄県農業用水需給計画調査業務報告書、
財団法人日本ダム協会:ダム年鑑2000

河川表流水取水施設(平成 11 年現在)

	取水ポンプ場名	河川名 水系	河川	日最大取水量 (m3/日)
1	武見	武見川水系	武見川	9,850
2	座津武	座津武川水系	座津武川	18,400
3	宇嘉	宇嘉川水系	宇嘉川	16,400
4	辺野喜	辺野喜川水系	辺野喜川	6,900
5	佐手	佐手川水系	佐手川	32,000
6	佐手前	佐手前川水系	佐手前川	8,600
7	与那	与那川水系	与那川	32,700
8	宇良	宇良川水系	宇良川	23,300
9	比地	比地川水系	比地川	14,700
10	田嘉里	田嘉里川水系	田嘉里川	19,900
11	喜如嘉	外堀田川水系	外堀田川	19,000
12	満名	満名川水系	満名川	23,300
13	西屋部	屋部川水系	西屋部川	21,600
14	大保	大保川水系	大保川	37,400
15	平南	平南川水系	平南川	31,680
16	源河	源河川水系	源河川	38,600
17	川崎	天願川水系	天願川	55,300
18	比謝川	比謝川水系	比謝川	63,900
19	長田川	比謝川水系	長田川	25,000

Figure 12: Dams and Pump Stations in Okinawa



注)2000(平成 12)年度は予算値

出典)沖縄県企画開発部地域・離島課資料

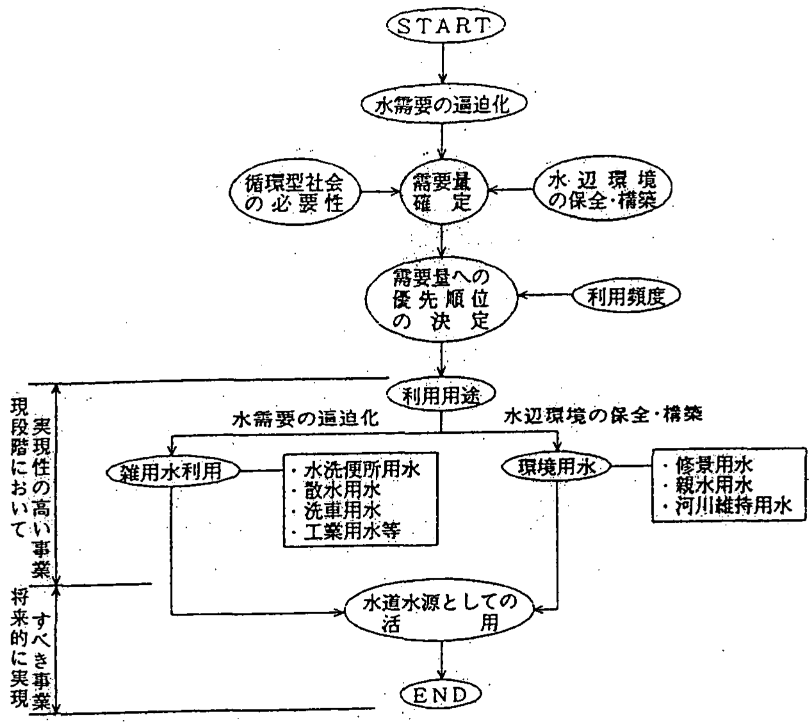
沖縄県水源基金の事業実績の推移

海底送水管の一覧

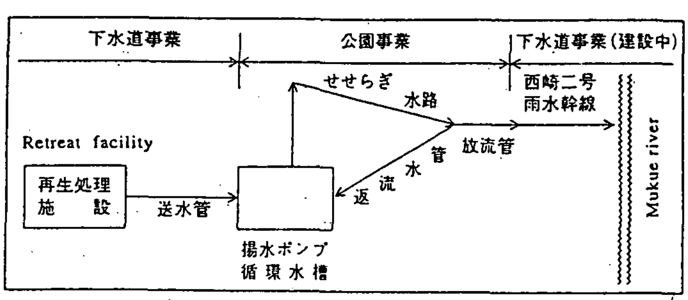
施工年度	送水管布設区間	事業主体名	施設計画 給水人口(人)	給水量(m3/日)	送水管総延長(m)	送水管口径(mm)
S46	平良市狩俣(宮古島)～池間島	宮古島(企)	2,500	420	2,903	150
S47～S49	西表島～新城島～黒島	竹富町	746	220	13,098	75～150
S47～S49	下地町前浜(宮古島)～来間島	宮古島(企)	548	206	1,601	125
S47～S49	勝連町平敷屋(沖縄本島)～津堅島	勝連町	1,600	270	4,606	125
S50	奥武島～オーハ島	仲里村	117	21	555	75
S50～S51	石垣市新川(石垣島)～竹富島	竹富町	550	140	4,242	150
S50～S51	本部町備瀬(沖縄本島)～伊江島	県企業局	8,000	1,700	5,226	200
S50～S51	今帰仁村運天(沖縄本島)～古宇利島	今帰仁村	1,200	255	1,482	150
S52～S53	西表島～小浜島	竹富町	1,000	400	2,904	150
S52～S53	知念村吉富(沖縄本島)～久高島	知念村	540	140	6,550	100
S54～S55	西表島～鳩間島	竹富町	100	40	6,542	75
S54～S55	平良市狩俣(宮古島)～大神島	宮古島(企)	200	80	3,700	75
S55	瀬底島(本部町)～水納島	本部町	140	71	4,300	75
S56～S57	本部町健堅(沖縄本島)～瀬底島	本部町	1,051	473	725	150
S56～S57	平安座島(与那城町)～浜比嘉島	勝連町	1,180	306	1,560	100

出典)沖縄県福祉保健部薬務衛生課:沖縄県の水道概要(平成10年度)

Figure 13: Projects at the Water Source and Water Transmission to Remote Islands



事業実施に到るフローシート

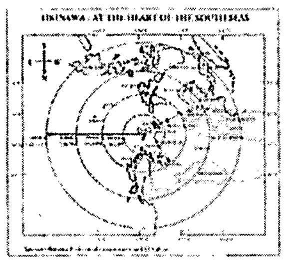


糸満市アクアパーク計画

Figure 14: Reusing Treated Sewage and Wastewater

OVERVIEW:
Water Resource Issues of Island Communities

Case Study of
Sustainable Development In Okinawa Prefecture



Sources: Okinawa Prefectural Government, H Kakazu

Hosei UEHARA
Director, Uehara Geotec Research Center

Introduction

- The 3rd Promotion & Development Plan (~2002) and the New Okinawa Promotion & Development Plan (2002~)
- Key Concepts: Peace, Comfort, and Vigor
- Goals: Sustainable development for self-sufficiency
  Hub of Asia-Pacific cooperation
- 21st Century Trends and Currents
- Development of logistic & transport systems, IT, energy, water resources

Remarks

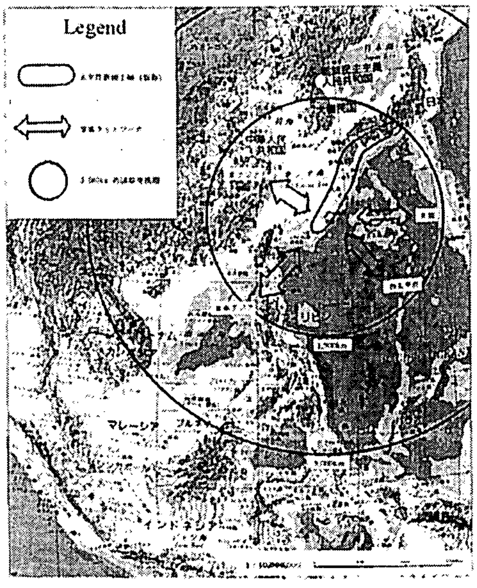
- Environmental Geotechnology
- Okinawa Prefecture's Long Term Plan for Water Supplies & Demand
- Diverse Water Utilization Methods

Keynote Speech/Hosei Uehara

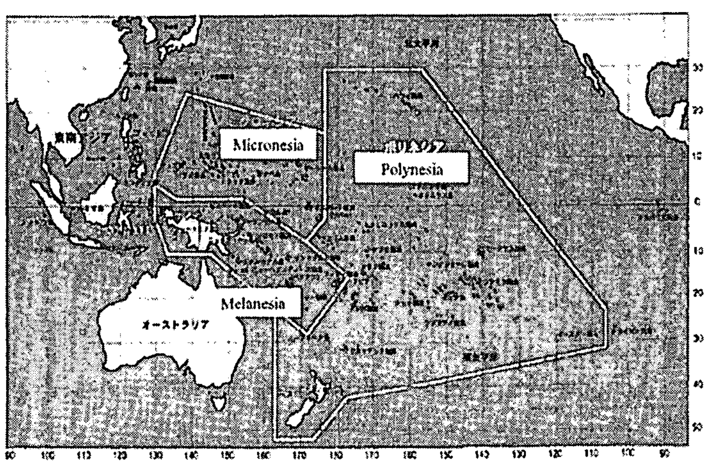
Basic Direction for Okinawa Regional Development (PROPOSAL)

Promote exchange within a 3,000 km radius of Okinawa, with the Asia-Pacific region.

Source: Okinawa Prefecture

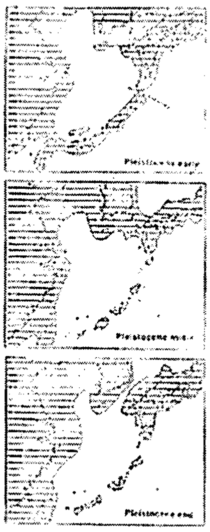


Inland Regions: Islands of the South & SW Pacific

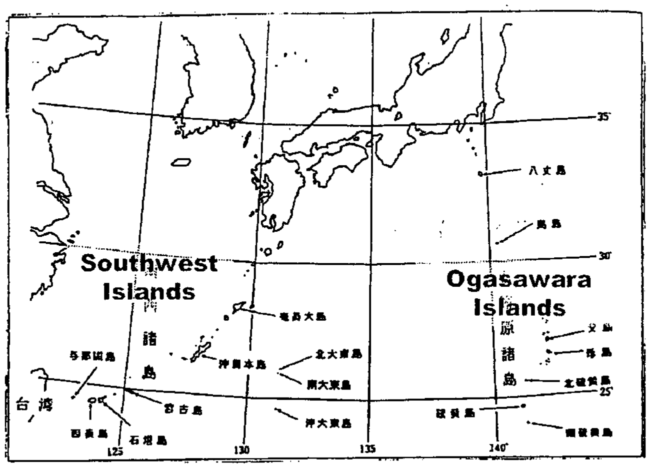


Source: Oceanic Culture Museum,
Ocean Exposition Commemorative Park Management Foundation

Japan and the Ryukyu Archipelago



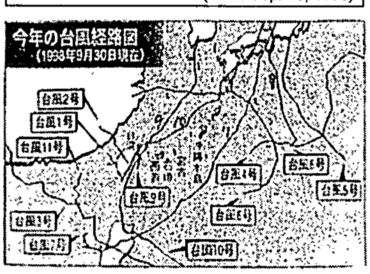
The Southwest Islands & Geological History



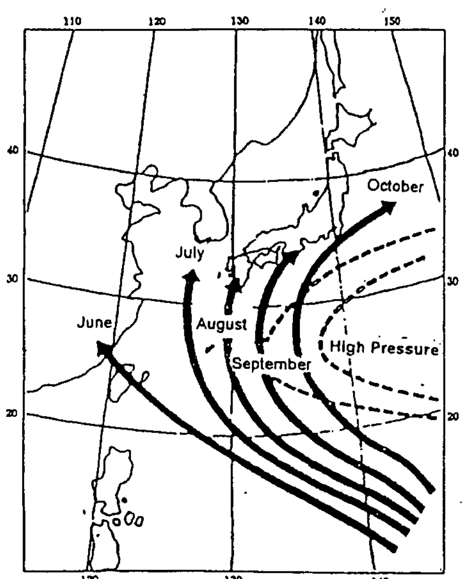
(Source: Old Geography of Ryukyu Islands / Kisaki,Oshiro,1977)

Typhoon Paths and Rainfall

Typhoon Paths, 1998
(As of Sep. 30, 1998)

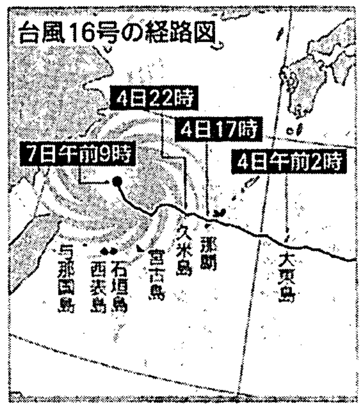


Usual Typhoon Paths by Month

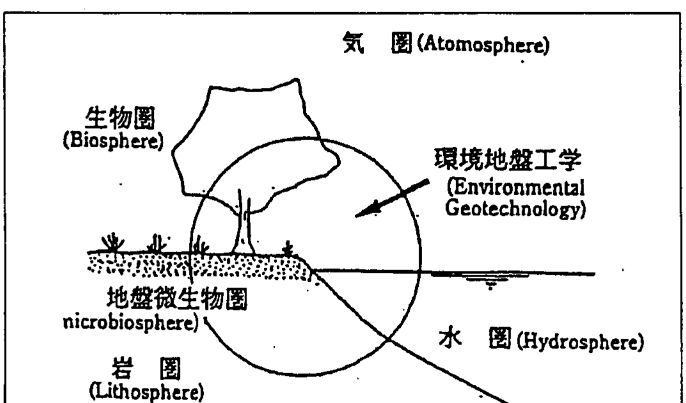


Typhoon Paths and Rainfall


目パッチリ、気性荒く、長居した
風速、雨量は記録ずくめ



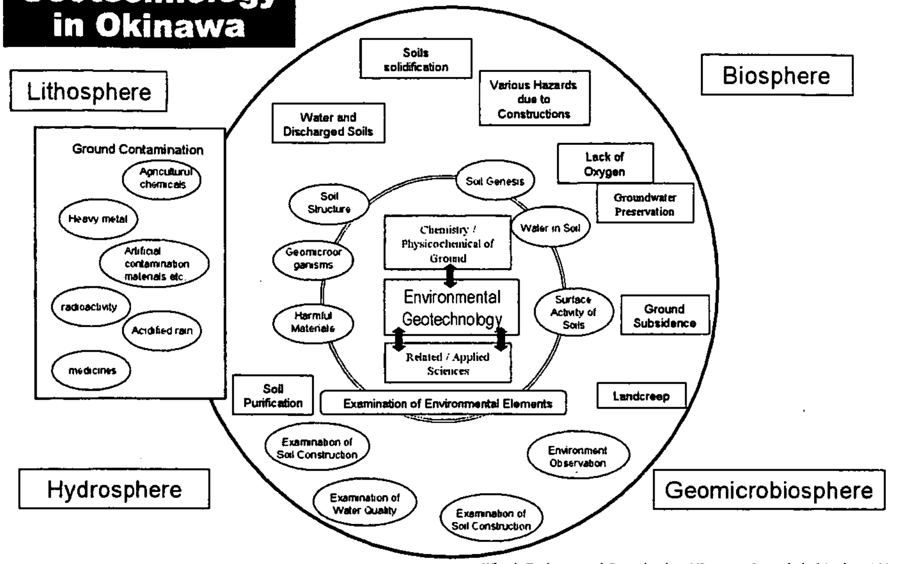
Environmental Geotechnology



The Scope of Environmental Geotechnology

(Source: Japanese Geotechnical Society, "What is Environmental Geotechnology?", 1994

Environmental Geotechnology in Okinawa



What is Environmental Geotechnology?(Japanese Geotechnical Society, 1994)

Keynote Speech/Hosei Uehara

Environmental Geotechnology on Okinawa

1) Island Surroundings	Weather, sea, tidal plain, latitude/longitude
2) Inland conditions	Area size, topography, geology, soil, water systems, flora & fauna, ecosystem, etc.
3) Human activities	Population, settlements, history, culture, agriculture, wastes, etc.
4) Artificial reformation	Development, construction, facilities, wastes, etc.
5) Imbalances of island nature	Changes in landforms, coast, water systems and ecosystems, public nuisance, etc.
6) Insular characteristics and measures	Island capacities, land usage, water resources development, conservation and preservation of the natural environment, disaster prevention, safety and amenities, etc.

Environmental Factors to be Studied

Keynote Speech/Hosei Uehara

Environmental Geotechnology on Okinawa

Geotechnical Engineering on the Islands

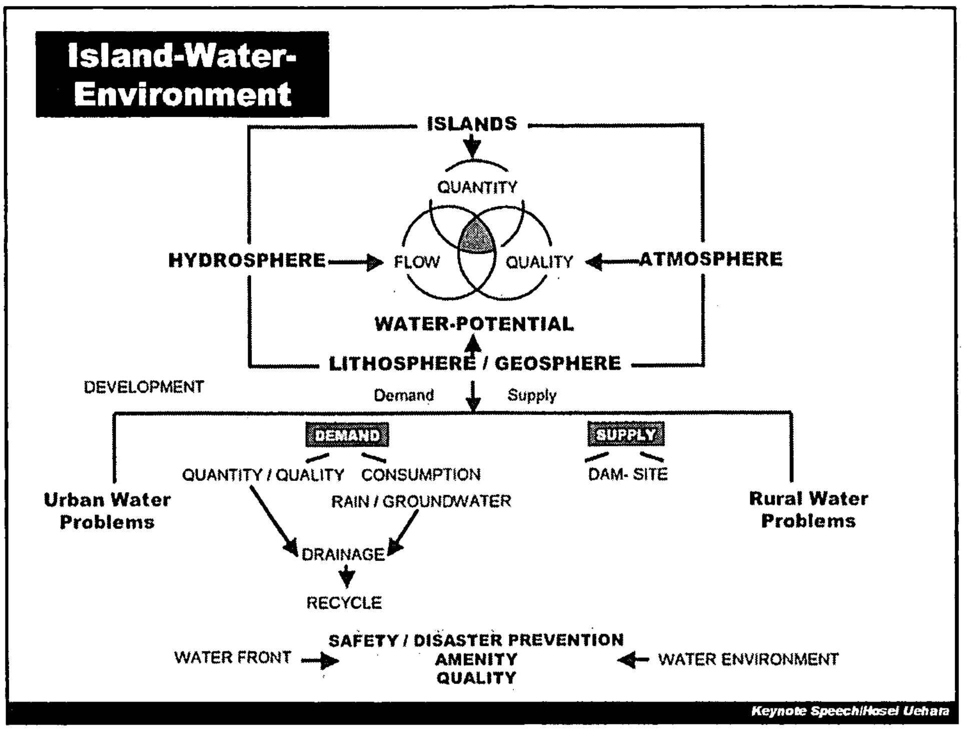
Environmental Factors on Islands	Geotechnical Subjects	
1) Latitude/Longitude, Temperature, Humidity, Sunshine, Precipitation, Evaporation, Water Temperature, Salt, etc.	* Effects of Climates on to the Soil (Genesis) * Effects of Island Topography and Geology on the Soil	Evalution
2) Area, Topography, Geology, Soil, Water System, Ecology, Underground Resources etc.	* Soil Map and Classifications (Sub-Tropical Soils) * Geological and Geotechnical Problems, Ground water	Projection
3) Residences, Livings, Primary, Secondary, and Tertiary Industries etc.	* Earth Materials and Foundation Problems for Structures and Facilities (Islands Capacity)	Regulations / Contr
4) Development, Agriculture, Reclamation and Residential Lot Development, Industries, etc.	* Measures for Planning, Designing, and Performance of Public Works, and Observation Data→Analysis→Method→Observation	Countermesures

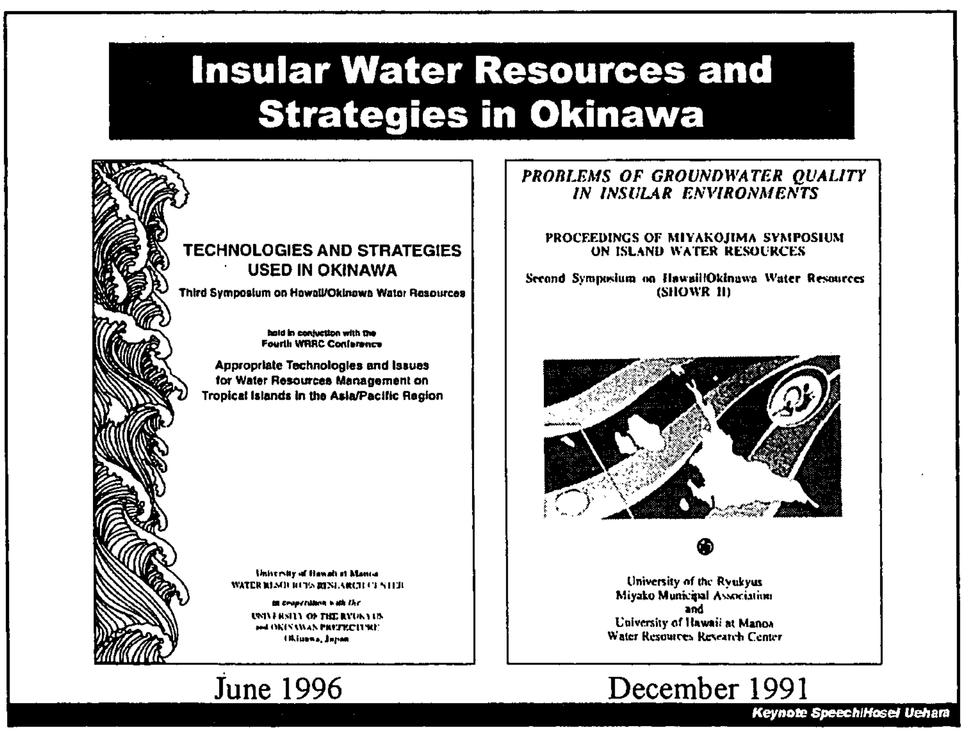
Keynote Speech/Hosei Uehara

The Role of Geotechnology in Insular Regions

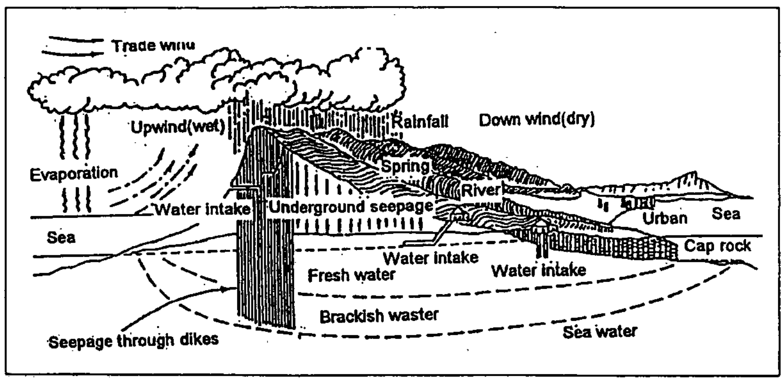
1. Construction and disaster control (soil erosion, landslides, cave-in's, etc.)
2. Land development and soil erosion into rivers and oceans
3. Land reclamation and environmental and fisheries concerns
4. Problems associated with water resource development
5. Waste disposal and environmental concerns
6. Construction vs. historical/cultural assets
7. Other environmental issues; reuse, recycling, and use of underground space

Keynote Speech/Hosei Uehara


Island-Water-Environment
ISLANDS
QUANTITY
HYDROSPHERE
FLOW
QUALITY
ATMOSPHERE
WATER-POTENTIAL
LITHOSPHERE / GEOSPHERE
DEVELOPMENT
Demand
Supply
DEMAND
SUPPLY
QUANTITY / QUALITY
CONSUMPTION
DAM- SITE
Urban Water Problems
RAIN / GROUNDWATER
Rural Water Problems
DRAINAGE
RECYCLE
SAFETY / DISASTER PREVENTION
WATER FRONT
AMENITY
QUALITY
WATER ENVIRONMENT
Keynote Speech/Hosei Uehara

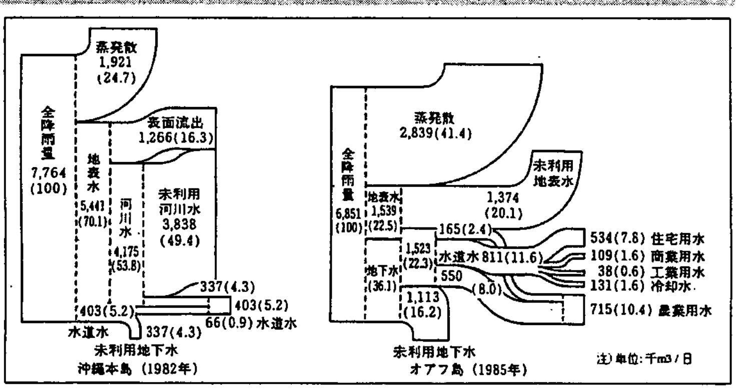

Insular Water Resources and Strategies in Okinawa
TECHNOLOGIES AND STRATEGIES USED IN OKINAWA
Third Symposium on Hawaii/Okinawa Water Resources
Appropriate Technologies and Issues for Water Resources Management on Tropical Islands in the Asia/Pacific Region
PROBLEMS OF GROUNDWATER QUALITY IN INSULAR ENVIRONMENTS
PROCEEDINGS OF MIYAKOJIMA SYMPOSIUM ON ISLAND WATER RESOURCES
University of the Ryukyus
Miyako Municipal Association
and
University of Hawaii at Manoa
Water Resources Research Center
June 1996
December 1991
Keynote Speech/Hosei Uehara

Hydrology of Oahu Is., Hawaii



Source: N. Miwa, “Prospects for Island Water Environments” 1,990-10, Hirugisha

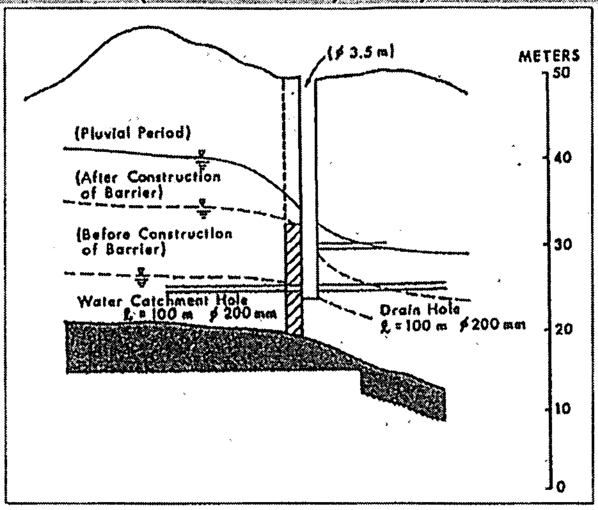
Comparison of Water Sources & Use in Okinawa and Hawaii



Source: N. Miwa, “Prospects for Island Water Environments” 1,990-10, Hirugisha

References:
1. Miwa, et al; Water and Survival in an Island Environment(1988)
2. Hawaii Water Resources Regional Study(1975)
3. Young; Water Quality, SHOWR(1987)
4. State of Hawaii; Data Book(1985)

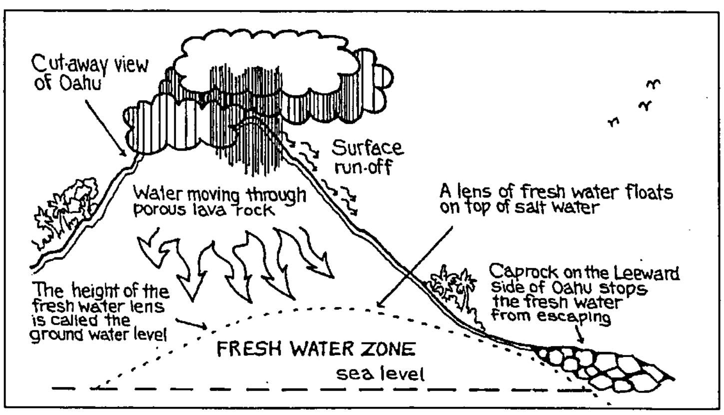
Visual Pumping Hole and Drain of Minafuku Underground Dam
(H. Furukawa, 1987)



Source: H. Furukawa, "Prospects for Island Water Environments" 1,990-10, Hirugisha

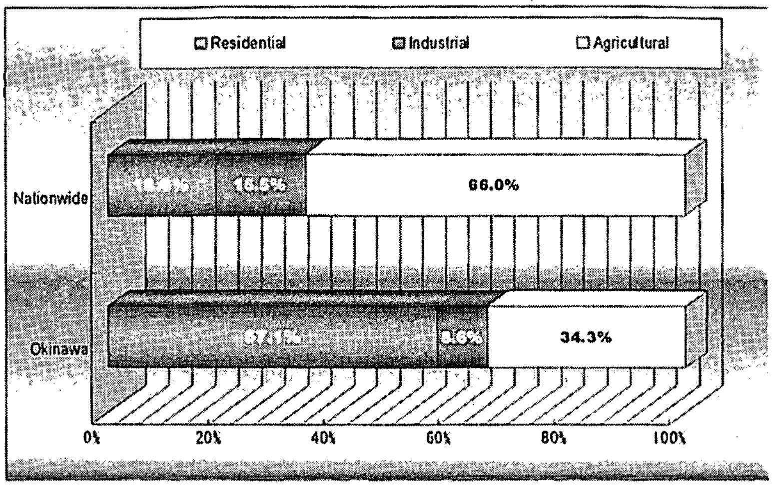
Keynote Speech/Hosel Uehara

How Groundwater Works



Keynote Speech/Hosel Uehara

Comparison of Water Usage in Okinawa and Rest of Japan



Source: Ministry of Land, Infrastructure and Transport, Water Resources Bureau, "Water Resources of Japan", 2001

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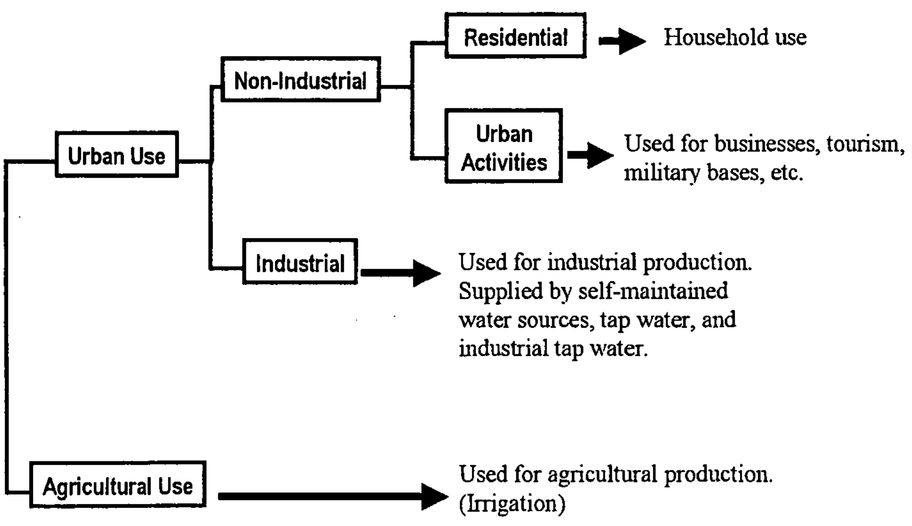
Water Usage



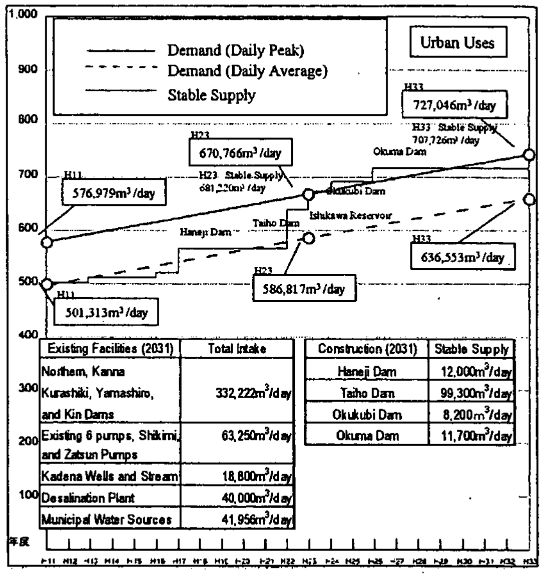
Keynote Speech/Hosei Uehara

Water Supply & Demand in Okinawa

Stable Supply	Construction of multi-purpose dams; western water resources development, development of local water sources; construction of seawater desalination plant
Agricultural Use	Irrigation and drainage facility
Effective Usage	Water conservation, use of rainwater, springs and other water sources, recycling wastewater
Forest Reorganization	Forests to recharge the water sources

Source: 22nd Conference on Department Projects, Aug. 1, 2002, Department of Development and Construction, Okinawa General Bureau

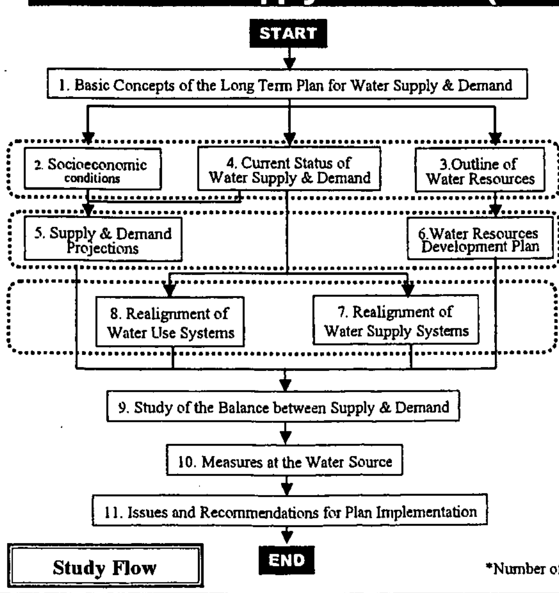
Supply & Demand (thousand m³ / day)



Existing Facilities (2031)	Total Intake
Northern, Kanna Kurashiki, Yamashiro, and Kin Dams	332,222m³/day
Existing 6 pumps, Shikimi, and Zatsun Pumps	63,250m³/day
Kadena Wells and Stream	18,800m³/day
Desalination Plant	40,000m³/day
Municipal Water Sources	41,956m³/day

Construction (2031)	Stable Supply
Haneji Dam	12,000m³/day
Taiho Dam	99,300m³/day
Okukubi Dam	8,200m³/day
Okuma Dam	11,700m³/day

Okinawa's Long Term Plan for Water Supply & Demand (Draft) March 2002



Project Blocs

No.	Bloc	Inhabited Islands	Municipalities
1	Northern Okinawa Is.	3	10
2	Southern Okinawa Is.	2	24
3	Miyako	8	6
4	Yaeyama	12	3
5	Outlying Islands Near Okinawa Is.	14	10

*Number of inhabited islands based on the 1995 National Census

Okinawa Prefecture's Long Term Plan for Water Supply & Demand (Draft) March 2002

Water Resource Development Methods

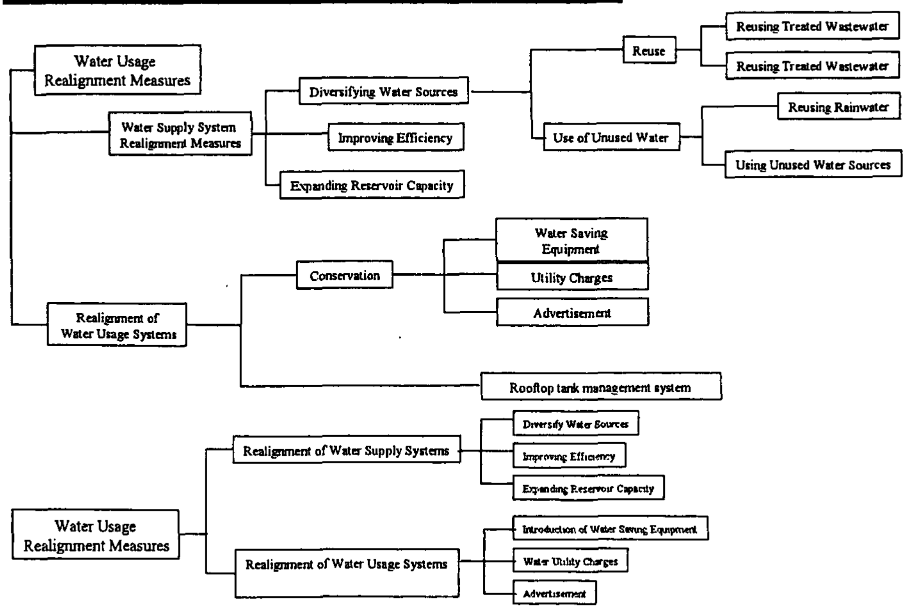
Water Source	Development Methods	Advantages/Disadvantages
Rivers	·Intake bypump ·Dam construction ·Headrace works	·High quality ·Requires measures at the water source ·Requires environmental measures
Groundwater	·Wells ·Underground dam construction ·Spring water collection system	·Low cost ·Requires water quality deterioration
Seawater	·Desalination plant construction	·Abundant source ·Not economical ·Requires environmental measures
Rainwater	·Rainwater collection system	·Simple, low cost ·Securing water volume ·Maintaining water quality
Recycled Water	·Advanced treatment plant ·Drainage system	·Reuse ·Maintaining water quality ·Not economical

Sources	Development Methods	Usage	Water Volume (m^3/day)	Timeframe
Rainwater	Individual Circulation	Install tanks on new homes	7,350 (over 10 yrs)	5 yrs
Wastewater Treatment	Regional Circulation	Used in New Naha Urban Center	2,130	5 yrs
	Regional Circulation	sed in new government buildings and school toile	3,750 (over 10 yrs)	
	Regional Circulation	Central & Southern Okinawa Redevelopment	2,580	
Water Conservation	Water Saving Faucets		-	10 yrs
	Water Saving Toilets (30% savings compared to conventional units)		-	
	Water Saving Washing Machines (27% savings compared to conventional units)		-	

Source: Taira, Nema and Shiroma, "Balance of Water Supply & Demand Between Various Uses"

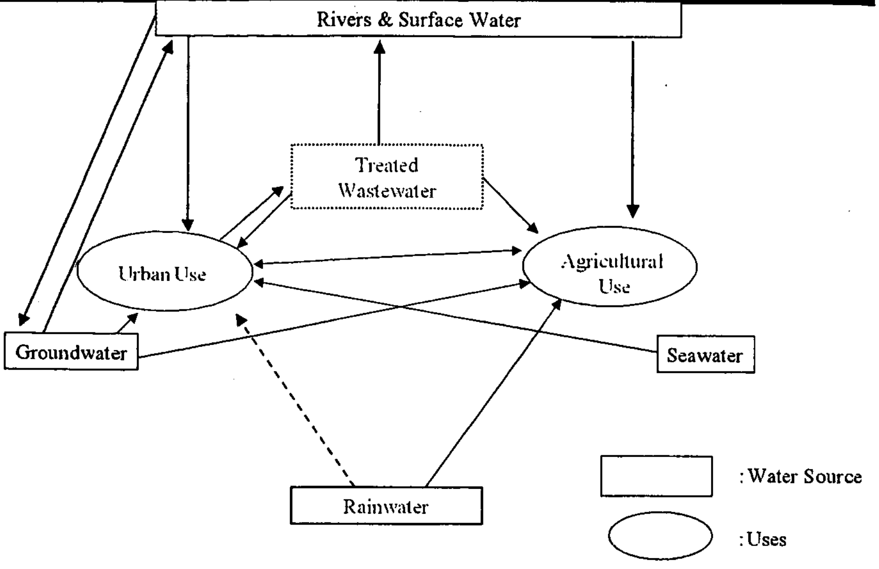
Keynote Speech/Hosei Uehara

Streamlining Water Usage



Keynote Speech/Hosei Uehara

Okinawa's Long Term Plan for Water Supply & Demand



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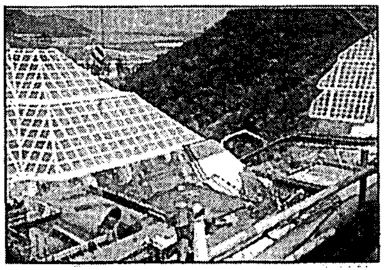
CONCLUSION

1. Solutions to Water Issues
   a. Multi-purpose dams and other infrastructure development
   b. Alternative water sources
      (1) Rainwater
      (2) Treated wastewater
      (3) Water conservation efforts

2. Recommendations
   a. Study of future supply vs. demand
   b. Diversifying water sources
   c. Improve efficiency, promote conservation
   d. Water source protection and drought measures
   e. Environmental conservation

Keynote Speech/Hosei Uehara

Small Dam on a Small Island

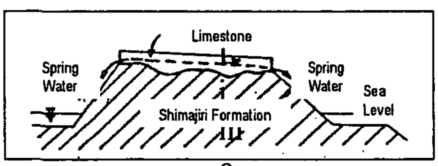


Dam Body

Gakiya Dam,
Iheya Village

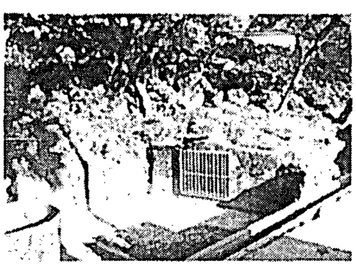
Erosion Control Facility

Use of Spring Water

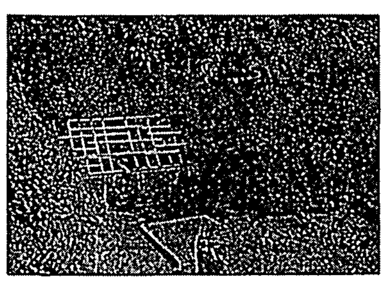


e

Typical groundwater between Ryukyu limestone and Shimajiri formation

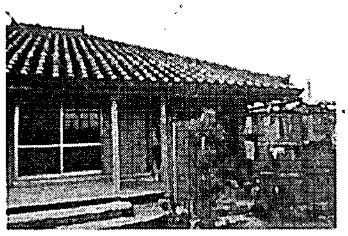


Spring

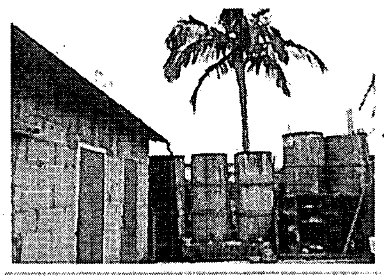


Fountain at Yamagawa, Shuri

Use of Rainwater



Rainwater Tanks in Old Residences



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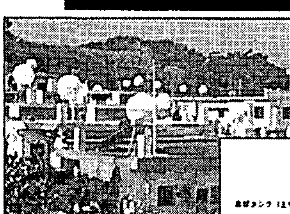
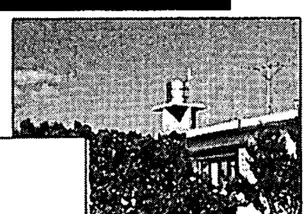
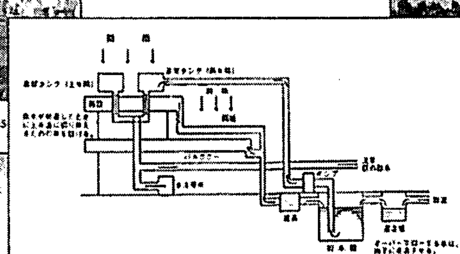
Rainwater Utilization Facilities



Water tanks on Okinawa's rooftops

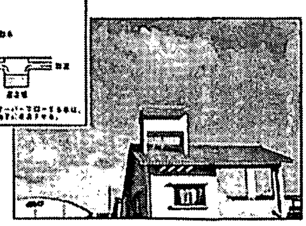


Rooftop water tank of stainless steel



Rainwater Utilization Flow Diagram

Rooftop water tank of FRP



Rooftop water tank of reinforced concrete

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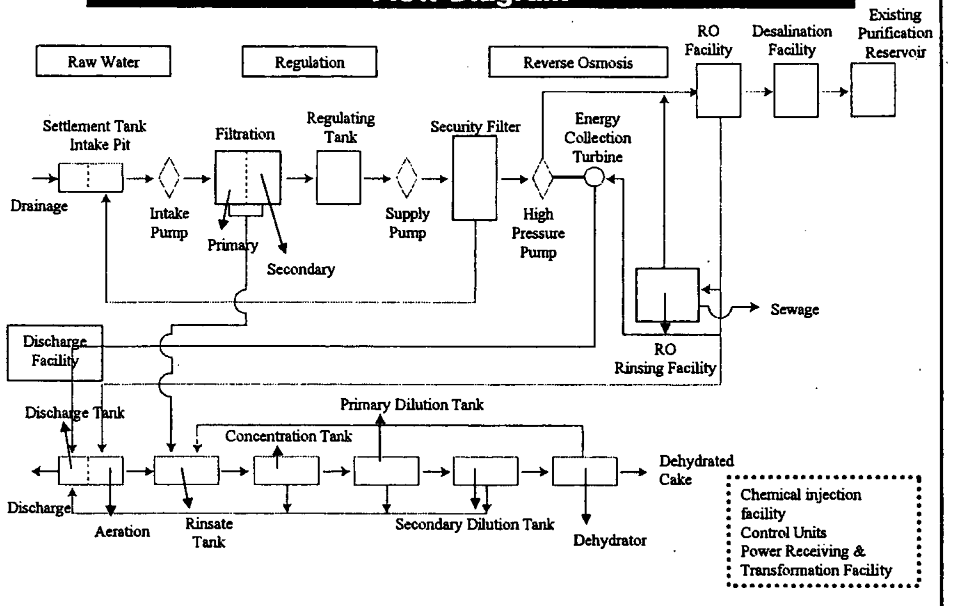
Okinawa Prefecture Seawater Desalination Plant Flow Diagram



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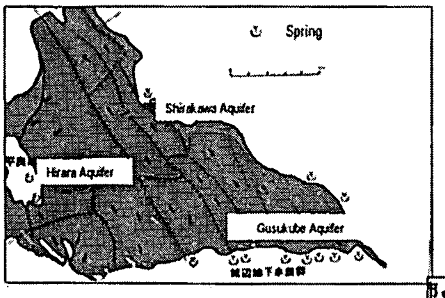
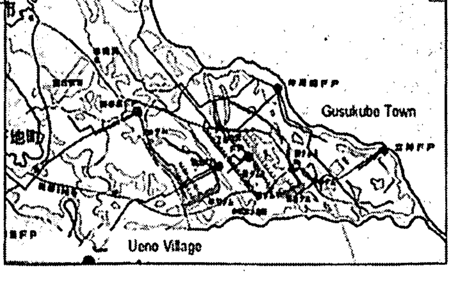
Miyako Island Underground Dam Plan





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Uses for Treated Wastewater

- Treated Waste water
  - (A) Mechanical Force
    - Flushing
      - Toilets
      - Washing Snow Away
    - Washing
      - Washing
        - Vehicles
        - Floors
        - Sand
        - Pipes
  - (B) Volume
    - Maintenance of river flow
    - Reviving clear streams
    - Dilution (sewage treatment)
  - (C) Moisture
    - Dust control
    - Irrigation
    - Sprinklers (parks, golf courses, etc.)
  - (D) Water Quality
    - Nutrient salts — Agricultural use
      - Paddy fields
      - Horticulture
    - Cleanliness
      - Ponds, artificial channels & fountains
      - Steams, ponds, canals
  - (E) Thermal Energy
    - Melting snow
    - Air conditioning by heat pumps
    - Cooling
    - Fire fighting

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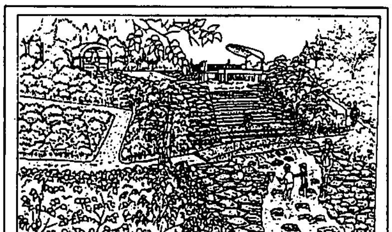
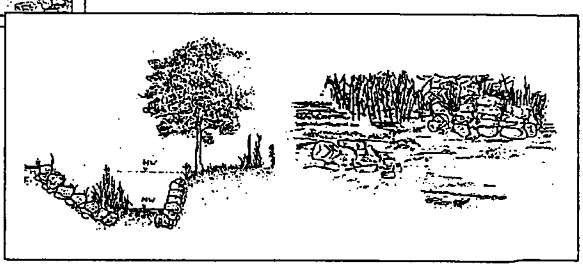
Use of Treated Water in Improving the Environment



Naha City Well Plan, 1995

Amenity



Ecology

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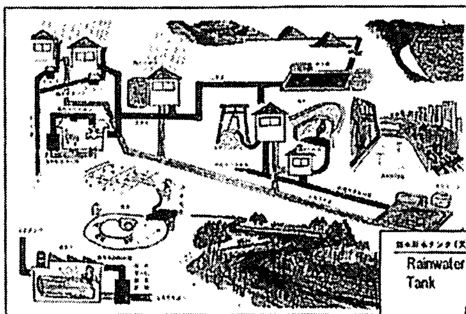
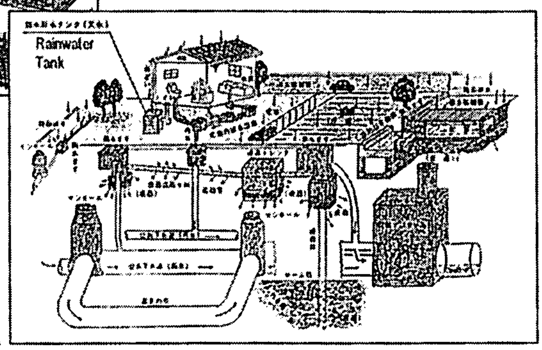
Reusing Treated Wastewater



Water Circulation Flow Diagram

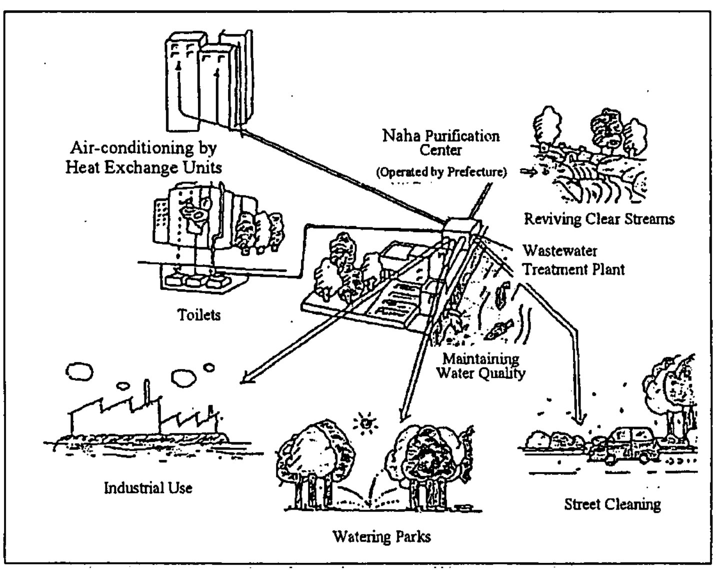
(Naha City Water Environment Conservation Plan, 1995)



Naha City Well Plan

Keynote Speech/Hosei Uehara

Reusing Treated Wastewater



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Waterfront Projects

Naha City Waterfront

Adopted	Commenced	Completed
FY 1994	Jun-94	Mar-99

Itoman City Waterfront

Adopted	Commenced	Completed
FY 1993	Oct. 1993	Mar. 1996

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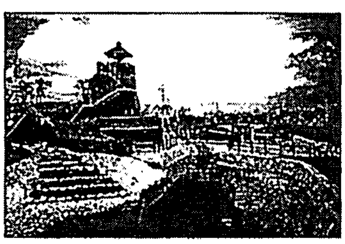
Water Encounter Park, Itoman City



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Eco-Dam Declaration:
Era of Ecological Conservation

Closing Remarks

1. **Sustainable Development**
2. **Bravo to Civil and Environmental Engineering**
3. **Think Globally, Act Locally**
4. **3R's & Create, Sustain, and Renew**

Pryer's Woodpecker

Okinawa Rail

Iriomote Wildcat

Source: Okinawa General Bureau

Keynote Speech/Hosei Uehara

Lecture 2

Case of JAPAN Ⅱ

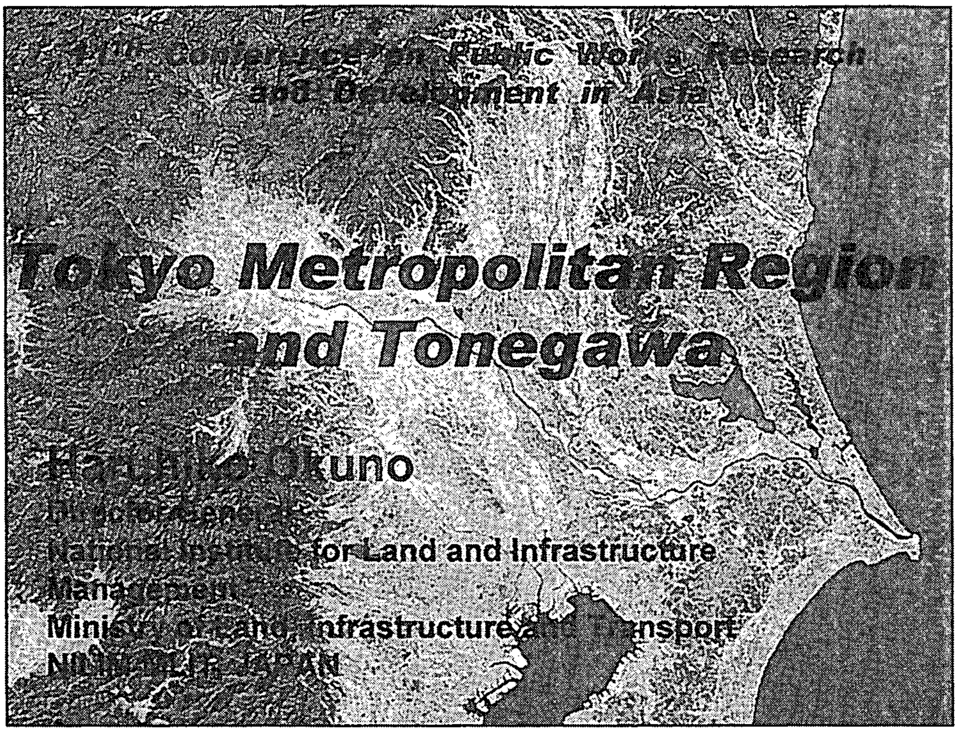
—Tokyo Metropolitan Region and Tonegawa—

Mr. Haruhiko OKUNO

Director-General,

National Institute for Land and Infrastructure Management

Ministry of Land, Infrastrucutre and Transport

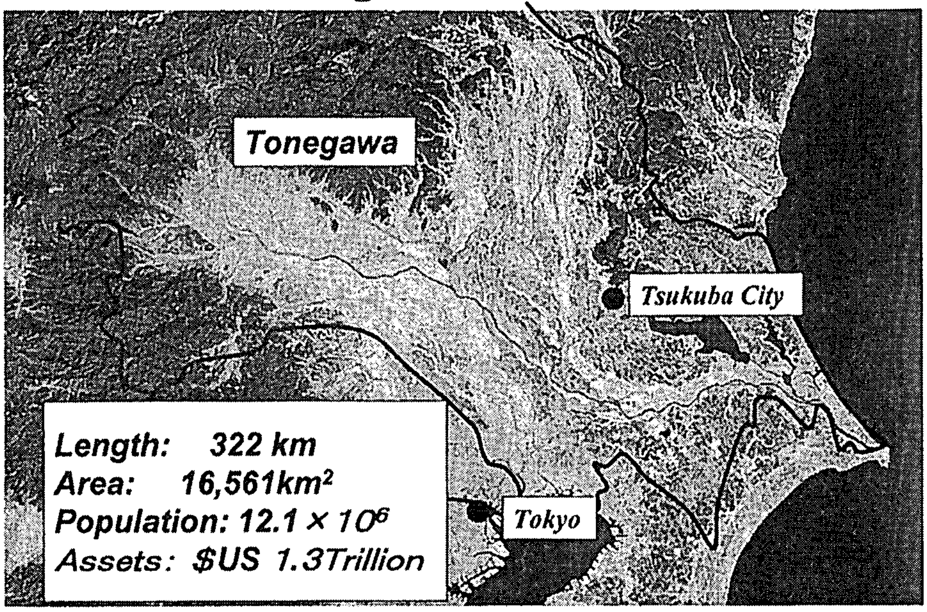


Objectives

- Review the history of Tonegawa riverworks projects (from Edo era circa 1600 - today)
- Review the issues arising from societal developments, and the role of river improvement projects, as exemplified by Tonegawa
- Explore future challenges and directions

Tonegawa

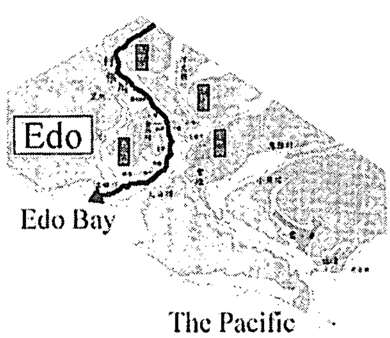
Topography



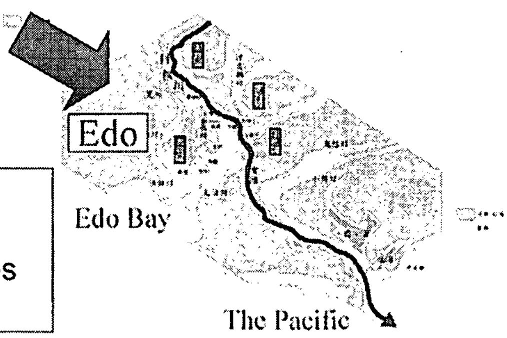
History of Tonegawa Riverworks

Edo era

Diversion Riverworks (1594~1654)



Redirect Tonegawa out to the Pacific Ocean from Edo Bay

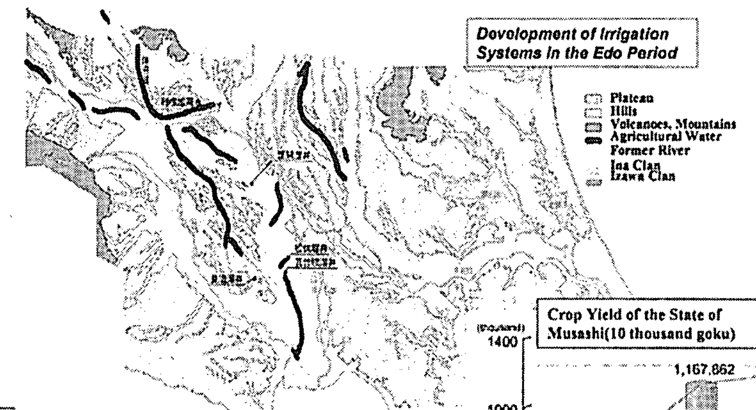


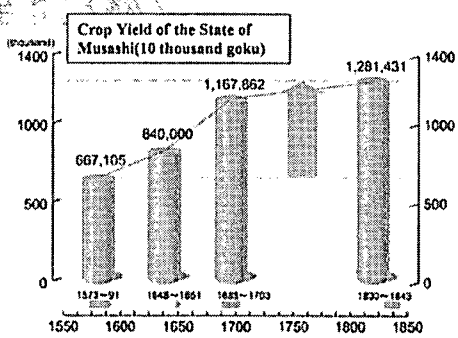
Objectives

1. Prevent floods in Edo
2. Develop new rice paddies
3. Allow navigation of ships

Rice Paddy Development

Edo era

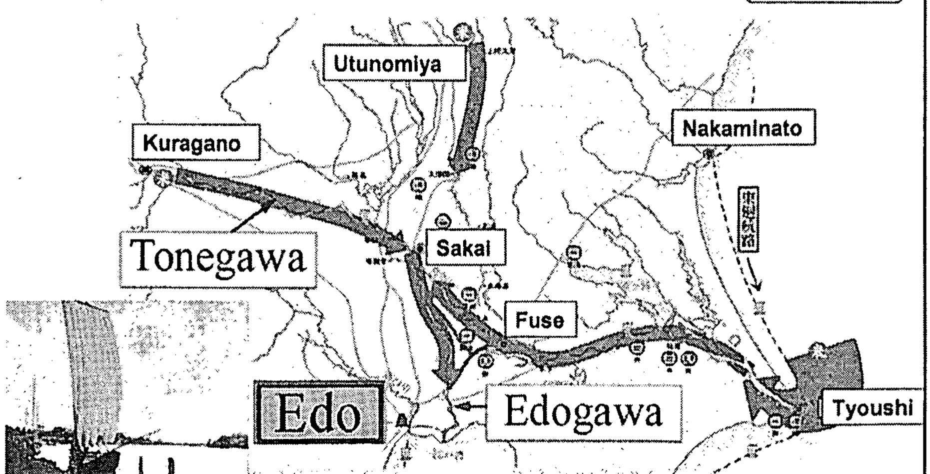




- The Tonegawa Diversion allowed the development of new rice paddies.
- Rice yields doubled, providing solid foundations for Edo's economy.

Navigation

Edo era



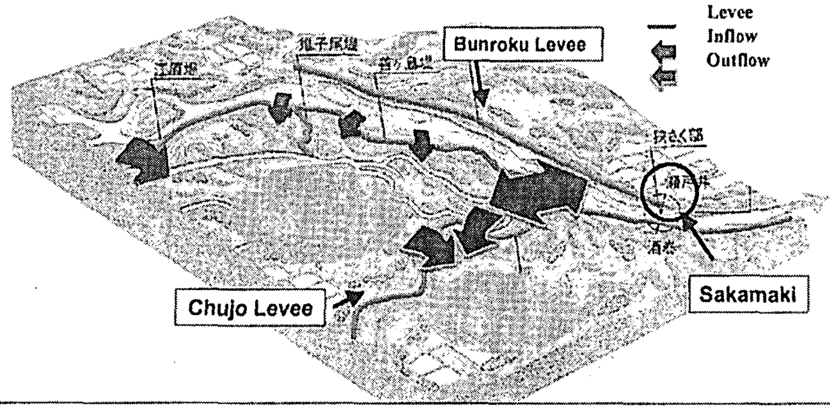
- The Tonegawa Diversion also allowed the development of an intricate inland navigation network, to serve as arteries of the Edo economy.

History of Tonegawa Riverworks

Edo era

Regulating Flow in the Middle Reaches (Chujo Levee)

How the Chujo Levee Works

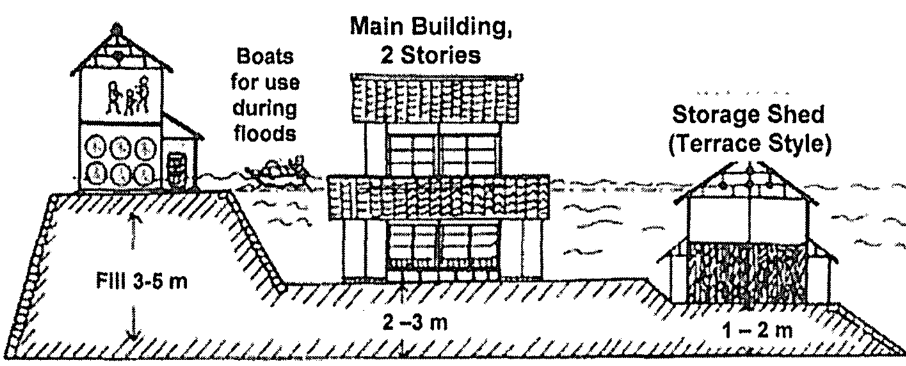


Area: 49 km^2, Capacity: 120×10^6 m^3

Mizuka: A local initiative developed by flood prone areas

Edo era

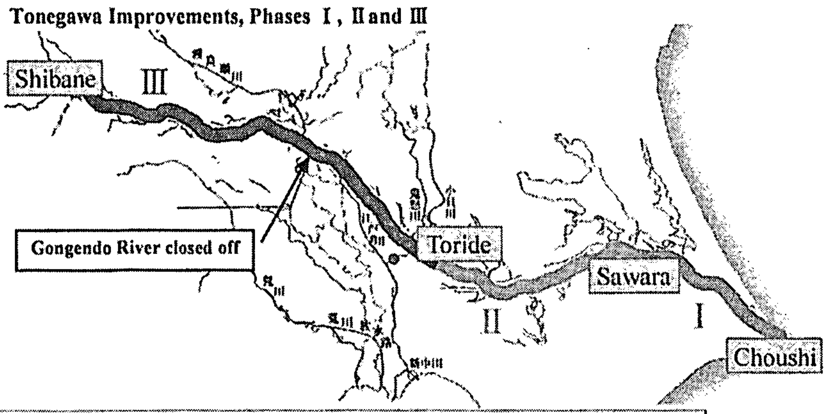
Mizuka



Mizuka: An Evacuation Refuge

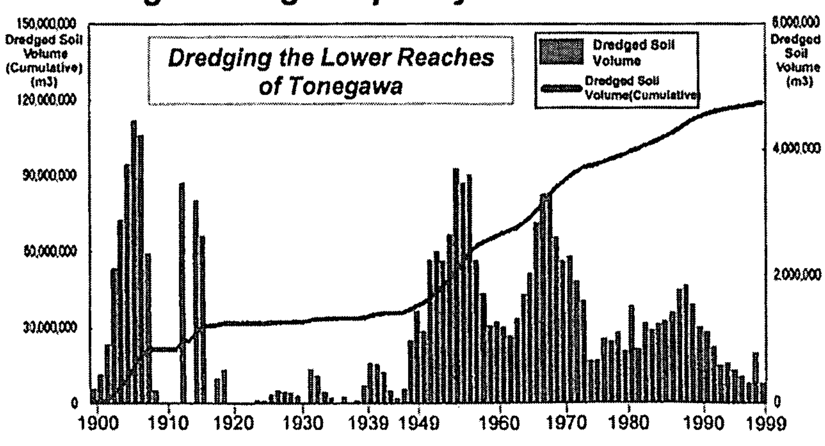
Original drawing by Shigeru Miyata, October 1, 1960

The First Modern River Improvements
(1900~1930)

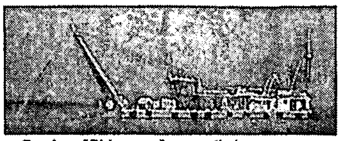


1900 Tonegawa Improvement Plan
Dredging and levee works from
the lower to the upper reaches

Dredging
Enhancing Drainage Capacity in the Lower Reaches



Dredged soil volume between
1900-1930 exceeded the
Panama Canal excavation.


Dredger "Shimousa" currently in use.

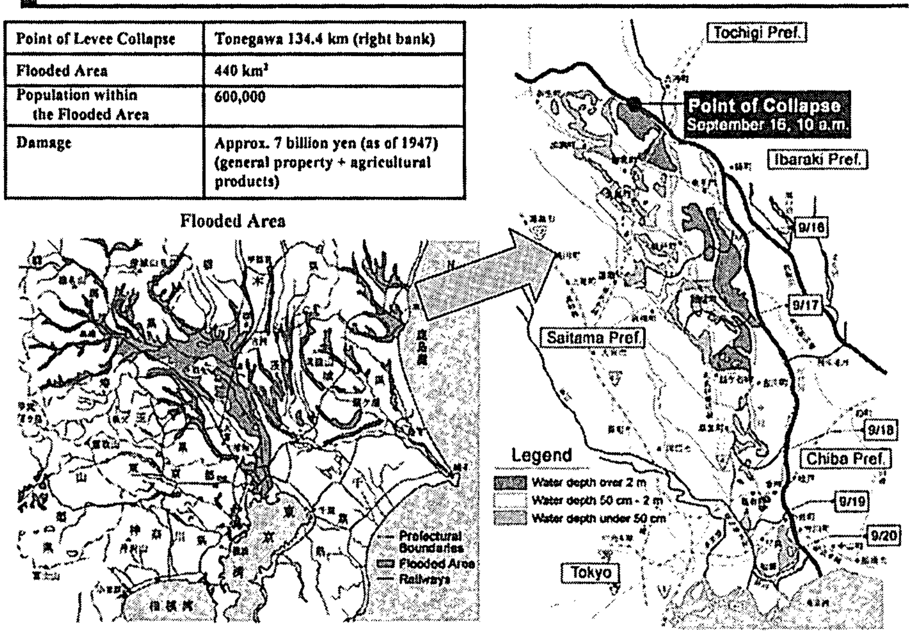
Construction of Retarding Basins in the Middle and Lower Reaches

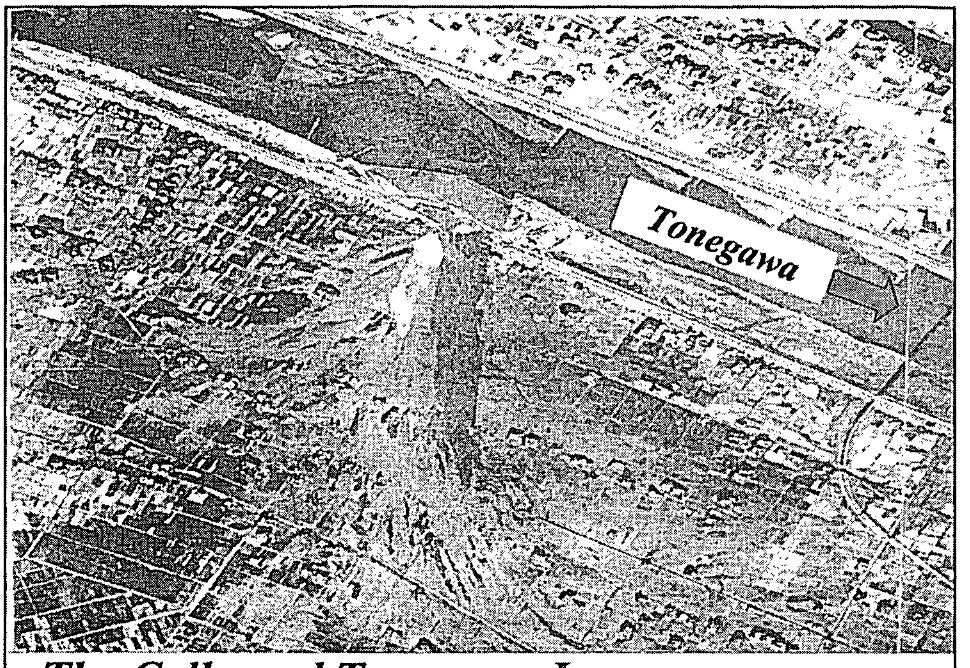
Watarase Retarding Basin (Construction began in 1911)

Damage from Typhoon Kathleen (1947)

Point of Levee Collapse	Tonegawa 134.4 km (right bank)
Flooded Area	440 km²
Population within the Flooded Area	600,000
Damage	Approx. 7 billion yen (as of 1947) (general property + agricultural products)

Flooded Area

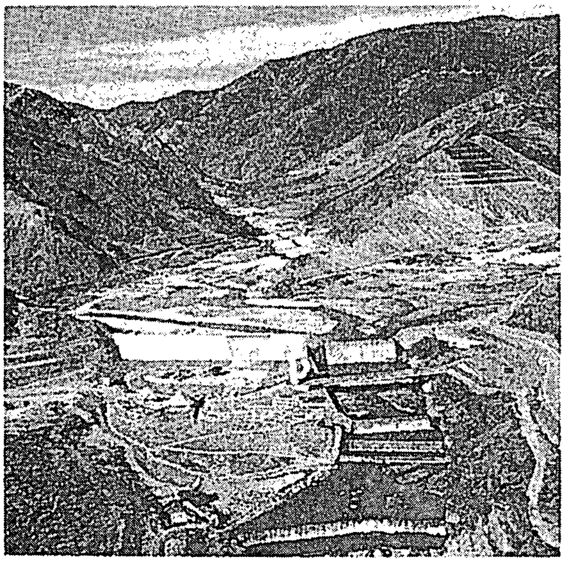




The Collapsed Tonegawa Levee October 28, 1947

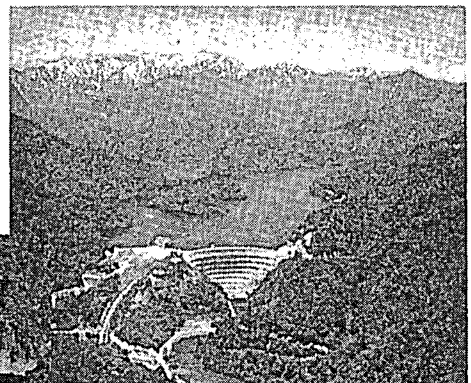
Sabo Projects at the Headwaters

Sabo Facilities for Erosion Controls

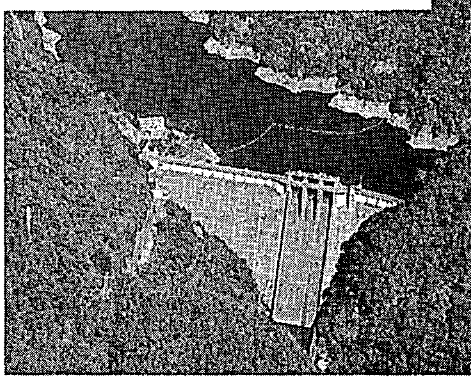


Ashio Sabo Dam
(Watarase River)

Dam Construction in the Upper Reaches



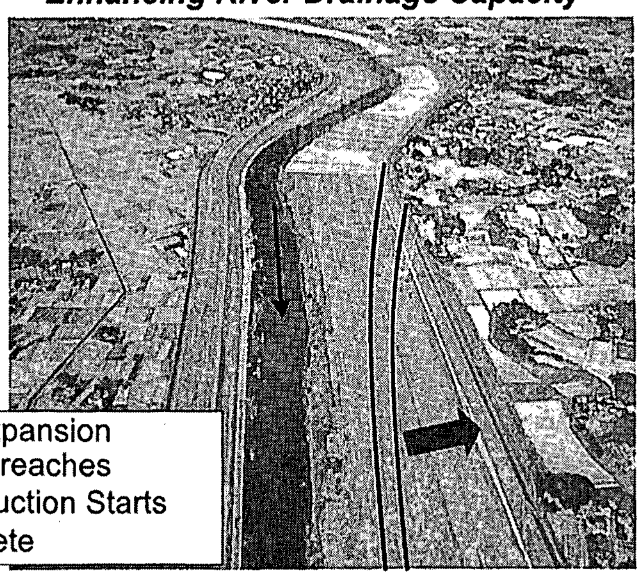
Yagisawa Dam (1967)



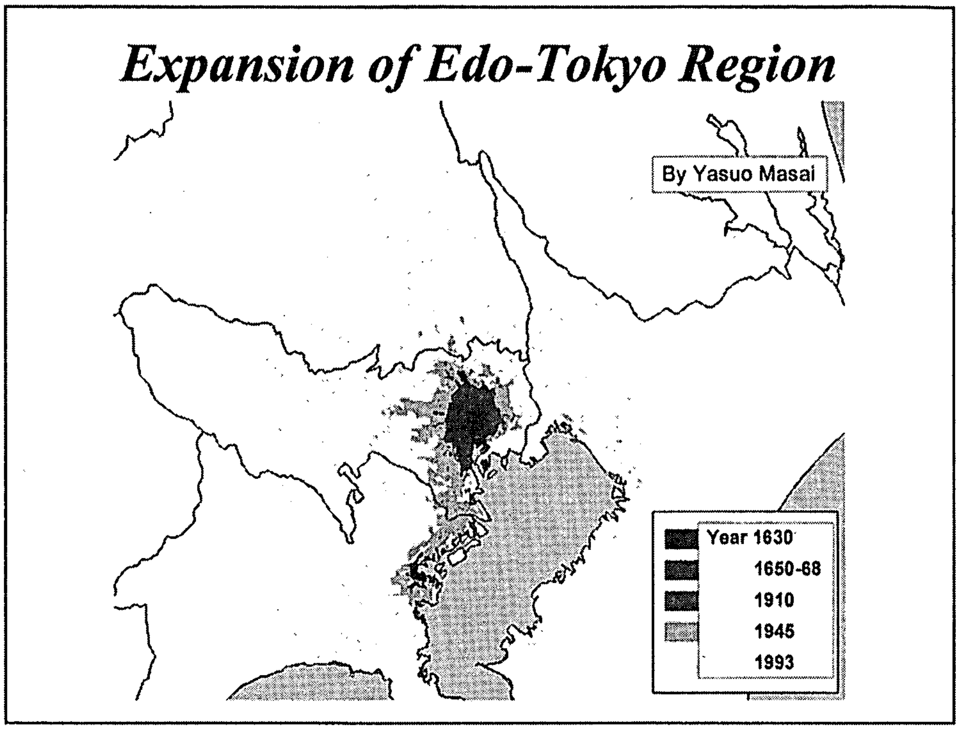
Fujiwara Dam (1957)

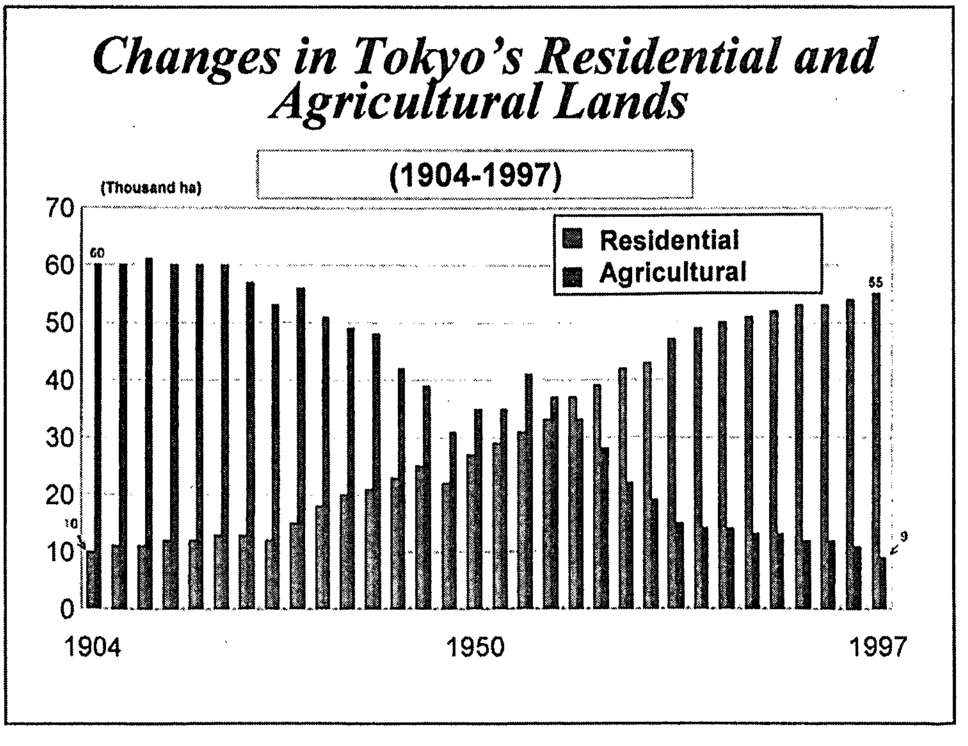
River Width Expansion

Enhancing River Drainage Capacity



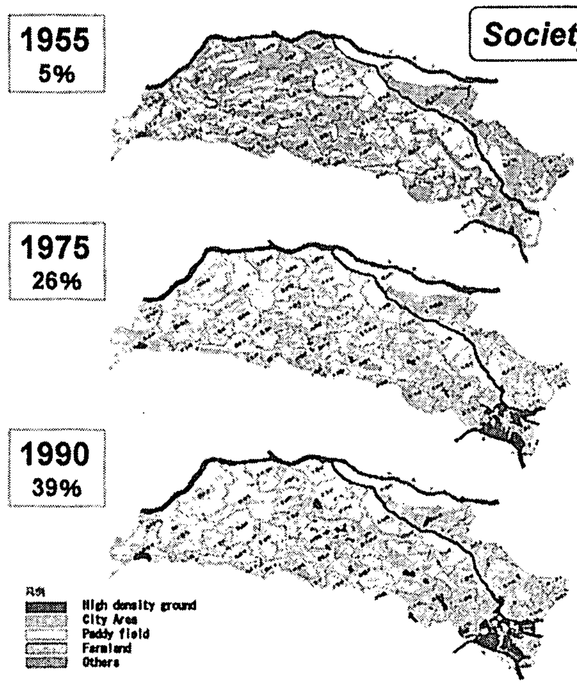
River width expansion
in the middle reaches
1949: Construction Starts
1967: Complete


Expansion of Edo-Tokyo Region
By Yasuo Masai
Year 1630
1650-68
1910
1945
1993


Changes in Tokyo's Residential and Agricultural Lands
(1904-1997)
(Thousand ha)
70
60
50
40
30
20
10
0
60
10
55
9
Residential
Agricultural
1904
1950
1997

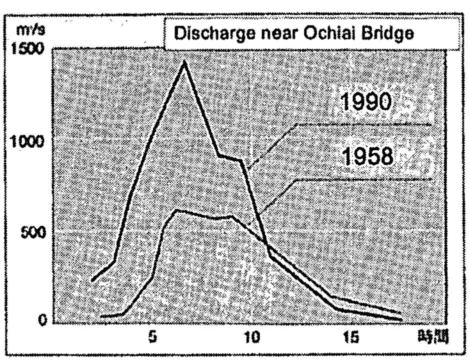
Land Use

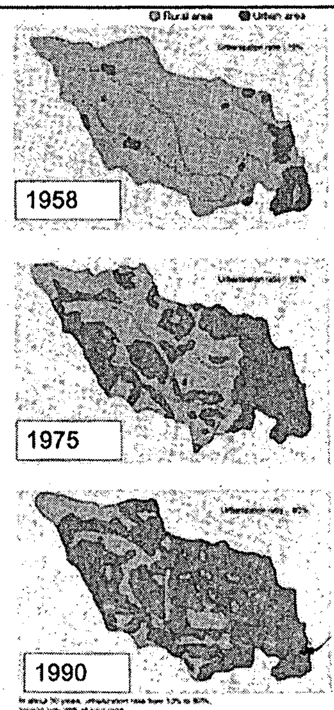
Society



Nakagawa River Basin

Water and Cities



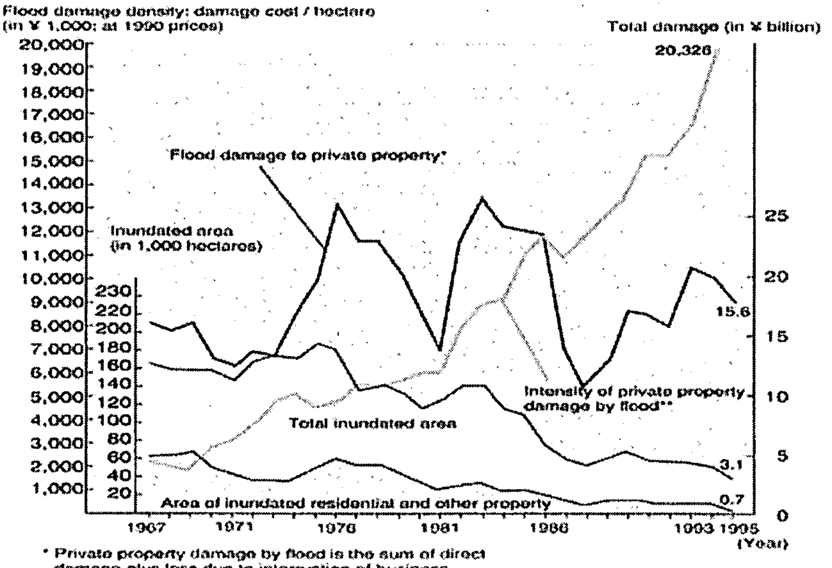


■ *Urbanization in Tsurumigawa*

Concrete, asphalt, loss of forests and vegetation increase downstream runoff and aggregate flood damage

Flood

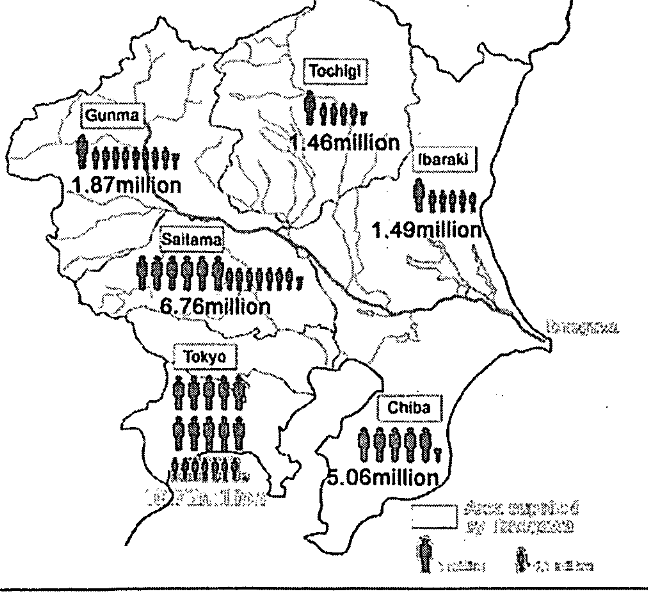
Current Problems



* Private property damage by flood is the sum of direct damage plus loss due to interruption of business.
** Density of private property damage by flood is calculated by dividing the private property damage by the area of inundated residential area.

Tonegawa Supplies Water to 27 Million in the Metropolitan Area

Current Problems



Drought (1)

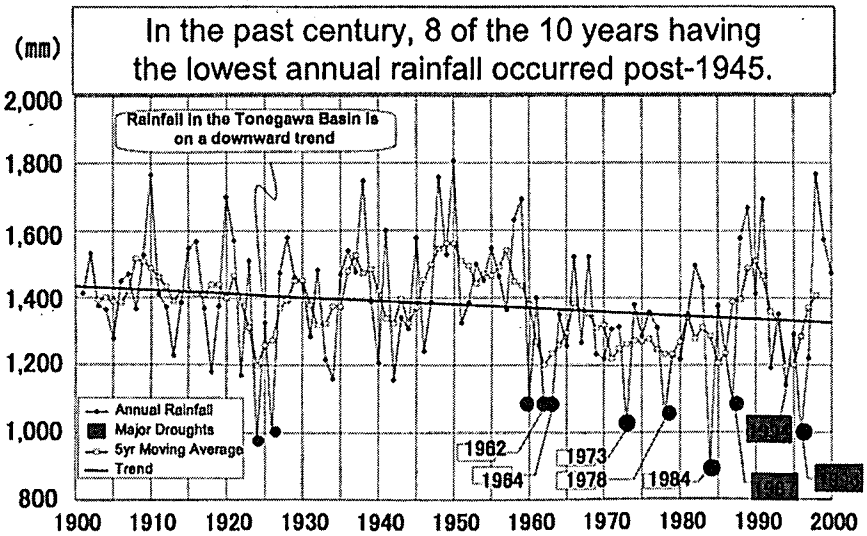
Current Problems

City	Present cycle of water shortage	Target level
Tokyo	3 years	10 years
San Francisco	11 years	Maximum Water shortage to date
New York	7 years	Maximum Water shortage to date
London	15 years	50 years

Drought (2)

Current Problems

In the past century, 8 of the 10 years having the lowest annual rainfall occurred post-1945.

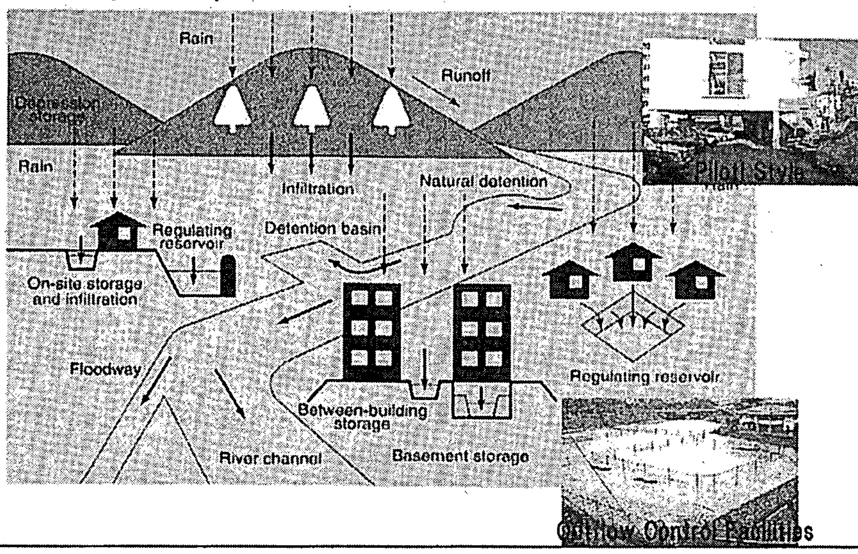


Changes in Annual Rainfall (Tonegawa, Upstream from Kurihashi)

Countermeasures

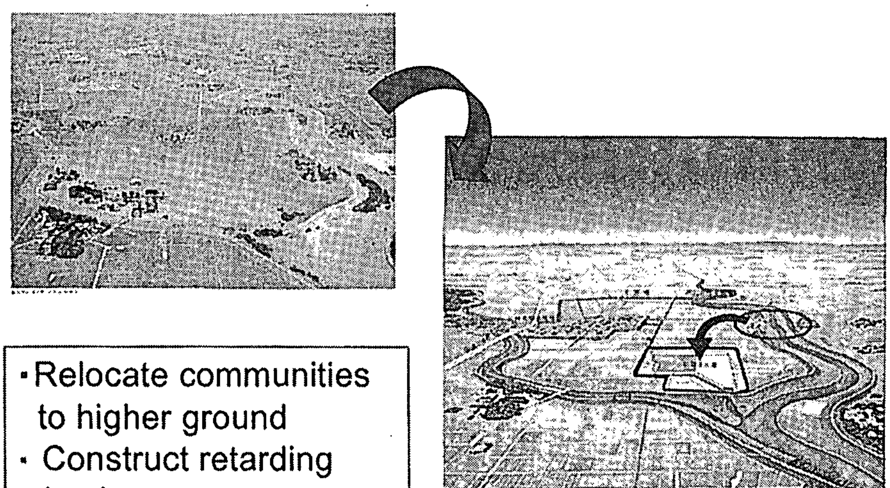
Comprehensive Flood Control Measures

■ Concept of comprehensive flood control



Countermeasures

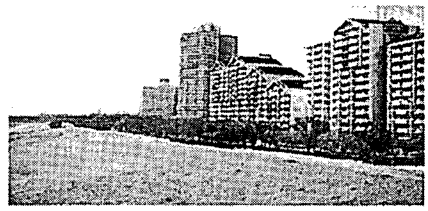
Construction of Retarding Basins



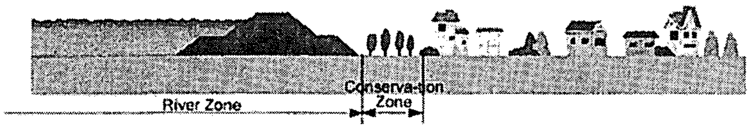
- Relocate communities to higher ground
- Construct retarding basins

Countermeasures

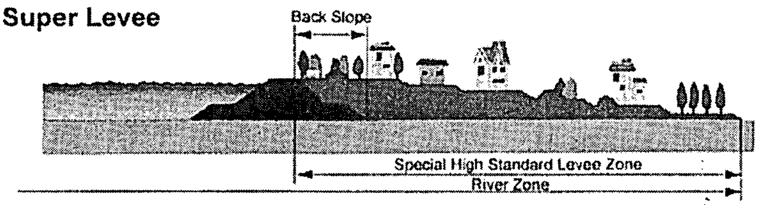
Super Levees



- **Traditional Levee**



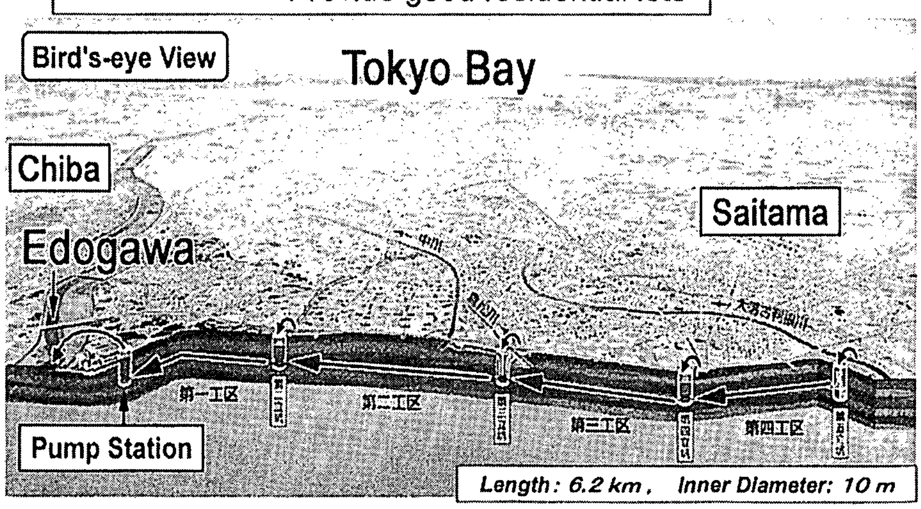
- **Super Levee**



Countermeasures

Metropolitan Area Perimetric Diversion Channel

Objective:	·Prevent flood damage ·Provide good residential lots

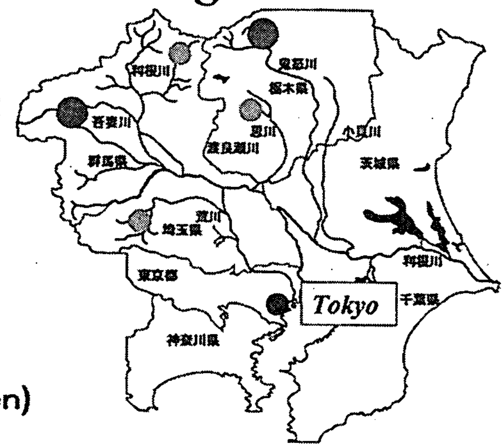


Countermeasures

Construction of Multi-purpose Dams

Yunishigawa Dam

Yanba Dam



● MLIT
● WARDEC
(under construction)

Contribution of Our Research Institute

- **Advanced research to meet the demands of the time, and leadership in Japan's public works programs**
- **Theoretical support for hydraulic calculations, hydrological surveys, river channel planning, levee and dam designs**
- **Large-scale model experiments to better understand phenomena and determine design values**

History and Achievements of Our Research Institute

1925: Seismic Design Theory on Gravity Dams by Dr.Mononobe

1926: Establishment of The First Hydraulics Laboratory in Japan (Akabane Branch)

1952: Establishment of The Largest Testing Center in the Orient using river/dam hydraulics model (Shinozaki Experimental Lab.)

1961: Developed the storage routing model, the water-level gauge (Suiken Model 61); Establishment of the Laboratory using large-scale river/coast hydraulics model (Kashima Hydraulic Lab.)

Conclusion (1)

At Tonegawa, levees, reservoirs and irrigation channels were developed to secure water and safety.

The flood plain was converted into residential lots and farmland to support livelihoods.

Population growth and urbanization led to increases in discharge volume and assets within the flood plain.

Potential damage during major floods has not decreased.

Comprehensive programs covering the entire basin, combining structural and nonstructural measures are necessary.

Conclusion (2)

Man has constantly modified nature to meet his needs , thereby coexisted with nature.

As this relationship continues in the future, it is important to implement measures that meet with the demand of the era.

Lecture 3

Case of KOREA

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Sustainable Water Resources Planning and Management in Korea: Perspectives and R&D

October 22. 2002.

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ABSTRACT

Korean government estimates the amount of water shortage will be 0.1 billion cubic meters in 2006, and 1.8 billion cubic meters in 2011. To add to the water shortage problems, Korea has endured frequent climatic extremes recently: five years of drought and three years of floods for the last ten year period (1993~2002). In order to resolve water-related problems a new comprehensive water resources plan (Water Vision 2020) is established to target year 2020. The Water Vision 2020 presents the principle strategies of water resources policy on the long-term and comprehensive viewpoints. To support the Water Vision 2020 technically, "Sustainable Water Resources Research Project", a ten-year research project, has been launched in 2001 as one of 21st Century Frontier R&D Program by the Korean government. Most of experts in Korea and a few researchers in abroad are involved in this research program to investigate policies and technologies needed in planning and operation for integrated water management including surface/ground water and alternative water resources. This manuscript describes the difficult state of the water resource planning in Korea and a new direction of sustainable water resources management in Korea.

Key Words: Korea, water shortage, sustainable water management

1. INTRODUCTION

The limitations of the water resources policy used in Korea since the 1960's are now surfacing. Although water demand continues to increase, the development of water resources by traditional methods has become environmentally, politically and socially difficult to sustain. As a result, the discrepancy between supply and demand is beginning to appear, and disputes concerning preferential allocation of limited water resources are occurring. Korean government estimates the amount of water shortage will be 0.1 billion cubic meters in 2006, and 1.8 billion cubic meters in 2011. To add to the problems, Korea has endured frequent climatic extremes recently: five years of drought and three years of floods for the last ten year period (1993~2002).

In order to resolve water-related problems it expects to happen in the future, new comprehensive water resources plan called Water Vision 2020 (Korean Ministry of Construction and Transportation, 2001) is established to target year 2020. Water Vision 2020 is considering the changes in the situation around water resources as well as paying attention to the problems concerning the people and the land. It presents the principle strategies of water resources policy on the long-term and comprehensive viewpoints.

To support the Water Vision 2020 technically, "Sustainable Water Resources Research Project", a ten-year research project for new water resources policy and technology has been launched in 2001 as one of 21st Century Frontier R&D Program supported by the Ministry of Science and Technology. One of the main objectives of the research project is to solve the water shortage problem for the next ten year period by adapting sustainable water resources management. To achieve the objective, policies and technologies needed in planning and operation for integrated water management including surface/ground water and alternative water resources are investigated.

This manuscript describes the difficult state of the water resource planning in Korea and a new direction of sustainable water resources management in Korea.

2. DIFFICULTIES OF NATIONAL WATER RESOURCES PLANNING

Since 1960s, the Korean government has established the National Water Resources Plan for water demand and supply prospect, water resources development and its use, flood and river environmental management, and it has made a fundamental guideline for them on the long-term and comprehensive viewpoints. The first National Comprehensive Water Resources Plan in 1965 made a basic strategy to promote the development of agriculture reservoirs for increasing crop products and hydropower generation dams to cope with electric power demand. The second National Comprehensive Water Resources Plan in 1980 was executed for the development of large multipurpose dams, estuary barrages, and river improvement for reduction of flood damage. In 1990, the third National Comprehensive Water Resources Plan have been established for stabilization of nationwide water supply using wide-area water supply network, reduction of flood damage, and formation of healthy river environmental. Recently, in 2001, the forth National Comprehensive Water Resources Plan settling 2020 as its target year is presented. This section describes the difficulties experienced in the past National Water Resources Planning in Korea.

2.1 Large Rainfall Fluctuation

Large differences exist in annual rainfall in Korea. When one of the worlds longest annual rainfall record from Seoul of 213 years from 1770 to 1990 is examined, the large fluctuations are apparent (Kim et al., 1993). Since the standard deviation of the annual precipitation accounts for 31% of the mean, 95% confidence lower limit is 1.65 times of 31%, 51% less than the mean. To satisfy water usage demand with 95% confidence level, the supply volume must be guaranteed with approximately 50% of an average annual rainfall. In Korea, approximately a half of the rainfall in Korea is lost to evapotranspiration. The amount of water lost to evapotranspiration would be assumed to not be affected by rainfall volume and as a result, if rainfall decreases by half, the amount of water available for use would be decreased by 1/4. As a result, in Korea, a reservoir capable of storing rainfall over a long period of time is needed. In other words, to ensure water supply, Korea needs to maintain at least one years supply of usable water.

2.2 Insufficient Standards of Water Supply System

The representative water resource supply, the multi-purpose dams of Korea, currently operate under the standards established during the drought from 1967 to 1968. Most of the large scale water resource projects developed in the 1970s used the criteria set from the 1967-68 drought because the data were readily available and the experience of the drought were fresh in the mind of the developers. However, as historical data clearly show that the drought of 1967-68 is far from an extreme drought. Korea experienced an extreme drought in the early 1900s from 1884 to 1910, a period of 27 years. For 27 years, the average rainfall did not exceed 70% of the average annual rainfall for the 213 years recorded. As a result of the drought period, insurrections and extreme social unrest occurred and even the Korean monarchy crumbled.

The 1967-68 drought condition standard used to establish the water resource policy for usable water supply does not sufficiently reflect Koreas drought characteristics. This policy was established considering the insufficient financial conditions of the 1970s. In addition, this policy, created for a population of 20 million Seoul Metropolitan people, is insufficient to provide usable water supply for the current population. This fact has been one of the most serious problems facing Korean water resource policy.

Although the problem of insufficient design level still remains, the Water Vision 2020 established in 2001 adopted an equivalent drought recurrence interval instead of the fixed 1967-68 drought condition. Thirty years of drought recurrence interval for urban water supply and ten years for agricultural water supply were used as a planning standard throughout the country.

2.3 Rapid Increase of Water Demands

Water demand has rapidly increased since 1965. Domestic water use is increasing due to population growth, the improvement of the life standard, and urbanization etc. Industrial water use had been largely used up to 1980s, while the water use is slightly increasing since 1990s due to the recycling ratio and the change in the structure of industries. As for agriculture water use, it is increasing due to the wide utilization of paddy fields and the progress in irrigation of dry fields. Since 1990, instream water use (environmental water use) is rapidly increasing due to the raising awareness in river environments. (Table 1)

It is expected that total water demand is going to increase steadily from 2001 to 2020. In the estimate of future domestic water use in Water Vision 2020, we consolidate demand management policy, targeting water pricing, leakage control, gray water reuse, and the spread of water-saving equipment. In addition, the estimate takes population growth and economic conditions into account, considering the achievements in domestic water use in the past. In regard with the basic unit of domestic water in future, it is anticipated to reach 348 litter/capita/day in 2011, which was 280 litter/capita/day in 1998 on the national average. The amount shows a steady increase by about 2% per year, reaching 8.6 billion cubic meters in 2011, which was 7.2 billion cubic meters in 1998. (Table 2)

Table 1. Changes in the water demand (unit : billion cubic meters/year)

water use	1965	1980	1990	1998
total	5.1	15.3	24.9	32.8
Domestic water	0.2	1.9	4.2	7.2
Industrial water	0.4	0.7	2.4	2.9
agricultural water	4.5	10.2	14.7	15.6
Instream water	-	2.5	3.6	7.1

Table 2. Prospects of water demand (unit : billion cubic meters/year)

water use	2001	2006	2011	2016	2020
Total	**33.6**	**34.7**	**36.9**	**37.4**	**37.8**
domestic water	7.2	7.6	8.6	8.8	8.9
industrial water	3.3	3.7	4.0	4.3	4.6
agricultural water	15.6	5.7	15.9	15.9	15.9
instream water	7.5	7.7	8.4	8.4	8.4

A steady increase in industrial water use is also anticipated, although the recycling ratio will be rising. The amount of demanded industrial water use is likely to reach 4.0 billion cubic meters, which was 2.9 billion cubic meters in 1998 on the national average.

In the future, the decrease of acreage of farmland will be expected up to 2011 due to the urbanization and regional development. However, it is expected that agricultural water use will not immediately fall down in proportion to the decrease of acreage of farmland. Rather than that, owing to the change of farming form, irrigation water for winter seasons such as greenhouse farming, increase of irrigation of dry fields and stock-farming water, the agriculture water use will change in slight increase. The use will reach 15.7 billion cubic meters in 2011, which was 15.6 billion cubic meters in 1998.

The needs for conservation and improvement of water environment are expected to intensify more to maintain and create natural and living environment, and to improve water quality. Therefore, it is anticipated that the environmental water use will be steadily increased, reaching 8.4 billion cubic meters in 2011, which was 7.1 billion cubic meters in 1998.

2.4 High Usage of Renewable Water Resources

The water available for use is the quantity that remains after evapotranspiration. If more than the remaining amount is used, whether from groundwater or surface water, the ultimate result is the drying up of water resources. As a result, the usable water quantity is referred to as renewable water resources and is used as an index to represents water scarcity of a country. In Korea, the national water resources plan states the renewable water sources to be 73.1 billion cubic meters/year. When the volume is divided by the population, the total annual volume available for use per person is 1,550 cubic meters. United Nations Economic and Social Commission for Asia and the Pacific (1992) estimated for 26 countries in Asia the average available annual water to be 4,143 cubic meters. The water available to Koreans is only 37% of the average for Asia.. Among the 26 surveyed counties in Asia, the only two nations below 1,700 cubic meters are Korea and Singapore.

Korea's heavy water use contributes to the water shortage problems. According to the national water resources plan, Korea uses 33.1 billion cubic meters of the 73.1 billion cubic meters available for use annually. Because 7.1 billion cubic meters is used for in-stream flow, the withdrawal water use becomes 26.0 billion cubic meters. Accordingly, approximately 35.6% of the renewable water resources are being used currently.

United Nations Department for Policy Coordination and Sustainable Development (1997) used this percentage to determine the water stress of a nation. Water usage under 10% does not result in water stress. Water usage between 10-20% is considered normal. Water usage between 20-40% results in water stress above normal and requires intensive management of supply and demand. If water usage percentage rises above 40%, a serious water shortage problem may result. In this scenario, water resources depend more and more on depleting groundwater and desalinization. Accordingly, to manage supply and demand, a special plan is needed. Water usage above 40% could be not sustainable and the water shortage may work to limit essential economic progress. The average water use is 35.6% in Korea and as a result, an asserted effort to regulate supply and demand is needed. It is important to keep in mind that 35.6% is only an average and in some watersheds, the water usage percentage far exceeds the 40% limit. In most of these watersheds, the environmental quality continues to degrade. Without a decrease in water use, such a high percentage of water use makes the management of a sustainable water resource very difficult.

2.5 Increase of Frequency and Peaks of Floods

In the last 15 years, Korea has experienced large-scale floods never recorded before. In 1987, a large flood in the Keum river watershed caused 1 trillion won (about two billion US dollars) worth of property damage. In 1990, an intense rainfall recording 400mm in the southern Han river basin caused break of levee near Seoul and resulted in a large flood. In 1996 at the Hantan river basin, a concentrated rainfall measuring over 600mm overwhelmed the Yonchun dams flood control volume and flooded the downstream region. Shortly thereafter, the dam collapsed. In August 1998, a surprising record rainfall fell across Korea. As a result, in the Chiri mountain range, flash floods occurred, a reservoir in Kangwha-do collapsed, and in Chungrang stream and mid-and-small river basins, property damage as well as loss of lives occurred. In 1999 at the Imjin river basin, a rainfall event over 700mm destroyed Yunchun dam once again, and caused severe flood damage in Moonsan and Yunchun.

The recent flood damage can be attributed to the change in rainfall characteristics. It is worth noting that rain events in 1998 broke the old records, such as the 118.6mm rainfall in one hour in Seoul. In the last twenty year period, most of the rainfall records were broken throughout country.

As stated before, the serious problem Korean water resources policy faces today is how to counteract the extreme floods. The recent flood events are new conditions never dealt with before. Accordingly, the construction methods established during different circumstances are no longer effective. Extreme rainfall events have increased compared to before and as a result, flood policy has also increased. In contrast, the flood control ability of multi-purpose dams have declined. Questions about the effectiveness of flood control facility properties such as flood frequency, safety factors, and clearance are beginning to arise. Questions are also arising about the flood control ability of multi-purpose dams. To maintain the flood prevention level like before, the flood control volume must be increased and the water supply volume must be decreased.

3. NEW DIRECTIONS

To resolve the difficulties of water resources planning, Korea's water resource policy needs to be revised. The current policy focused on water supply needs to be changed to a policy that focuses on the management of water resources as a priority. This shift in policy does not mean the abandonment of water resource development. The conversion to a policy of management should consider water supply guarantee, flood safety guarantee, and the improvement of the environment as priorities.

3.1 Sound and Stable Water Utilization

Increase of continuous water demand is prospected in the future due to growth of population and economics, urbanization, and extension of domestic water supply etc. However, implementation of structural measures like as building of dams to secure water resources are getting to be more difficult, since there is a scarcity of suitable dam building sites and raising awareness in river environments. To solve these situations, we need to promote the sound development of water resources through the multilateral water sources. At the same time, we should build up the society leading water conservation and make strategies to augment available water resources on the development of advanced water management technology. On these conditions we aim at acquiring balance in water demand and supply in most of the areas on the basis of the existing project standard that is a drought with recurrence interval of about 30 years.

3.2 Formation of Safe Land against Flood

A variety of flood control projects have been implemented to protect life and property against floods, but substantial flood damages would not be reduced. Frequent occurrences of rainfall over design flood standards have been immediate cause. However, rapid growth in population and its concentration in flood prone have made flood damages more serious areas since 1980s. At the same time, "damage potential" for floods is more increasing. Principle measures to solve these problems are channel improvements such as channel widening, levee construction and reinforcement, and riverbed dredging so that flooding of less than the design flood can be discharged without inundating land along the river. Besides of channel improvement, we are going to make a plan for basin improvement that the natural flood behavior of drainage is largely retained or improved. In addition, measures of pre-disaster mitigation and the development of accurate flood forecasting technology will be positively reinforced.

3.3 Creation of River Environment in Harmony with Nature

To protect flood damages, we have implemented channel improvement works through river channel straightening and construction of banks covered with concrete so that the fruit of flood loss prevention has been obtained. However, these works deprive creatures living in and around the rivers of their living spaces. From a different perspective, the environment of rivers has begun to be reevaluated as being important and rivers are seen as providing free open spaces for the general public in the cities and for use in outdoor sports. In this way, we have been given great responsibility for the care of our natural environment while at the same time are entrusted with devising new ways of protecting and preserving diverse river functions.

3.4 Research for Sustainable Water Resources Management

The difficult water situation made the government (Ministry of Science & Technology and Ministry of Construction) launch a huge and long range (10 year long) R&D program called Sustainable Water Resources Research Project in the name of 21C New Frontier Project from the last year (2001).

The program is divided into five research areas: (1) technology for integrated management of water resource, (2) technology for the assurance of surface water, (3) technology for the assurance of ground water, (4) technology for the assurance of alternative water resource, and (5) creative technology for the assurance of water resource. Most of experts in water and wastewater including scientists and engineers are, wholly or partially, involved in this national program. It is expected that Korea can solve the problems of water shortage by securing extra 3 billion cubic meters of water in 2011 as the program proceeds.

In the areas of alternative water resource security, development and application of water reuse technology is regarded as one of the major approach to satisfy two aspects, that is, pollution reduction and production of new source of water. It is known that 66 percents of wastewater produced a day end up with the discharge of 10 million cubic meters per day of treated effluent from municipal wastewater treatment plants. Calculation simply tells that 0.36 billion cubic meters of new water resource per year can be available if only 10 percent of wastewater could be reused. Technologies mainly focused on are such as the membrane bio-reactor (MBR), nanofiltration (NF), soil aquifer treatment (SAT), and advanced oxidation processes (AOPs)/ toxicity monitoring.

4. SUMMARY AND CONCLUSIONS

The limitations of the water resources policy used in Korea since the 1960's are now surfacing. Although water demand continues to increase, the development of water resources by traditional methods has become environmentally, politically and socially difficult to sustain. As a result, the discrepancy between supply and demand is beginning to appear, and disputes concerning preferential allocation of limited water resources are occurring. To add to the problems, Korea has endured frequent climatic extremes recently.

Korea's water resource policy needs to be revised. The current policy focused on water supply needs to be changed to a policy that focuses on the management of water resources as a priority. This shift in policy does not mean the abandonment of water resource development. The conversion to a policy of management should consider water supply guarantee, flood safety guarantee, and the improvement of the environment as priorities.

The new direction of water management will be guided effectively by the comprehensive and long range (10 year long) R&D program called Sustainable Water Resources Research Project in the name of 21C New Frontier Project from last year (2001). Most of experts in water and wastewater including scientists and engineers are, wholly or partially, involved in this national program. It is expected that Korea can solve the problems of water shortage by securing extra 3 billion cubic meters of water in 2011 as the program proceeds.

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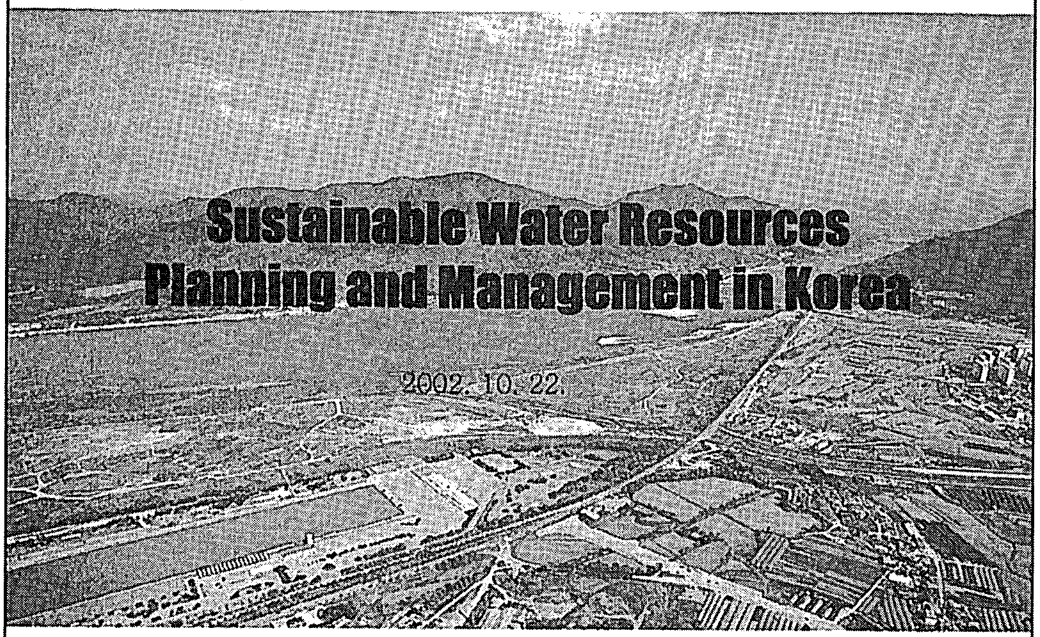
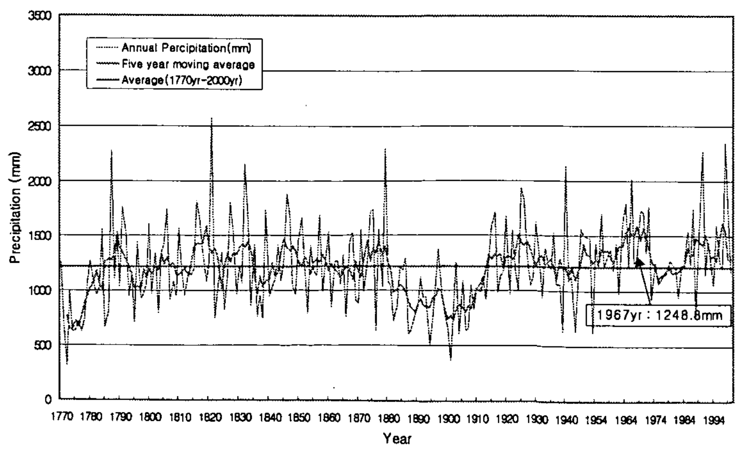


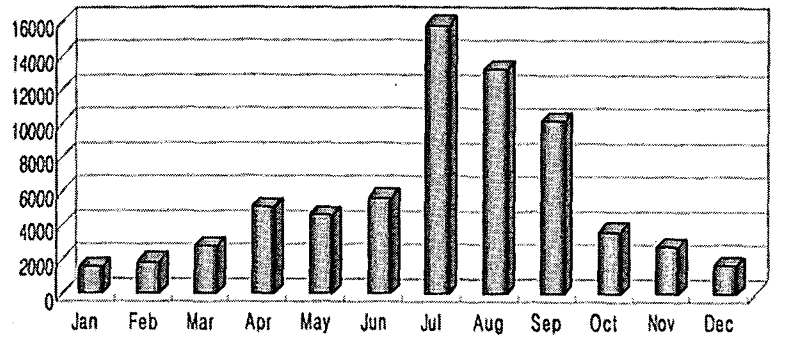
1

Annual Rainfall Fluctuation
Seoul: 1770-2000



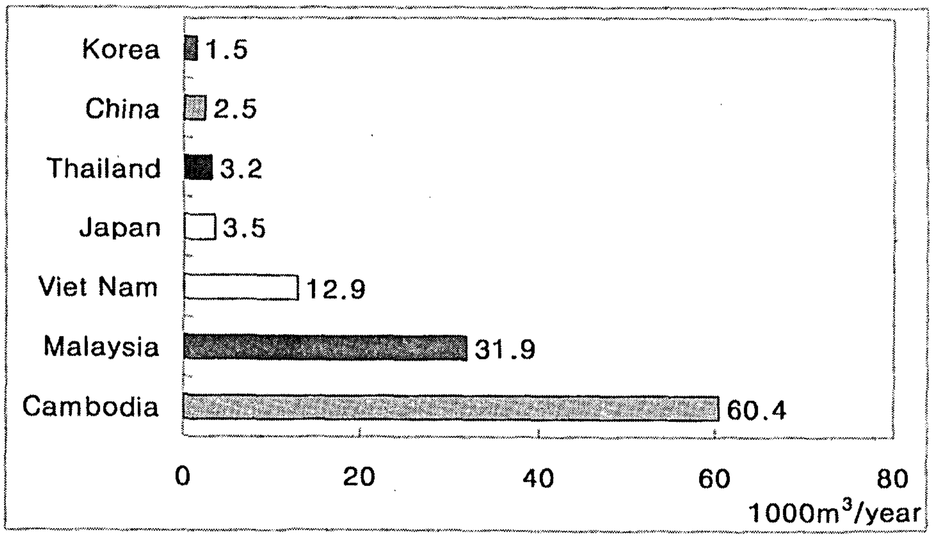
2

- Uneven Seasonal Rainfall Distribution
  - Two thirds of annual rainfall is occurred during the summer season.



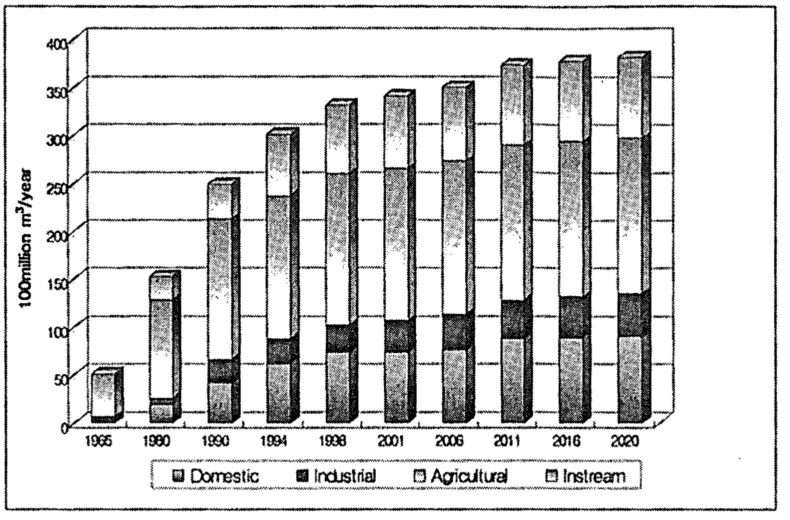
3

Renewable Water Resources Per Capita



4

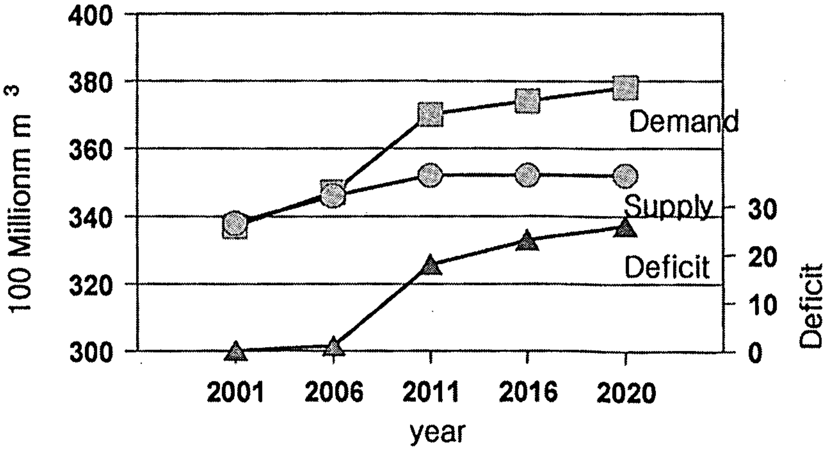
Water Demands



5

Water Demands

- Water Shortage begins from 2006



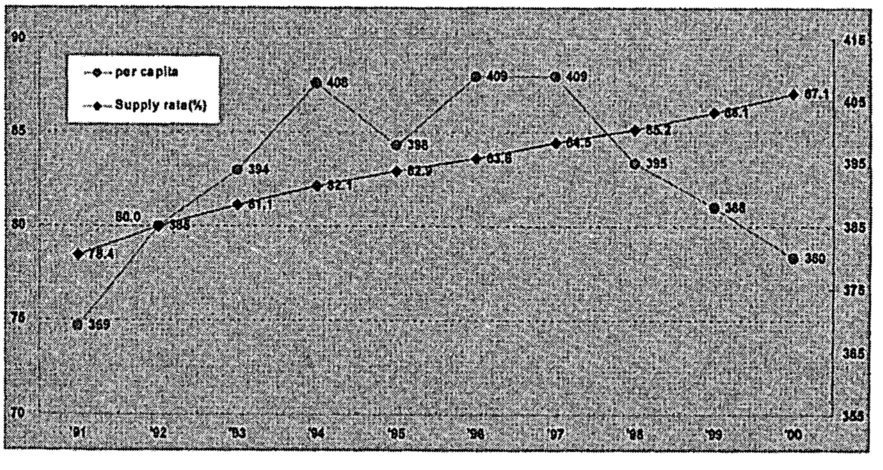
6

Household Water Use per Capita

Korea	233 ℓ/day	(1993)
Japan	240 ℓ/day	(1995)
Germany	145 ℓ/day	(1990)
GB	240 ℓ/day	(1993)
USA	367 ℓ/day	(1990)

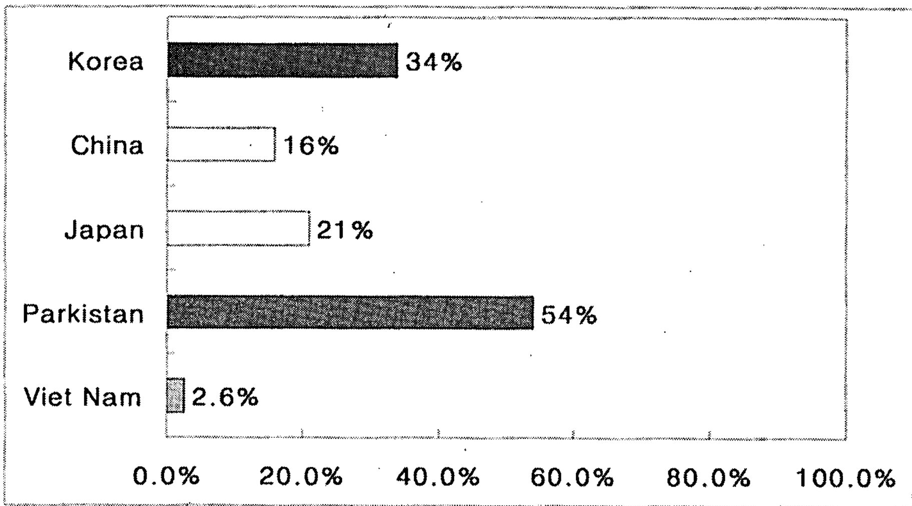
7

Domestic Water Supply Status



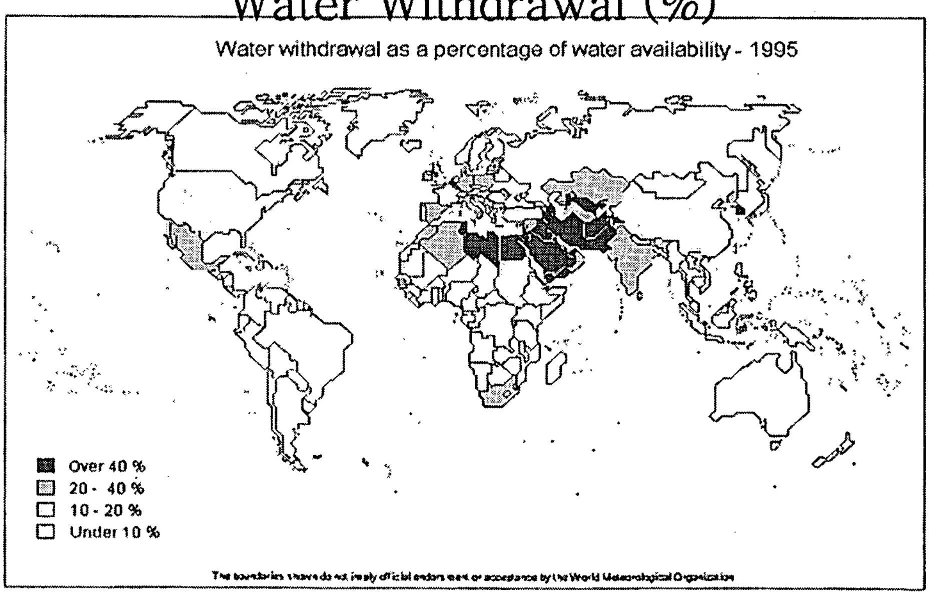
8

Percentage of withdrawal



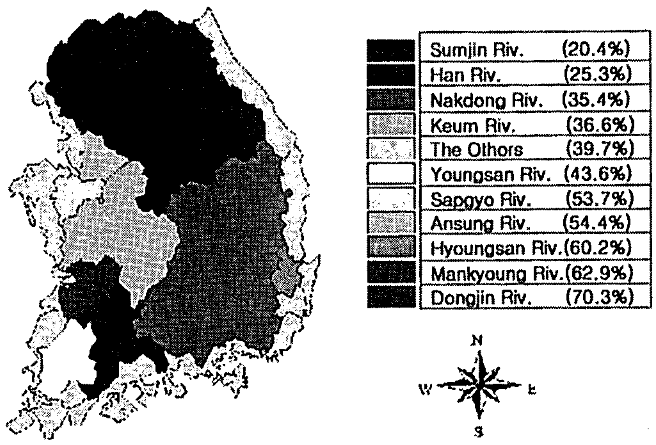
9

Water Withdrawal (%)



10

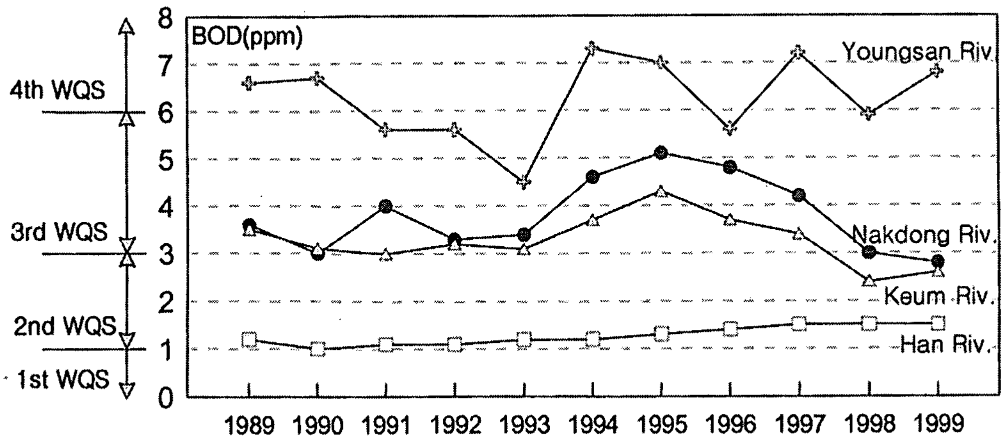
Highly Uneven Regional Water Withdrawals



- Water withdrawals from most of medium/small watersheds exceed 50%.

■ Water Quality

– environmental satisfactory ratio is low

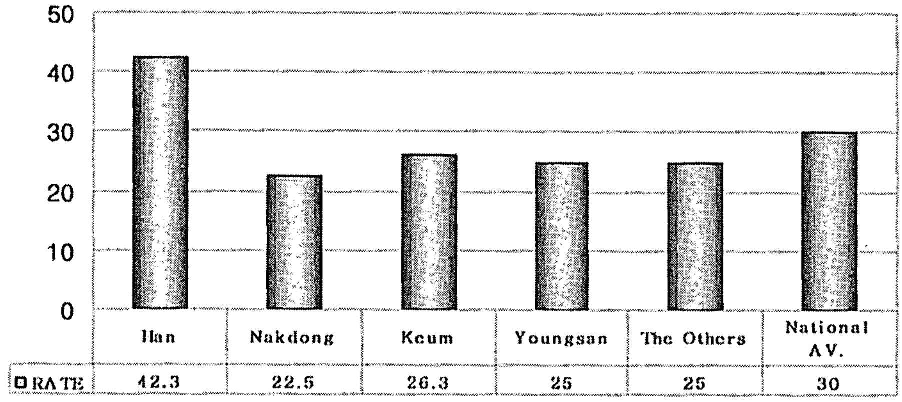


* WQS : Water Quality Standards

12

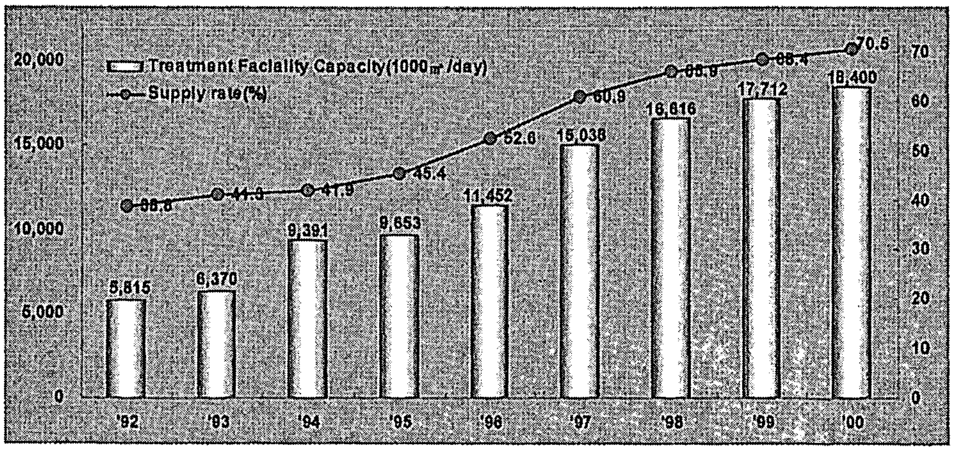
Success Ratio for Water Quality Standards

- Since 1991, 194 reaches are monitored.
- 29.4 percents are satisfactory in 2001.



13

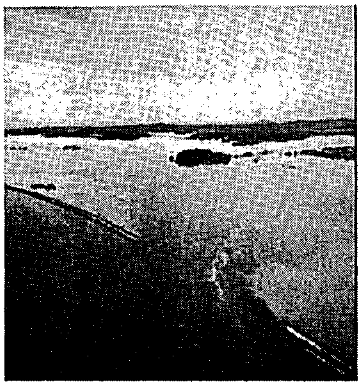
Waste Water Treatment



14

Increase of Frequency and Peak of Floods

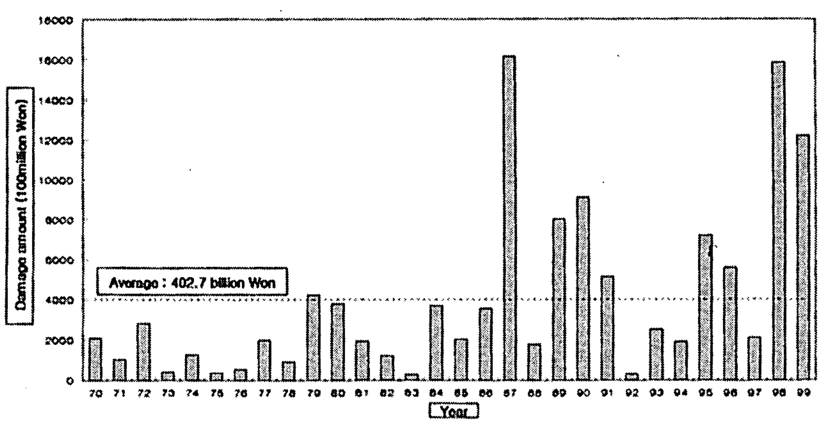
- Floods After '1990 : 1990, 1996, 1998, 1999, 2000



'1990

'1998

Trends of Annual Floods Loss
- increases owing to urbanization and climatic changes since 1980's



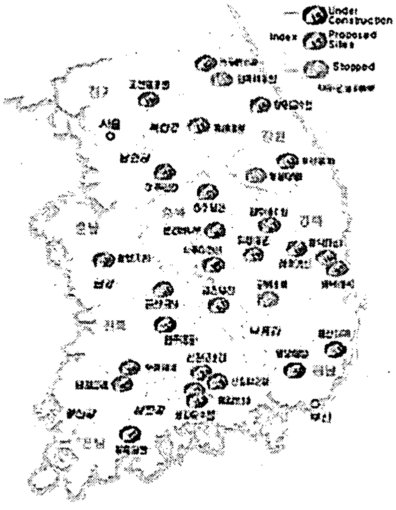
16

Sound and Stable Water Utilization

Demand management by efficient use and reuse of water resources

Development of water resources through the multilateral water sources

Acquiring balance in demand and supply with recurrence interval of about 30 years



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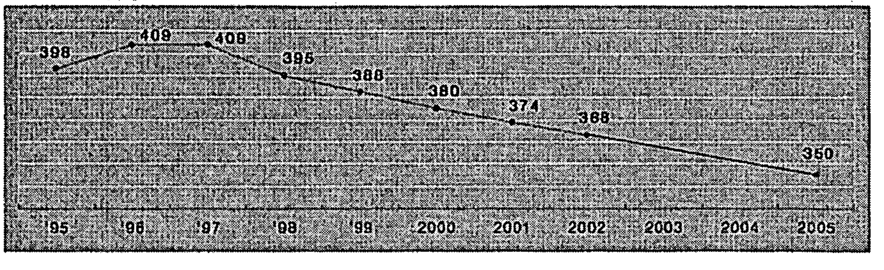
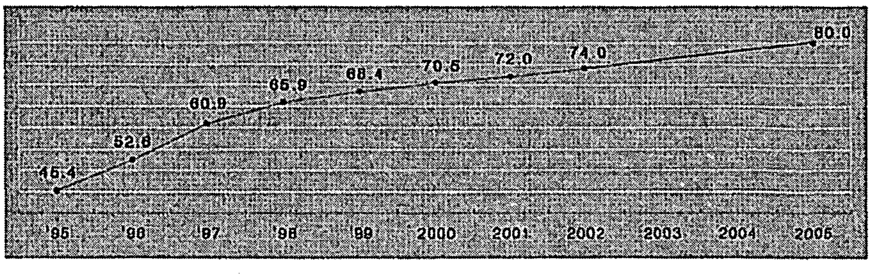
Water Supply in LPCD



Waste Water Treatment



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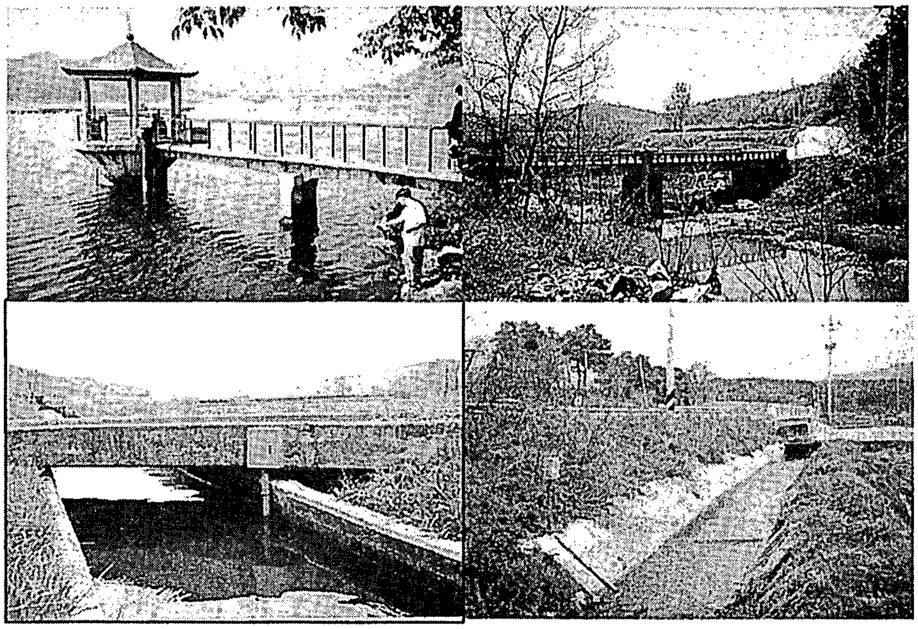


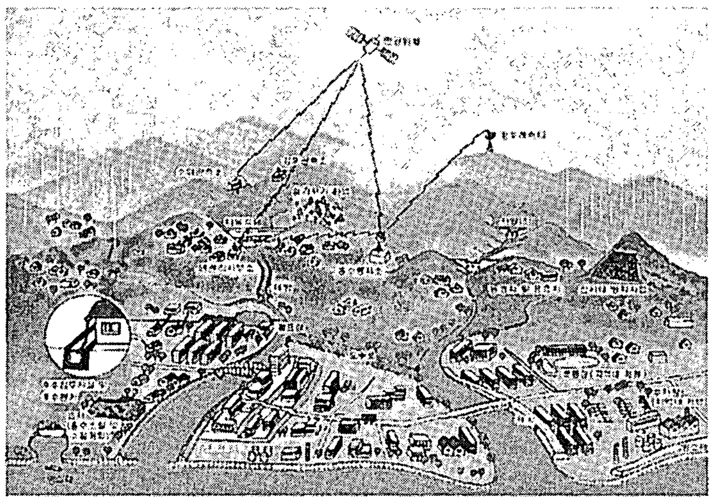
19

Creation of River Environment in Harmony with Nature

20

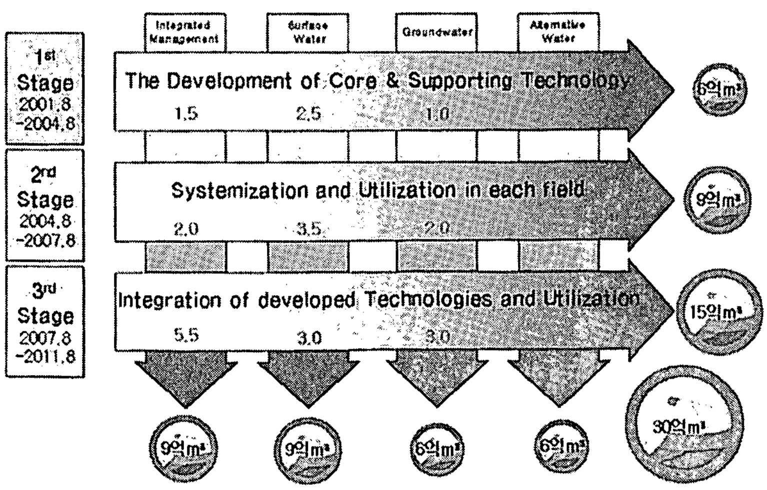
Formation of Safe Land against Flood

- **Integrated River Basin Management for Flood Control**



21

Target Water for Each Stage



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23

Summary

- Limitations of the water resources policy used in Korea since 1960's are now surfacing.
  - difficulties to make new developments for increasing demand
  - difficulties to improve water environments
  - difficulties to prepare measures for frequent climatic extremes

- Korea's water resource policy has been shifted to new directions
  - demands management for improving water use efficiencies
  - pollutants management for improving water qualities
  - sustainable floods management

- The new direction of water policy is guided by strong R & D program.
  - will secure extra 3 billion cubic meters in 2011 (10% of water use)

24

Lecture 4

Case of INDIA

Mr. Kaushal N. AGRAWAL

Additional Director General,

Central Public Works Department

Ministry of Urban Development

India

Mr. K.N. AGRAWAL

WATER RESOURCES AND RIVER MANAGEMENT FOR SUSTAINABLE DEVELOPMENT IN INDIA

by

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Chief Engineer, CPWD
Govt. of India, New Delhi

INTRODUCTION

All development projects have environmental, economic and social consequences, some beneficial and other adverse. Water resources projects are no exception to this. With the increase in economic activities and the consequent potential for stress on ecosystems and natural resource stocks, the study and recognition of linkages between freshwater issues and other sectoral and cross sectoral issues are becoming increasingly important.

The main challenge facing the management of water resources is how to maximize all the positive impacts and minimize the adverse impacts; how to ensure reliable water supply and efficient use in the agricultural sector, mitigate flood damages, control water pollution and at the same time reduce environmental and social impacts, such as rehabilitation and resettlement of displaced people, mitigate the problems of water logging and salinity and reduce the spread of waterborne diseases and the problems associated with pollution. The idea of environmentally sound water management or sustainable development and management of water resources is to convey the concept that development is to be accomplished with minimum damage to the environment. However, translating the concept into a reality is a difficult task.

India has 15% of the world population but only 4% of the world's water supply. Preserving the quality and the availability of the freshwater resources is the most pressing of the many environmental challenges being faced by the nation. It is imperative that conservation, recycle, reuse of precious water and treatment of wastewater are given serious attention for sustainability of built environment for our populous country.

This report attempts to bring out the Indian scenario of various related issues concerning water resources including those of Flood Disasters, Sediment Disasters, Water shortages, Water contamination and damage to ecosystems.

1. FLOOD DISASTERS

Floods are natural phenomena, which particularly occur in plains, where inadequate riverbed slopes result in inundation of a large width of the valley. The flat gradients of the plains also cause silting of rivers that in turn results in higher flood levels. With the spillover of human activities on such flood plains, the floods become a cause of disaster. Over 40 million hectares, which is about 12% of the total geographical area of India, experiences periodic floods. The average area affected by floods annually in India is about 7.5 m. ha of which crop area is about 3.5 m. ha. Floods have claimed on an average about 1500 human lives and 94000 cattle ever year. The floods are also a cause of large-scale damages to forests & crops besides causing deaths of aquatic and wildlife, in various National Parks, delta region, low altitude hilly areas and alluvial flood plains of several Indian states like Assam, Arunachal, Uttrarakhand, U.P., Bihar, Orissa and West Bengal.

1.1 Flood Prone Area

The *flood prone area* may be a single index that may be useful in preliminary assessment of problem of flood in a region or country as a whole.

Rashtriya Barh Ayog (RBA – the Indian National Commission on floods) attempted in 1980 to project the picture of area liable to floods, using the data for the period 1953 to 1978. While assessing the area liable to floods as about 34 m. ha., the RBA recognized that annual flooding is not coextensive and that different areas are often flooded in different years by different streams. It further recognized that some protected areas in India till then could have been affected in some of the years on record. The 'protected area' till then was indicated by RBA as 10 m. ha. The area liable to floods was taken by it to be about 40 m. ha (instead of 44 got by adding 10 and 34 m. ha). Thus the figures of area prone to floods have not so far related the maximum area affected in a year with the probable return period of such flood and is more an estimate based on some judgement rather than a reliable basic data to prepare a Perspective Plan. Further, the assessment would change if the unit were changed to taluka/district.

1.2 Water Logging

Another important problem concurrently with flooding is water logging of flat land, such as the vast Indo-Gangetic plain and the deltaic area of main rivers such as Mahanadi, Godavari, Krishna and Cauvery and smaller rivers in the East Coast. The water logging is a consequence of -

1.2.1 Stagnation of rainwater during monsoon storms over flat areas primarily from lack of adequate capacity of outlet channels or adverse topography of the terrain. The extreme flat slopes even up to 1 in 10,000 to 20,000 in Punjab, Haryana, Uttar Pradesh, Bihar & West Bengal and deltaic area in the East Coast with slopes of 1 in 10,000 contribute to such condition.

1.2.2 Over bank spill of floodwater, which enters the unprotected area and stagnates over low lands and saucers in the basin and can not return back to the main river even after the flood recedes.

1.3 Flood Control Measures

The structural measures of flood management apart from constructing embankments include reservoirs, channel improvements, anti-erosion spurs etc. The non-structural measures include flood plain zoning, flood proofing, disaster preparedness, flood forecasting and warning etc.

1.3.1 Structural Measures

Major embankment projects taken up are on rivers Kosi and Gandak (Bihar), Godavari and Krishna (Andhra), Mahanadi, Subernaekha (Orissa) and Brahmaputra (Assam). These embankments played an important role in providing reasonable protection to affected areas, even with occasional breaches and other problem like drainage congestion, and enabled economic development.

There are few cases of reservoirs built only for flood control purpose. Multi-purpose reservoirs would involve a balancing of different interests like irrigation, power generation and flood control, which are often at variance with one another. The aim is to realize optimal benefits from the project as a whole. A reservoir is more effective for flood control if a designated space is reserved and a reservoir regulation arrangement is laid down. As far as possible, co-operation of existing reservoirs be planned in such a manner that flood moderation is achieved to the maximum extent even where no specific storage has been provided for flood cushion. There is opposition to water storage projects by environmental activists by exaggerating minor adverse environmental impacts while suppressing their tremendous beneficial socio-environmental impacts.

1.3.2 Non-Structural Measures

a) Flood Plain Zoning (FPZ)

The basic concept of FPZ is to regulate land use in flood plains to restrict flood damage by determining flood risk locations and their extent. It envisages limiting if not preventing, indiscriminate development in such areas so as to minimize the losses in the event of major floods, beyond what the protection measures are designed for or in case of their failure. Central Water Commission (CWC) of India has circulated essential features of flood plain management, to the State Governments apart from giving wide publicity in various fora.

The Working Group on flood control program for the 10^{th} Five Year Plan of Government of India recommended that it would be best to seek flood management as an integral part of the package of measures that may include multipurpose storage dams, embankments, detention basin etc, as may be appropriate in specific cases. The emphasis is to work out a comprehensive strategy for the entire basin, including non-structural measures like flood plain zoning, flood forecasting and warning etc.

The Working Group also suggested enacting legislation to effectively ensure flood plain zoning. The areas, which are prone to floods of different return periods, can be first delineated and identified. It recommended that a Standing committee of experts should be set up to lay down detailed norms and prepare pilot flood risk and zoning maps for typical river basins /sub basins and generally monitor and guide the states in FPZ activities. It should comprise Central and State Officials as also outside experts and NGOs in addition to representatives of people living in flood-vulnerable areas.

The people and authorities concerned should be made aware of the risk of living in these flood plains and the consequences thereof. Instruments such as differential insurance rates, additional surcharge on the premium of properties in risk areas, etc. can be used for encouraging desirable measures and discouraging harmful ones.

b) Flood Forecasting

Flood forecasting is an important part of disaster preparedness under the non-structural measures of flood mitigation, which can reduce the potential flood damages considerably. Technical advancement can help in predicting the flood and giving a longer lead-time for action. Flood forecasting can be used as an important tool in taking up integrated development of the basin and meeting multiple demands. CWC has established a flood forecasting system covering 62 major rivers covering almost all the flood prone states of India that however needs to be modernized and strengthened.

1.4 Rashtriya Barh Ayog's Recommendations

The aspects emphasized by RBA- the National Commission on Floods, include the need to assess flood damage rationally; review the performance of embankment system and incorporating the same in the flood control plan of the State; coordination among concerned organizations to ensure reduction of flood problems; adoption of suitable flood control measures as a part of comprehensive planning for water resources. Preparation of contour maps for flood prone basins, studies of erosion patterns and project maintenance works etc. are also needed.

1.5 Disaster Preparedness

Developing nations, which can ill afford such disasters, are also the least prepared and as a result suffer the devastating impacts. The developments, if haphazard and on piecemeal basis, increase the vulnerability against natural disasters such as floods. The expenditure incurred in disaster preparedness is repaid several times over in savings of unbudgeted disaster relief and recovery expenses. Disaster Preparedness would minimize the impact of natural hazards like floods.

2. SEDIMENTATION DISASTERS

Sediment flow in rivers is a natural process caused by erosion, transportation and deposition of sediments. Civilization owes itself to this process as it came into being in the valleys of the Nile, Tigris, Euphrates, Indus and the Yellow rivers, brought about by the fertile deposits of these rivers. However what was a boon in that time & space has now acquired the dimensions of a disaster. This is especially true in the context of water storage projects. Loss of topsoil with the runoff from precipitation, loss of generated biomass by way of grazing, pilferage of firewood and brushwood for fuel etc. has been taking place at an alarming rate due mainly to various human factors. Reduction in vegetative cover by felling of trees and grazing makes the topsoil more vulnerable to the action of wind and rain. With the loss of topsoil, chances of survival of grass, herbs, shrubs, bushes and trees on the uncultivated land appreciably reduce, thereby exposing the soil to further degradation. This process continues in most of the watersheds, in the process of struggle for survival by the rural landless laborers in the vicinity. In the absence of such harmful intervention of human beings, natural degradation is a slow process and often restorative by nature. There is an obvious need to take steps to prevent such degradation of the catchment area.

Uncontrolled deforestation, forest-fires, over-grazing, improper methods of tillage, improper agricultural practices and various human activities are responsible for accelerated soil erosion. Due to impact of rain and water flowing over land surfaces, in gullies and stream channels, large quantities of top soil is eroded from the catchment and carried by the rivers, not all of which reaches the sea. Earthquakes, large-scale landslides and other activities such as cutting of forests, mining, road building and other construction activities accelerate this process.

Out of India's total land area of 329 million hectares, about 175 million hectares is prone to sediment erosion. It is estimated that about 6000 million tonnes of soil is eroded every year in India as a result of sheet erosion. Besides, gully and ravine erosion ravages 8000 ha annually. The sediment erosion and transportation causes serious problems such as loss of fertility of soil, reservoir sedimentation, channel aggradations, increase in peak flood flows, depletion of ground water flow etc. The 1950 earthquake of magnitude 8.6 on Richter Scale that occurred in the Indian state of Assam, brought so much sediment down the Brahmaputra river that some of the tributaries silted up and caused major changes in the morphology of the river. It also caused flooding in large portions of the Brahmaputra Valley in the next several years.

Sedimentation causes serious problems in engineering projects for irrigation, navigation, and hydropower development and flood control. Costly maintenance, loss of efficiency and in some cases, damage of important engineering works have been experienced due to deposition of sediments in reservoirs, navigation and irrigation channels. Depletion of storage in a reservoir on account of sediment deposition causes many problems. Besides, storage loss which is of much economic significance, there are planning and operational problems due to silting of reservoirs. The entry of sediments in the canals or in the turbines may cause serious operational problems as well as sometimes jamming of hydraulic gates.

Various measures for watershed development and catchment area treatment are undertaken in India for soil and water conservation which help in prolonging life of storage reservoirs, reduction in watershed degradation, improving fertility of soil, augmenting supply food, fodder and fuel, moderating floods and enhancing total production, employment and income.

3. WATER RESOURCES OF INDIA AND WATER SHORTAGES

India experiences extremes of climate. Normal annual rainfall varies from 100mm in Western Rajasthan to over 11,000mm at Cherapunji, in the northeastern part of the country. The annual average rainfall is of the order of 1,170mm, which together with snow melt yields nearly 4,000km^3 of water. After deducting for infiltration and evaporation, the average surface flow in the river systems of the country is estimated at 1,869 km^3. The constraint in exploiting the available water is that the major part of the flows occurs as floods during short periods and there are obvious limitations in storing all the quantity. The utilizable surface flow is estimated at 690km^3. The utilizable groundwater potential is estimated at 432 km^3. Thus, the total utilizable water resources of the country are about 1,122km^3.

3.1 Water resources assessment

(a) Surface water

Out of the average annual flow of 1,869 km^3 a live storage of only 171 km^3 of water has been developed through about 3,000 large dams. An additional live storage of 3 km^3 is estimated to have been created through medium projects, each having a capacity less than 10 million m^3. Thus, the total live storage is about 174 km^3 at completed projects. Dams to create additional live storage of 72 km^3 are now under construction and for 132 km^3 are being planned. With the live storage of 25 km^3 of minor tanks, the ultimate live storage would be 403 km^3, which would be around 22 per cent of the average annual flow of the rivers.

The Central Water Commission, Government of India has a network of 877 key stations through the country in collect and compile hydrological data, as well as to take measurements of river flows on a regular basis. In addition, silt observations and water quality observations are made at a few selected sites. Most of the hydrological data collection activity is manual, though automation has been introduced at some of the stations. Snowmelt and glacial ice melt provide a major part of the run off in the mountainous areas of the Himalayas. The snow melt forecasts provide an important input to the river management. Remove sensing techniques have been found useful in predicting the snowmelt run off.

To improve India's institutional and technical capability to measure, collate, analyze, disseminate and use data concerned with quantities and qualities of surface and ground water, including the use of data for hydrological design a project entitled "Hydrology Project" is being implemented in peninsular river basins of India under the World Bank Assistance.

(b) Groundwater

With the increased emphasis on groundwater in the last few years, a scientific assessment of the groundwater potential of the country was undertaken and extensive exploration work was carried out in the country. In the reassessment based on guidelines laid down by a Ground Water Estimation Committee of 1984 and the additional available data, the annual replenish able ground-water is estimated as 432 km^3. The present annual utilization is 115 km^3 through 15.3 million groundwater structures. A hydrographic network of about 15,000 stations monitors the levels and the quality of groundwater. Monitoring shows that some areas as exhibiting signs of over-exploitation. There is a proposal to extend the network to 17,000 stations.

(c) Need of Storage Dams

It must be noted that future demands of water can be met only by exploiting almost all the 1122 bcm of utilizable water by conventional means. It would thus be essential to utilize the entire 690 bcm of the utilizable flows for which storages of the order of 400 b.cu.m will have to be created. Water demands forecasts show that Rajasthan, Maharashtra, Gujarat, Haryana, Karnataka and Tamilnadu could face heavy water supply shortfalls. The water shortages would be far more serious in the water short basins like the Cauvery, Pennar, Sabarmati, Mahi, and Krishna etc. To meet the bulging water requirements, it would be necessary to ensure substantial augmentation of water supplies; requiring sufficient raising of water storage capacities, thus necessitating completion of new large water storage projects.

The recent Supreme Court Judgement for Narmada Projects has also highlighted that against the utilisable storage 690 cu. km. of surface water resources out of 1869 cu. km.; so far storage capacity of all dams in India is only 174 cu. km., which is incidentally less than the capacity of Kariba Dam in Zambia/Zimbabwe with a capacity of 180.6 cu. km. and only 12 cu. km. more than the Aswan High Dam of Egypt. The impact on environment should be seen in relation to the project as a whole. Water of poor quality leads to ill health, whereas water in insufficient quantity claims large chunks of time spent in augmenting the supply; otherwise, the significant time could be spent on more remunerative tasks.

3.2 National Water Policy - 2002

National Water Policy was first adopted in 1987. Since then a number of issues and challenges have emerged in the development and management of the water resources. Therefore, The National Water Policy has been reviewed and updated in April 2002.

National Water Policy - 2002 sets out the following water allocation priorities: (1) drinking water; (2) irrigation; (3) hydropower; (4) ecology, (5) Agro-industries and non-agriculture industries (6) navigation and other uses. Its highlights are given below:

- Water is a scarce and precious natural resource, to be planned, developed conserved and managed as such, and in an integrated and environmentally sound basis, keeping in view the socio-economic aspects and needs of the states. Efforts to develop, conserve, utilize and manage this crucial resource in a sustainable manner have to be guided by the national perspective.
- Water resources development and management is to be planned for a hydrology unit, such as a drainage basin as a whole or for a sub-basin, multi sectorally, taking into account surface and ground water for sustainable use incorporating quantity and quality aspects as well as environmental considerations. Individual development projects and proposals should be formulated within the frame work of over all plan keeping in view the existing agreements/ awards for a basin/sub-basin for optimal results.
- Water resources projects involve a number of socio-economic issues such as sustainability, appropriate resettlement and rehabilitation of project-affected people, public health concerns of water impoundment, dam safety etc. Problems of water logging and soil salinity have emerged in some irrigation commands, leading to the degradation of agricultural land. Complex issues of equity and social justice in regard to water distribution are required to be addressed. The development and over-exploitation of groundwater resources in certain parts of the country have raised the concern and need for

judicious and scientific resource management and conservation. All these concerns need to be addressed on the basis of common policies and strategies.

- Improvements in existing strategies, innovation of new techniques resting on a strong science and technology base are needed to eliminate the pollution of surface and ground water resources, to improve water quality. Science and technology and training have to play important roles in water resources development and management in general.
- Water resource development projects should as far as possible be planned and developed as multipurpose projects. Provision for drinking water should be a primary consideration. The study of the likely impact of a project during construction and later on human lives, settlements, occupations, socio-economic, environment and other aspects shall form an essential component of project planning. In the planning, implementation and operation of a project, the preservation of the quality of environment and the ecological balance should be a primary consideration.
- The adverse impact on the environment, if any, should be minimized and should be offset by adequate compensatory measures. The project should, nevertheless, be sustainable.
- The planning of projects in hilly areas should take into account the need to provide assured drinking water, possibilities of hydro-power development and the proper approach to irrigation in such areas, in the context of physical features and constraints of the basin such as steep slopes, rapid run-off and the incidence of soil erosion. The economic evaluation of projects in such areas should also take these factors into account.
- Special efforts should be made to investigate and formulate projects either in, or for the benefit of, areas inhabited by tribal or other specially disadvantaged groups such as socially weak, scheduled castes and scheduled tribes. In other areas also, project planning should pay special attention to the needs of scheduled castes and scheduled tribes and other weaker sections of the society. The economic evaluation of projects benefiting such disadvantaged sections should also take these factors into account.
- The drainage system should form an integral part of any irrigation project right from the planning stage.
- For construction of storage and the consequent resettlement and rehabilitation of population a skeletal national policy needs to be formulated so that the project-affected persons share the benefits. States should accordingly evolve their own detailed resettlement and rehabilitation policies, taking into account the local conditions. It is to be ensured that the construction and rehabilitation proceed simultaneously and smoothly.
- Both surface water and ground water should be regularly monitored for quality. A phased programme should be undertaken for improvements in water quality. Effluents should be treated to acceptable levels and standards before discharging them into natural streams. Minimum flow should be ensured in the perennial streams for maintaining ecology and social considerations. Principle of 'polluter pays' should be followed in management of polluted water. Preservation of existing water bodies by preventing encroachment and deterioration of water quality.
- Efficiency of utilization in all the diverse uses of water should be optimized and an awareness of water as a scarce resource should be fostered. Conservation consciousness should be promoted through education, regulation, incentives and disincentives. The resources should be conserved and the availability augmented by maximizing retention, eliminating pollution and minimizing losses. For this, measures like selective linings in the conveyance system, modernization and rehabilitation of existing systems including

tanks, recycling and re-use of treated effluents and adoption of traditional techniques like mulching or pitcher irrigation and new techniques like drip and sprinkler may be promoted, wherever feasible.

- There should be a master plan for flood control and management for each flood prone basin. Adequate flood-cushion should be provided in water storage projects, wherever feasible, to facilitate better flood management. In highly flood prone areas, flood control should be given overriding consideration in reservoir regulation policy even at the cost of sacrificing some irrigation or power benefits.
- From the present emphasis on the creation and expansion of water resources infrastructures for diverse uses, there is now a need to give greater emphasis on the improvement of the performance of the existing water resources facilities. Therefore, allocation of funds under the water resources sector should be re-prioritized to ensure that the needs for development as well as operation and maintenance of the facilities are met.
- For effective and economical management, the frontiers of knowledge need to be pushed forward in several directions by intensifying research efforts in various areas, such as - hydrometeorology; snow and lake hydrology; surface and ground water hydrology; river morphology and hydraulics; assessment of water resources; water harvesting and ground water recharge; water quality; water conservation; evaporation and seepage losses; recycling and re-use; better water management practices and improvements in operational technology; crops and cropping systems; soils and material research; new construction materials and technology (with particular reference to roller compacted concrete, fiber reinforced concrete, new methodologies in tunneling technologies, instrumentation, advanced numerical analysis in structures and back analysis); seismic design of structures; the safety and durability of water-related structures; economical designs for water resource projects; risk analysis and disaster management; use of remote sensing techniques in development and management; use of static ground water resource as a crisis management measure; sedimentation of reservoirs; use of sea water resources; prevention of salinity ingress; prevention of water logging and soil salinity; reclamation of water logged and saline lands; environmental impact; regional equity.

In summing up the National Water Policy emphasizes the vital importance of water for human and animal life, for maintaining ecological balance and for economic and developmental activities of all kinds. Considering its increasing scarcity, the planning and management of this resource and its optimal, economical and equitable use has become a matter of the utmost urgency. Concerns of the community need to be taken into account for water resources development and management. The success of the National Water Policy will depend entirely on evolving and maintaining a national consensus and commitment to its underlying principles and objectives. State Water Policy backed with an operational action plan shall be formulated in a time bound manner say in two years.

4. WATER CONTAMINATION AND DAMAGE TO ECO SYSTEMS:

4.1 Water Pollution

The growth of urban megalopolis, increased industrial activity and dependence of the agricultural sector on chemicals and fertilizers has led to the over loading of the carrying capacity of our water bodies to assimilate and decompose wastes. The increasing discharge of domestic and industrial wastes has also led to the contamination of ground water, making it unfit for human consumption at many places. It is estimated that 80% of all diseases and over $1/3^{rd}$ of deaths are caused by consumption of contaminated water and on an average as much as $1/10^{th}$ of each person's productive time is sacrificed to water related diseases.

4.2 Protection of Natural Water Resources

Responsibility should be assigned to various civic and industrial authorities to treat the wastewater before disposing it in conveyance drains or natural streams. Water quality should be monitored regularly at every outfall drain. State wise river basin conservation plan should be formulated for different basins. The pathogenic, toxic and biological, physical and chemical effects of various types of water pollution in different scenario and regions should be scientifically analyzed, collated, understood and suitable action plans should be framed.

4.3 Water Quality Improvement

Strict environmental laws (command and control measures) or market – based instruments for controlling water pollution must be scrupulously applied and implemented to large and medium scale enterprises. Common effluent treatment plants (CETPs) can provide a viable solution to the problem of water pollution by small scale industries, which are not able to bear the cost of treatment of their effluents on an individual basis. We should strive hard for strengthening of monitoring capabilities of various organizations regular monitoring of discharges by firms and public access to information on discharge by polluters and ambient air & water quality.

4.3.1 Water quality criteria

Any stretch of river or coastal water may be subjected to more than one organized use. The list contains irrigation, drinking, industry, power generation, fisheries and wild life propagation, navigation, recreation and aesthetics, and even receptacle for treated wastes. In any stretch there would be one use which would be demanding the highest quality of water and that stretch is designated by that best water quality use (designated best use). The recognized designated best uses along with nomenclature (class of water) are listed in table 1. Based on critical analysis of water quality carried out by them the Central Pollution Control Board (CPCB) has classified four rivers as in table 2.

Table 1. The recognized designated best uses along with nomenclature (class of water)

Designated best use	Nomenclature (class of water)
Drinking water source without conventional treatment but after disinfection	A
Outdoor bathing	B
Drinking water source with conventional treatment followed by disinfection	C
Fish culture and wild life propagation	D
Irrigation, industrial cooling or controlled waste disposal	E

Table 2. Classification of critical rivers in India

River	Total length (km)	% of length in various categories				
		A	B	C	D	E
Ganga	2,525	--	11	56	33	--
Yamuna	1,376	--	36	64	--	--
Brahmi	799	--	23	77	--	--
Subarnarekha	395	--	--	90	--	10

4.3.2 Ganga Action Plan Phase-I

The Ganga Action Plan Phase-I was initiated in February, 1985 to combat the problem of pollution of the Ganga. The Action Plan envisaged diversion and treatment of domestic wastes in 27 important towns situated along the river. In all, 261 schemes were undertaken for sewage interception and diversion, sewage treatment, low cost sanitation measures, electric crematoria and river front development. The various schemes have been aimed to reduce the pollution in the Ganga by atleast 75 per cent. Of the 261 schemes, 211 have been completed by now and the remaining are expected to be completed in the next two years.

4.7.3 Ganga Action Plan Phase-II

The second phase of Ganga Action Plan (GAP) for pollution abatement of Yamuna and Gomti rivers at an estimated cost of Rs. 4,210 million has been approved. The second phase of GAP has also envisaged formulation of Action Plan for Pollution Abatement of River Damodar. The works that were required but were not included in the first phase of GAP are proposed to be covered under this phase.

4.7.4 National River Action Plan

An approach paper on the National River Action Plan (NRAP) has been approved by government at an estimated cost of Rs.10,000 million spread over a period of 100 years. NRAP will include grossly polluted stretches of all those rivers of the country not covered in the GAP Phase I and II.

4.8 Environmental Aspects

India is a land of rivers having predominantly agriculture based economy. Development of a river valley projects has become a lifeline of progress and prosperity of the country. Water Resources Development (WRD) Projects are indispensable as they are inextricably linked to the country's economy besides their need for the welfare of the people. However, in the last two decades, a very strong opposition has been voiced to the construction of large dams arguing that irreparable damage to the environment may result due to such projects. On the one hand a fear syndrome has been created in recent years against WRD projects by exaggerating the likely or assumed adverse environmental impacts and by ignoring or suppressing their tremendous benefits. On the other hand, controversial debates are generated on the grounds that the possible environmental impacts are not properly evaluated in many projects. As a result, many potential economic development activities, which could generate wealth and employment to people have been blocked in several large cities, towns and villages due to acute shortage of water especially during the dry season. At the same time, progress floods routinely continue to affect the economic causing large scale loss of lives and properties.

4.8.1 Rehabilitation & Resettlement

The problem relating to resettlement and rehabilitation (R&R) are far more complex than are generally perceived by the public policy makers or the project implementing authorities. The objective of any R&R package should be to provide the same quality of life, if not better to the affected persons than what they have been enjoying before displacement. Generally suitable compensatory measures such as providing alternative land to the affected persons should be made. Unfortunately some projects had to be shelved on this account alone. An argument is made that the tribal population should not be displaced at all, as they cannot adapt in a different environment. This approach may result in perpetuation of their backwardness. Experience in the northeastern region indicates that the tribal people definitely want water storage projects for bringing in overall economic prosperity to them. Awareness and persuasive approach are needed to tackle this problem. At the same time the rehabilitation packages should provide for more than one option and be made attractive enough at a fractional cost of the project benefits, so that affected people are induced to accept them.

Meanwhile, the construction of multi-purpose projects like Sardar Sarover and Tehri Dam attracted the attention of a large number of Non Governmental Organizations (NGOs) both in India and abroad, mainly on the issue of R&R. There has been an adverse publicity regarding these projects, particularly relating to the problems in proper implementation of the resettlement and rehabilitation of PAPs.

Government of India has recently evolved a draft National Policy for R&R of displaced people to help the State/Project authorities in expediting construction activities. The policy is under consideration for adoption.

4.8.2 Safety of Water Resources Projects:

There are about 3,600 dams in India of which more than 2,300 are of 15m and more in height. 45 of them have been classified as dams of national importance that have heights of 100m and above and/or having storage capacities of 1 cubic km or more. The Dam Safety Organization in India was created in Central Water Commission in the year 1979 to assist the state governments to locate the causes and potential distress areas that could affect the safety of dams and allied structures.

Reservoir induced seismicity is generally considered as a source of the man made disaster associated with the creation of a reservoir. Koyna dam in Maharashtra is often cited as an example. Though it has not been conclusively proved that the creation of reservoir induces seismicity, yet as a precautionary measure a number of seismological stations are set up at the dam sites for observations and analyzing the results for planning necessary preventive measures. Dams are also designed to withstand the seismic forces considering the maximum design flood. Dam break analysis is also carried out as an integral part of the design activity of large storage structures so as to plan and take necessary mitigation measures in the event of occurrence of unlikely disaster.

4.8.3 Flora and Fauna

In case some unique or endangered species of flora and fauna are threatened by the project, suitable measures are to be taken for their rehabilitation. Similarly, if the project interferes with wild life migration, suitable arrangements ought to be made for their habitat. An extremely rare step for environmental protection would be to abandon a project, if it endangers rare species of plants or animals, in order to preserve the natural heritage. However, as the project submerges only a small fraction of forestland, it should be feasible that the endangered species of plants or animals are provided for in the vicinity of the project in the same watershed. Gene banks to preserve Species and to regenerate them in favorable conditions, elsewhere, are also possible.

Silent Valley project in Kerala, though a promising project planned to develop hydropower, was shelved, as it was affecting prime virgin forest with rare species of plants. On a positive side Heran reservoir in Gujrat which provided assured water enough for wild life has actually helped in population growth of wild life and crocodiles which were on verge of extinction. Pong reservoir is now acting as a resting place for migratory birds and number of rare species of birds have now been sighted in these areas. Water reservoir projects have in general enhanced the natural environment for development of flora & fauna in its vicinity.

Significant increase in the numbers of tigers, panthers, elephants and Cheetals have been observed in the famous Jim Corbett National Park with the availability of green fodder, clean water throughout the year and improved climatic conditions after construction of the Ramganga Multipurpose Dam Project. Rare species of birds also flock there. Similar phenomenon of an increase in birds and wildlife has also been observed around the Rihand and Matatila reservoirs, which were previously barren lands. Some of the best tourist places of India like Ukai tourist resort, Periyar wild life sanctuary, Shalimar garden, Brindavan garden, Pinjore garden, Kalindi-Kunj, Matatila Garden, Dhyaneshwar Udyan and the Ramganga Udhyan are the bye-products of river valley projects.

4.9 Water Conservation & Improving Water Use Efficiency

In almost all major urban centres there is an acute problem of adequate water supply while the sources of augmentation are very few. It is roughly estimated that in urban water supply, 30 to 40 % of the municipal water is wasted through the distribution system. In Industrial sector too, there is a scope of economy in use of water. It is estimated by Bureau of Industrial Costs and Prices that 10 to 30% saving in water consumption in industries is possible by recycling, modifications in processing, evaporation control etc. Apart from ensuring leakage control, water conservation strategy in industries should include introduction of appropriate technology to ensure efficient use of cooling and process water and necessary pollution control mechanisms and maximum recycling and reuse.

In irrigation, the efficiency of water use can be increased by improved methods of irrigation such as drip and sprinkler irrigation and by careful planning of conjunctive use of ground water with surface water. Linking of canal distributaries are also tools for controlling water losses. In the industrial sector there is a vast scope of water saving by recycling and reuse of the wastewater.

5. OTHER WATER RELATED PROBLEMS

5.1 Reuse and Recycling of Water

The water intake by the industries is affected by the extent to which water is reused. Reuse is common in large-scale industries using substantial quantities of water. Pollution of water by the effluents discharged by the industries is a serious hazard increasingly being faced by the country. Although fresh water is a renewable source, generation of new and complex wastes by industries is adding to the complexity of water pollution. Both surface water and ground water are affected by such pollution.

Recycling and reuse of wastewater is, therefore, being increasingly resorted to wherever fresh water supplies are inadequate. Wastewater discharged by an urban center or an industry at a particular point in a river gets diluted by the river and another city or industry on the downstream draws the river water and uses it after the necessary treatment. This is generally referred to as indirect reuse. Apart from this, even within an industry a certain amount of water is normally recycled after necessary treatment for specific purposes. A high percentage of demand for industrial water is for cooling purposes. Recycle of industrial processed water should be introduced for cooling purposes wherever economically feasible, since cooling can tolerate low quality of water. Reuse of processed water reduces fresh water consumption as well as the quantity of wastewaters.

Treating municipal wastewater and reusing it for industrial purposes has been successfully accomplished by certain industries in the city of Mumbai. Other cities are now being encouraged adopting the same as far as feasible.

5.1.1 Options and Initiatives

There are various options for recycling and reuse of grey water (bathroom and kitchen wash) and black water (sewage). However, the grey water and black water from large residential complexes like Cooperative Housing Societies, multistoried buildings and industrial effluents from large industries can be recycled and reused for various purposes other than drinking.

The grey water may be put into various types of treatment such as grease trap, anaerobic filter etc and the filtered water may be let into wet land, polishing ponds etc. and can be reused for gardening and horticulture etc. The black water may also be put into various types of treatment such as screen, grit removal primary, secondary and tertiary treatment etc. and the treated waste water can be let into wet land for irrigation or for ground water recharge.

The State Governments may create Urban Development Fund for Urban Infrastructure development and the same can also be used for setting up of pilot projects for waste reuse, recycling and resource recovery.

5.1.2 Incentives and Legal Aspects

Suitable fiscal concessions and subsidies may be considered by the Central and State Governments to the industries, commercial establishments and any other agencies which adopt/practice waste reuse, recycling and resource recovery. Similarly, in case the Urban Local Bodies on their own would like to take the initiative and set up waste reuse, recycling and resource recovery schemes in their respective areas, similar fiscal concessions and subsidies may also be made available to them by the Central and State Governments. In fact, it may be made mandatory in phases that large industry and commercial establishments must meet a sizeable percentage of their non-potable water requirements from the reclaimed water. Similarly, for irrigating crops, horticulture, watering public lawns/gardens, flushing of sewers, fire-fighting etc. reclaimed water should only be used and to this effect, there is a need for legislation or amendment in the municipal bylaws.

5.2 Questionable Use of Water as a Carrier of Wastes

Removing wastes from industries, and homes by using water as carrier over long distances, to extract most of the waste in the sludge, and then leaving polluted water as effluent, need to be closely examined. Better alternatives need to be found to treat the waste at its origin, without using so much water. Use of low flushing and dry toilets as well as use of 'grey water' drained from showers, kitchens and laundries to flush the toilets, should be targeted for adoption in at least in all new construction of commercial institutions and planned colonies in all class I and II cities We have to adopt water sensitive urban planning so that rainwater is used adequately and the runoff from impervious areas, such as car parks, roads and footpaths can be infiltrated into the aquifer after ascertaining its quality without endangering the aquifer.

5.3 Archeology and Heritage

At times mineral deposits, archaeological monuments or shrines are threatened by submergence due to reservoirs. Mineral wealth can be exploited to the possible extent before inundation. It is also possible to protect the mineral wealth and monuments falling in the shoreline zones by constructing ring bunds.

Sometimes historical and cultural monuments may fall in the submerged area of a reservoir. The temple of Abu sibel in Egypt and the Nagarjunkonda in India are living examples of how ancient monuments have been saved and given a greater lease of life. Many temples have been successfully shifted with religious fervour in the Bargi, Srisailam and Sardar Sarovar projects. The Jyotirling temple has been preserved in the planning of the Omkareshwar Dam and improvement in the approach roads and bridges would also be integrated with the project. Similarly, Dargah at Galiakot, which would have come under submergence of Kadana reservoir on the river Mahi in Gujarat, was protected from submergence by constructing a ring bund. Srisailam, Narayanpur and Almatti reservoirs are good examples; where historical monuments have been rehabilitated successfully.

CONCLUSION

A balance between the thrust areas of development (infrastructure and consumer goods), which are said to improve the quality of life, and the social aspects like bare necessities of life in the areas of water, food, fiber, power, education, health, housing and nutrition is needed. The media plays an important role in shaping the thoughts of the people, and it should set its focus right to set the agenda and making the society conscious through balanced & informed public debate. Due to the large temporal variations in river flows, storage of water becomes inevitable. Non-development of water storage projects is not a viable or available option. It is imperative that conservation, recycle, reuse of precious water and proper treatment of wastewater are given serious attention for sustainability of built environment for our highly populated country.

While water is a medium for the transmission of water borne diseases; water is also a primary contributor to the control of infectious diseases through its use for personal and domestic hygiene. Availability of water in India is under tremendous stress due to growing population, rapid urbanization, industrial growth and other demands for maintaining ecology. Integrated water management is of vital importance for poverty reduction, environmental sustenance and sustainable economic development in India because water has the potential for both disease causation and prevention.

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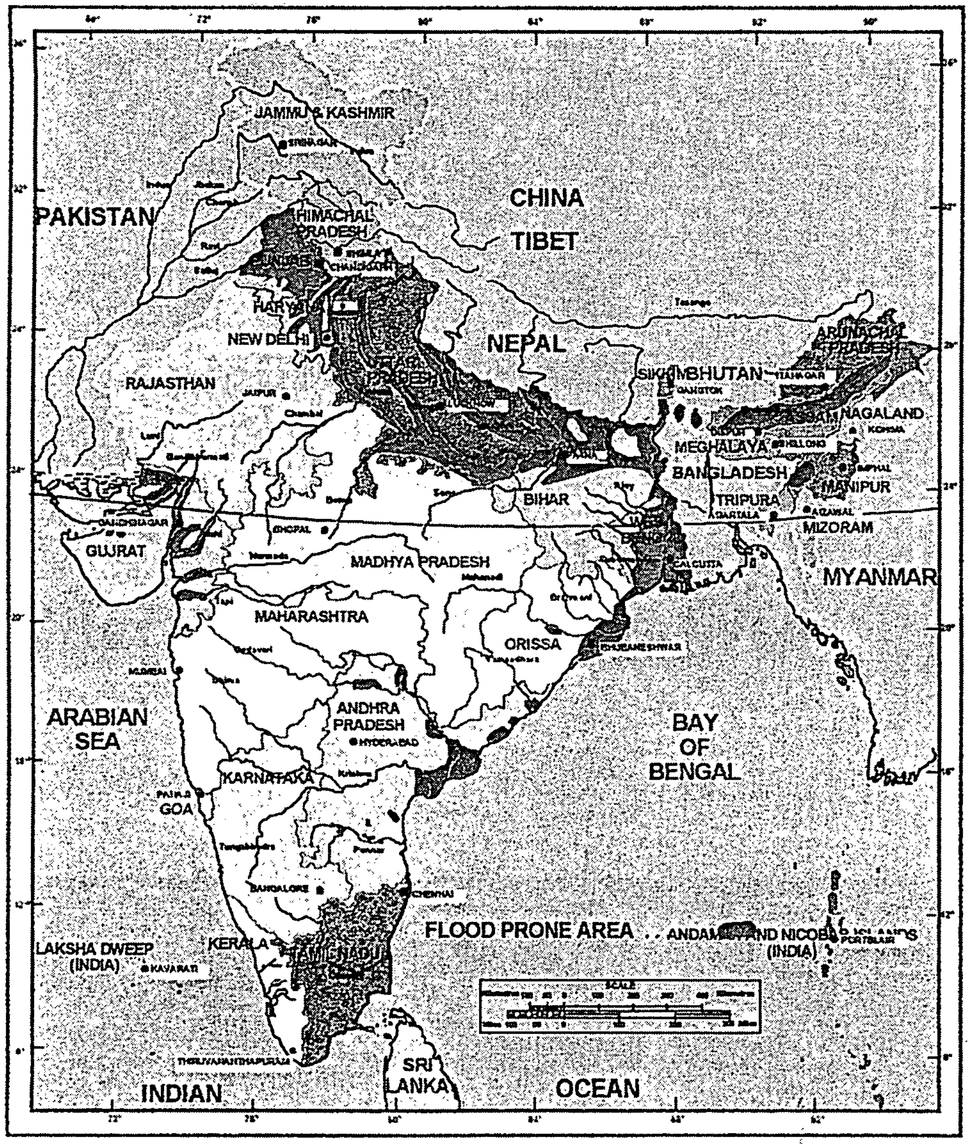
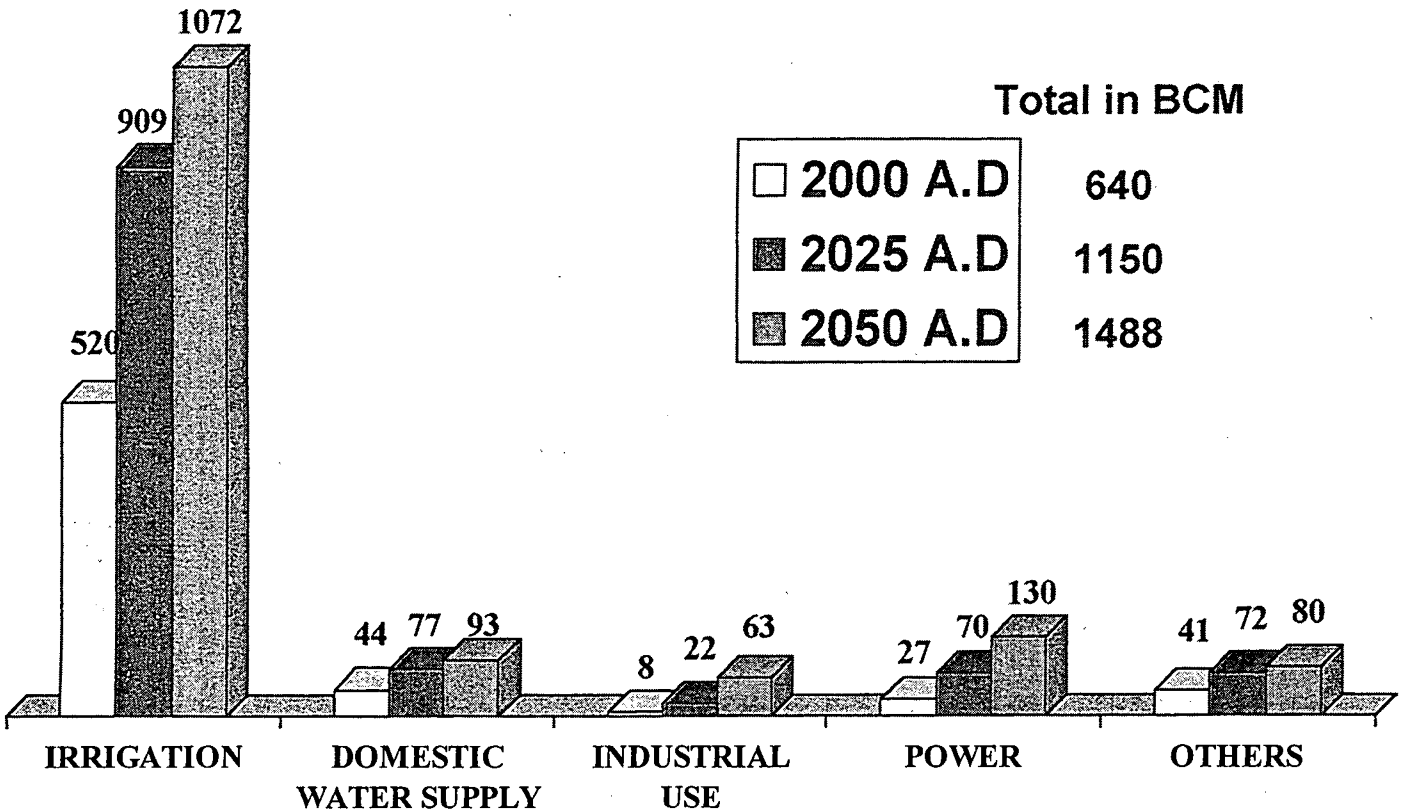
AREA LIABLE TO FLOODS



WATER DEMAND PROJECTIONS



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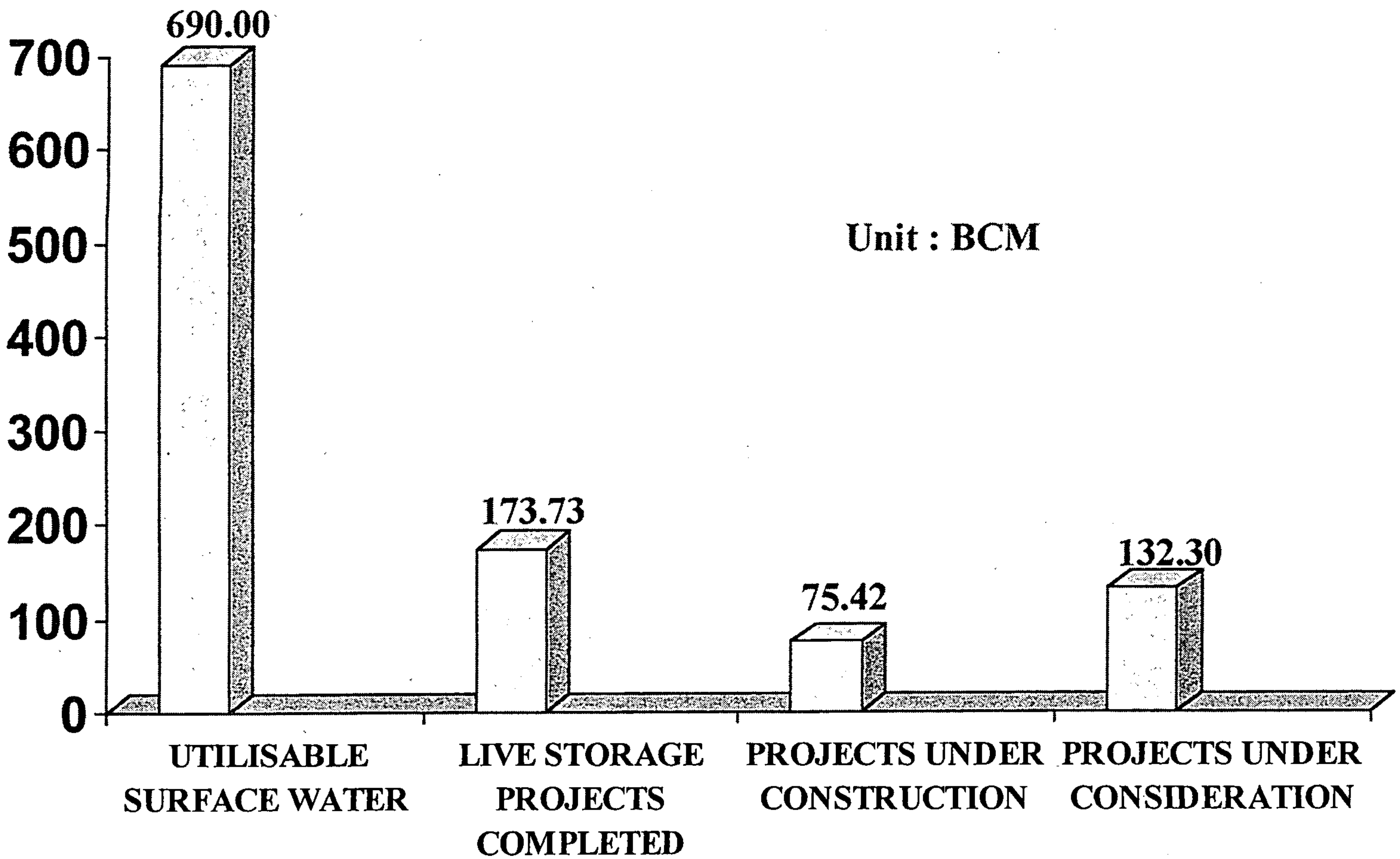
STATUS OF CREATION OF RESERVOIR STORAGES IN THE COUNTRY



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Lecture 5

Case of PHILIPPINES

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Public Works & Highways

REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
BUREAU OF DESIGN

COUNTRY REPORT

Water Resources and River Management for Sustainable Development

OCTOBER 2002

Sofia T. Santiago
OIC, Director III
Bureau of Design

PART I : GENERAL SITUATION

1.1 Geographical and Meteorological Characteristics

1.1.1 Geography

The Philippines is an archipelago composed of about 7,100 islands and islets with an aggregate area of approximately 300,000 km2. It is bounded by the South China Sea on the west, by the Pacific Ocean on the east, by the Sulu and Celebes Sea on the South and by the Balintang Channel on the north. The country is divided into three major island groups, namely: Luzon, the largest, with an area of 141,000 km2, Mindanao, the southernmost major island, with 102,000 km2 and Visayas with 57,000 km2. The entire island group is closely scattered within the tropical belt and southeast of Asian mainland.

1.1.2 Topography

The topographical features of the country varies from the low marsh, which is about one foot above high water at the head of Manila Bay in the Luzon island to 2,954m above mean sea level, the height of the country's highest peak, Mt. Apo in the Mindanao island. The largest mountain areas and the most extensive plains are founding in the island of Luzon. The country has few inland lakes but many semi-enclosed bays. There are four large marshes – two in Luzon and two in Mindanao.

1.1.3 Geology

The following variety of rocks exist in the country: igneous, sedimentary and metamorphic. Basement complex is generally made up of gabbro, andesites, agglomerates, serpentine, greisses, schist, volcanic breccias, volcanic tuff, quartzite and basalt flows.

On the other hand, Philippine soils have considerable depth even on relatively steep slopes due to rapid chemical weathering and slow physical weathering of rocks. Hence, organic matter in the country is very small. Plant material in the tropical forest is about 2 to 3 times that in the temperate forest, but because of rapid chemical decomposition, very little humus is found. Carbon dioxide and organic acids provided by this plant material through attack the rocks, causing its rapid chemical weathering.

1.1.4 Climate

The Philippines is located in the tropics and the climate prevailing in any particular place in the country is influenced by its geographical position and wind system prevalent in different locations at certain times of the year. The classification of climatic conditions is based more on the type of rainfall than on slight differences in temperature. Four types of climate are adopted and are categorized as dry season and wet season induced by minimum or maximum rain period, as indicated below:

i) Type I : Two pronounced seasons, dry from November to April, wet during the rest of the year

ii) Type II : No dry season with a very pronounced maximum rainfall period from November to January

iii) Type III : Seasons are not very pronounced with relatively dry season from November to April and wet season during the rest of the year

iv) Type IV : Rainfall more or less distributed throughout the year

Figure 1.1.4 shows the distribution of climate regions in the Philippines.

Rainfall intensities range from very light to heavy and may occur as continuous, intermittent, or showery. Precipitation is influenced by prevailing air streams or monsoons, tropical typhoons, the Inter-tropical Convergence Zone, topography, fronts, easterly waves, and local thunderstorms.

The country has a wide range of precipitation with the highest intensity of 9,006mm recorded in 1910 in Baguio City and lowest of 94mm in Ilocos Sur in 1948, both places in Luzon. The average yearly precipitation is 2,360mm over the numerous rain gauging stations in the islands.

1.1.5 Typhoons

The Philippines is located along the path of tropical cyclones generated in the Pacific Ocean. About twenty (20) tropical cyclones a year originates from this area out of which nine (9) affect the country. From 1948 to 1999, the Philippines experienced a total of five hundred thirty seven (537) tropical cyclone passages. The graphical distribution of these passages is shown in Figure 1.1.5.

1.2 Population and Land Use

1.2.1 Population

The Philippines has a total population as of 76.5 million, that corresponds to a population density of 228 persons/km^2. Out of the total, about 13% lives in the Metropolitan Manila Area (15,690 persons/km^2), the political and economic/trade center of the country. Population growth peaked in 1970 at 3.08%/year but decreased through the years recording 2.32%/year in 1990-1995.

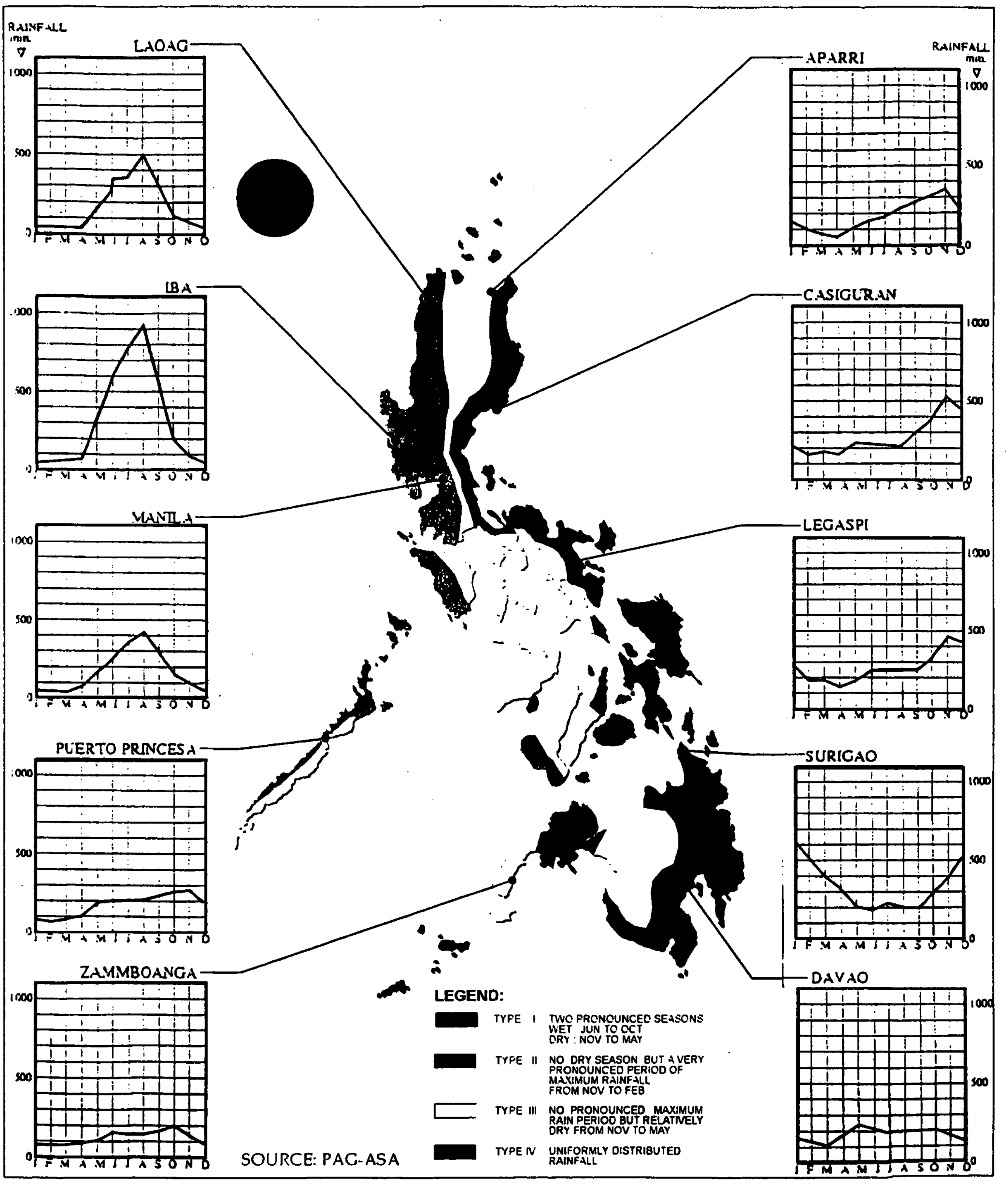


Figure 1.1.4

Climate Regions of the Philippines

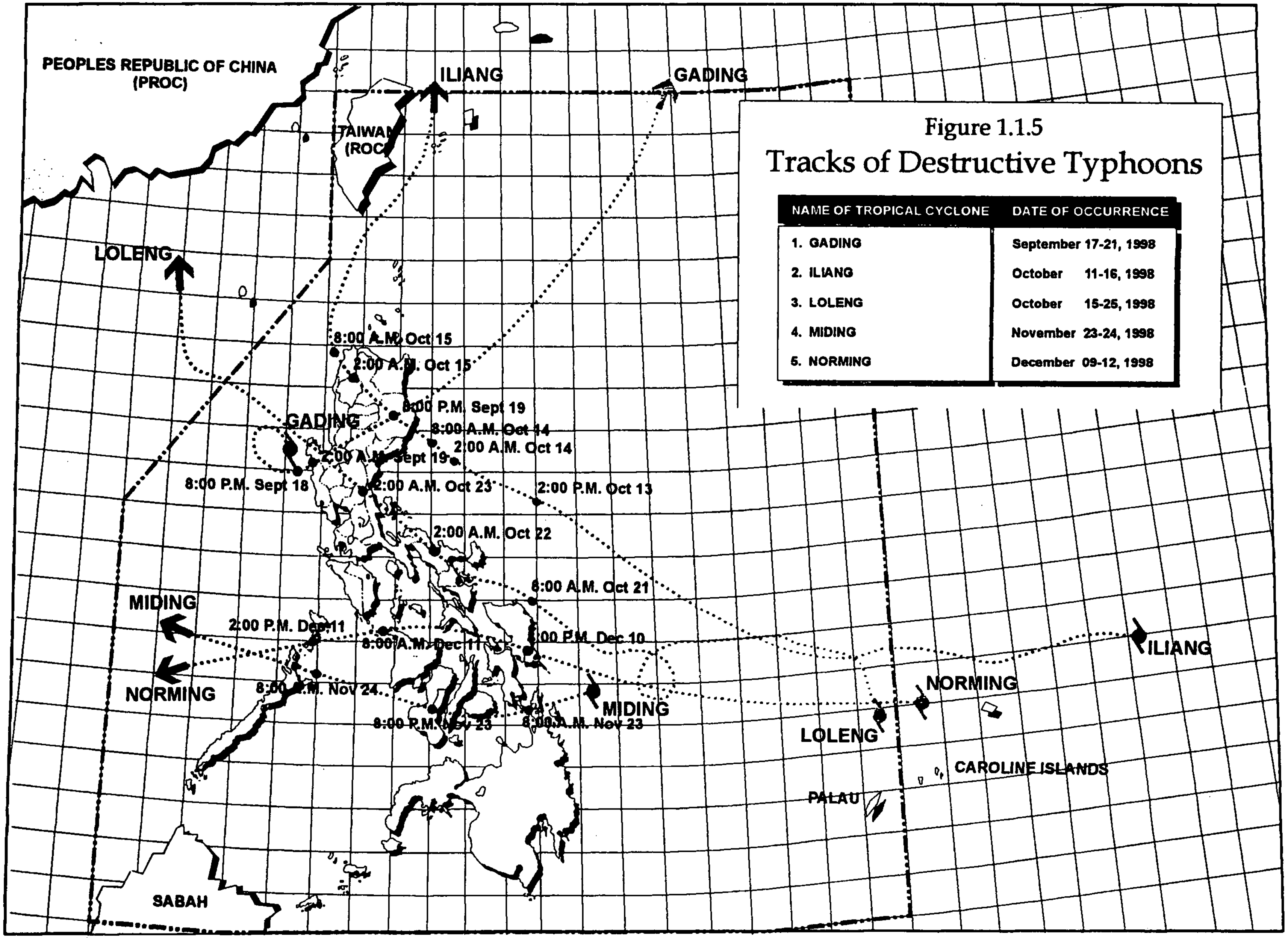


Figure 1.1.5
Tracks of Destructive Typhoons

NAME OF TROPICAL CYCLONE	DATE OF OCCURRENCE
1. GADING	September 17-21, 1998
2. ILIANG	October 11-16, 1998
3. LOLENG	October 15-25, 1998
4. MIDING	November 23-24, 1998
5. NORMING	December 09-12, 1998

Table 1.2.1
Population and Density by Region, as of 2000

Region	Population (thousands)	Density (person/km^2)
NCR (National Capital Region)	9,932	15,690.00
CAR	1,365	70.56
Region 1	4,200	333.40
Region 2	2,813	90.28
Region 3	8,030	438.00
Region 4	11,794	239.70
Region 5	4,674	258.00
Region 6	6,208	303.72
Region 7	5,701	363.16
Region 8	3,610	155.33
Region 9	2,831	167.44
Region 10	3,505	174.86
Region 11	3,676	173.10
Region 12	3,222	143.36
Region 13	2,095	98.46
ARMM	2,803	116.90
Total	**74,498**	**228.00**

1.2.2 Land Use

The Philippines has a territory of 300,000 km^2, classified into forest land of 158,883 km^2 and alienable/disposable land of 141,117 km^2 as of December 1995. The alienable/disposable land covers the urban area, the industrial areas and all other alienable and disposable land, while the forest land includes residential area of 32, 729 km^2 (23.1%), timberland of 101,159 km^2 (71.7%), national parks of 13,411 km^2 (9.4%), military & naval reservation of 1,303 km^2 (0.9%), civil reservation of 1,660 km^2 (1.2%) and fishpond of 756 km^2 (0.5%). Land Classification by region is shown in Table 1.2.2.

Table 1.2.2
Land Classification by Region, as of 2000

(Unit: Km^2)

Region	Total Land	Alienable and Disposable Land	Forest Land
NCR	636	482	154
CAR	18,293	3,407	14,887
Region 1	12,840	8,101	4,740
Region 2	26,838	9,601	17,237
Region 3	18,231	10,519	7,712
Region 4	46,924	21,613	25,312
Region 5	17,632	12,221	5,412
Region 6	20,223	14,088	6,135
Region 7	14,951	9,592	5,359
Region 8	21,432	10,237	11,195
Region 9	15,997	7,623	8,375
Region 10	28,328	10,669	17,658
Region 11	31,693	12,124	19,568
Region 12	14,373	5,468	8,904
ARMM	11,608	5,428	6,180
Total	**300,000**	**141,172**	**158,828**

PART 2: RIVERS IN THE PHILIPPINES

2.1 Principal / Major River Basins

There are 421 principal river basins in the country with drainage areas ranging from 41 km^2 to 25,649 km^2. About 60% of these river basins have drainage areas ranging from 100 km^2 to 500 km^2, as listed below.

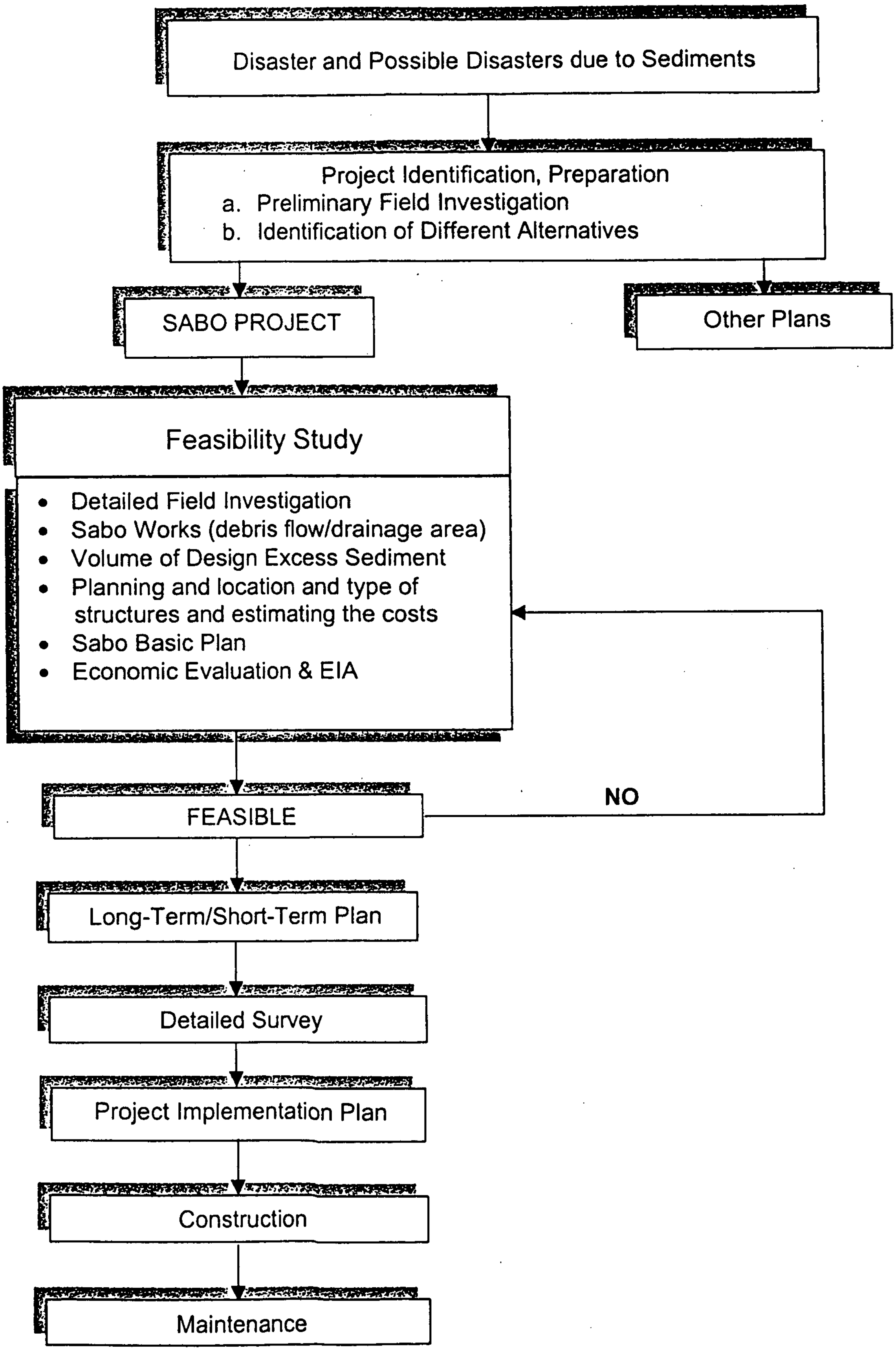
Drainage Area (km^2)	Number of River Basins
50-100	51
101-200	113
201-500	155
501-1,000	63
1,001-2,000	22
2,001-5,000	9
5,001-10,000	5
>10,000	3

Of the 421 principal river basins, 20 are considered major rivers with catchment areas of more than 1,000 km^2. The largest river basin in the country is the Cagayan River basin with a catchment area of 25,649 km^2 located in the Cagayan Valley Region. Figure 2.1 shows the major rivers while Table 2.1 below lists the major rivers and catchment areas.

Table 2.1
Major River Basins

No.	River System	Region	Catchment Area (km^2)	River Length (km)
1	Cagayan	Cagayan Valley	25,649	505
2	Mindanao	Southern Mindanao	23,169	373
3	Agusan	CARAGA	10,921	350
4	Pampanga	Central Luzon	9,759	260
5	Agno	Central Luzon	5,952	206
6	Abra	Ilocos	5,125	178
7	Pasig-Marikina-Laguna de Bay	NCR, Southern Tagalog	4,678	78
8	Bicol	Bicol	3,771	136
9	Abulug	Cagayan Valley	3,372	175
10	Tagum-Libuganon	Southeastern Mindanao	3,064	89
11	Ilog-Hilabangan	Western Visayas	1,945	124
12	Panay	Western Visayas	1,843	132
13	Tagoloan	Northern Mindanao	1,704	106
14	Agus	Southern Mindanao	1,645	36
15	Davao	Southeastern Mindanao	1,623	150
16	Cagayan de Oro	Northern Mindanao	1,521	90
17	Jalaur	Western Visayas	1,503	123
18	Buayan-Malungun	Southeastern Mindanao	1,434	60
19	Laoag	Ilocos	1,353	73
20	Amnay-Patrick	Southern Tagalog	993	58

PROCEDURE ON SABO WORKS



DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS

MAJOR RIVER BASINS IN THE PHILIPPINES

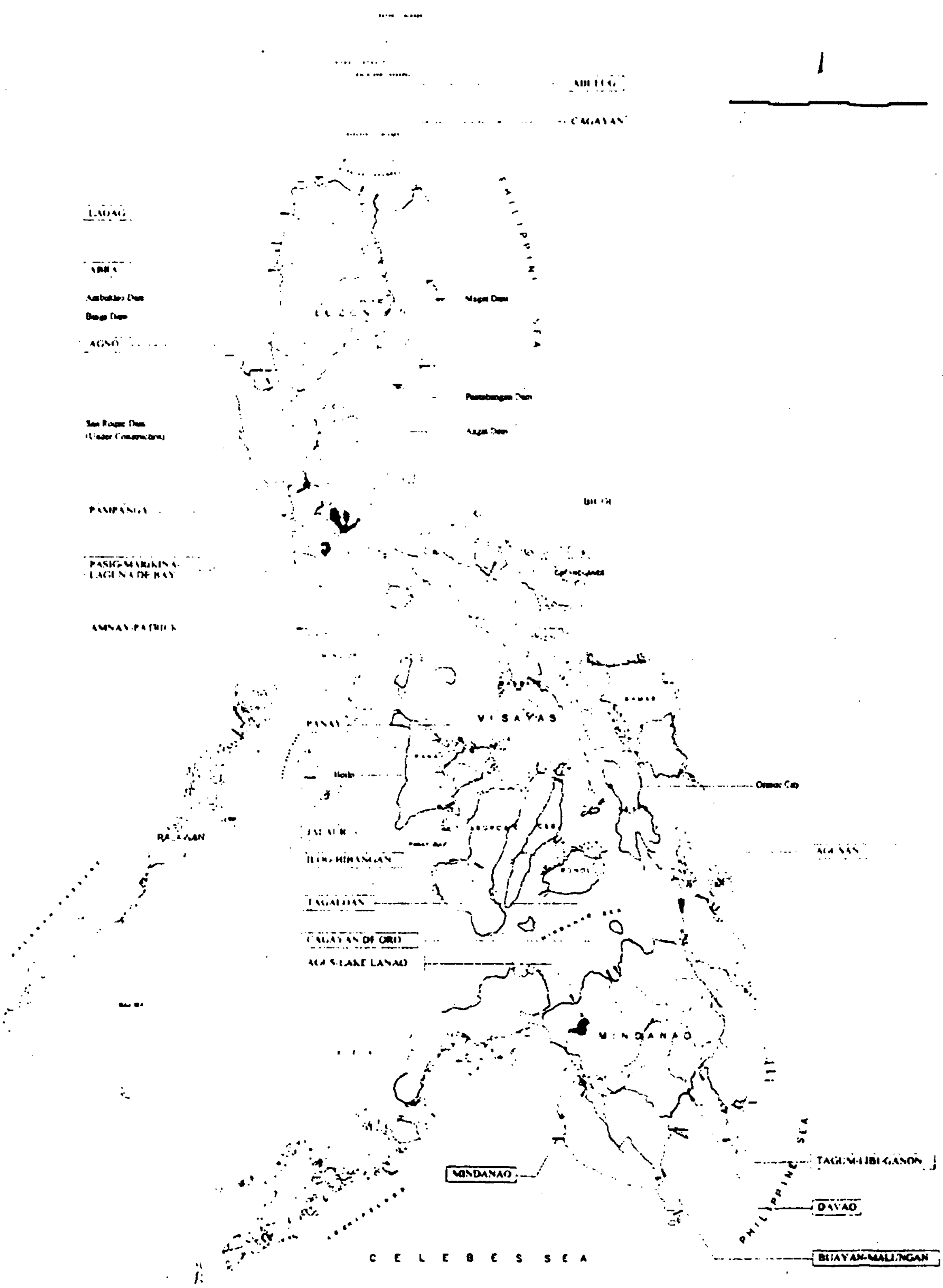


Figure 2.1

PMO - Major Flood Control Projects
PMO - Flood Control and Sabo Engineering Center

2.2 Conditions of River Systems

Rivers in the Philippines are characteristically short and steep. Most of the rivers flow directly from mountain headwaters to the sea. The aforementioned major river basins, however, have river delta ranging from 50 kms. to 280 kms.

In comparison with rivers in other parts of the world, most of major Philippines rivers are short and steep with channel gradients ranging from 0.40% - 0.70%. However, the two largest Philippines rivers, i.e., Cagayan and Cotabato rivers, have channel gradients of 0.08% and 0.13%, respectively.

Cagayan River which is the largest, has relatively gentle slope with a length of approximately 475 km and elevation of about 4000 m. It traverses the entire length of the Cagayan Valley flowing in a northerly direction from its headwaters in Quirino Province to its mouth in the Babuyan Channel.

Mindanao River is the second largest, having an approximate length of 405 km and headwater elevation of 550 m located in Bukidnon. At the convergence point of major tributaries of the river about 200 km from the river mouth, the Liguasan Marsh is formed by overflowing. The marsh covers an area of approximately 280,000 hectares cutting across the tree provinces in North Cotabato, Sultan Kudarat and Maguindanao.

Common to all major river systems in the Philippines is the inadequacy of the existing river channel carrying capacity which generally corresponds to only about 2.0 yr. probable flood.

2.3 Problems and Issues

2.3.1 Flood Disaster

The Philippines due to its geographical location is one of the most disaster-prone countries in the world. It lies along the path of about 20 tropical cyclones a year, about 9 of which directly affect the mainland and cause enormous damage to lives and properties. These cyclones are often accompanied with destructive wind forces that cause storm surges and heavy rainfall which result in inundation in river basins and low-lying areas.

Total cumulative damage for the last 20 years had reached approximately ₱124 Billion and has caused loss of lives of 27,000 casualties. Damaged to houses affects as average of 502,000 families annually.

Damages caused by typhoons experienced in the Philippines from 1970-1999, including their dates of occurrences, areas affected and corresponding damages, are shown in Table 2.3.1 below.

Table 2.3.1
Damages of Destructive Typhoons
1970-1999

Year	Casualties			Population Affected		Houses Damaged		Value of Damages
	Dead	Missing	Injured	Families	Persons	Totally	Partially	(Million Peso)
1970	1,328	494	1,917	18,370	109,980	-	-	501
1971	89	110	72	-	-	-	-	40
1972	298	5	33	-	-	-	-	178
1973	74	89	24	2,024	12,144	-	-	250
1974	153	89	118	97,085	444,330	1,441	4,589	365
1975	39	8	8	4,518	26,523	698	1,547	19
1976	313	185	37	504,510	2,744,379	3,917	4,912	725
1977	99	23	118	137,411	821,638	15,679	16,115	335
1978	663	395	834	520,405	2,853,104	68,376	94,147	1,575
1979	69	68	79	155,919	924,326	54,283	58,649	415
1980	143	29	55	306,895	1,666,498	16,510	47,573	1,465
1981	484	264	1,922	250,965	1,472,417	93,965	159,251	1,275
1982	337	223	347	266,476	1,569,022	84,042	97,485	1,659
1983	126	28	168	140,604	747,155	29,682	85,072	522
1984	1,979	732	4,426	741,510	4,048,805	310,646	313,391	5,869
1985	211	300	17	318,106	1,643,142	8,204	211,151	2,725
1986	171	43	151	287,140	1,414,188	7,106	36,357	1,777
1987	1,020	213	1,455	668,628	3,882,534	242,336	345,370	4,083
1988	429	195	468	1,173,994	6,081,566	134,344	355,459	8,676
1989	382	89	1,087	502,600	2,582,822	56,473	184,584	4,494
1990	670	262	1,392	1,265,652	6,661,474	223,525	636,742	12,678
1991	5,199	4,281	355	150,894	759,335	15,458	83,664	4,187
1992	117	95	53	352,944	1,755,811	3,314	8,006	5,071
1993	794	200	1,634	1,446,031	7,465,711	164,174	444,909	19,987
1994	242	48	247	617,228	3,056,232	58,567	223,358	6,381
1995	1,204	642	3,025	1,561,334	7,693,526	294,147	719,124	15,256
1996	124	50	90	260,581	1,255,289	2,690	17,559	2,834
1997	91	8	44	442,298	2,204,761	2,325	20,546	1,046
1998	498	106	873	1,590,905	7,197,953	137,020	406,438	17,822
1999	56	3	25	270,424	1,281,194	144	687	1,555
TOTAL	17,402	9,277	21,074	14,055,451	72,375,859	2,029,066	4,576,685	123,765
AVERAGE	580	309	702	501,980	2,584,852	78,041	176,026	4,126

Source : National Disaster Coordinating Council (NDCC)
• : Based on Current Prices

2.3.2 Key Problems in Philippine Rivers

2.3.2.1 Urban development within the confines of river waterway and flood plain.

- Restricts flood flows resulting in increased localized riverbed aggradation/degradation, localized bank erosion and damage to existing flood control facilities

- Loss of life and property from severe floods

- Restricts access to existing flood control facilities for maintenance works

- Delays new flood control project implementation

2.3.2.2 Deafforestation and resulting increased sediment runoff into river systems

- Increased sediment runoff into river systems result in localized bank erosion, localized riverbed aggradation and degradation and reduced storage capacity to water impounding structures

2.3.2.3 The Philippines is in a volcanic/earthquake region hence volcanic eruptions and earthquakes impacts on river systems

- Volcanic eruption (Mt. Pinatubo-1991) resulting in substantial effusion of lahar into river systems leading to significantly increased riverbed aggradation and damage to existing facilities such as bridges, dikes, etc.

- Earthquake damage to existing facilities is always significant like the Luzon 1990 earthquake – magnitude 7.8

2.3.2.4 Compared to other infrastructure sectors like roads, bridges, flood control sector is in a lower priority which results to less allocation than necessary, hence, staged implementation

2.3.2.5 Reliance on ODA/Foreign Assistance. Like other developing countries, the Philippines relies on ODA / Foreign assistance for major flood control projects

PART 3: RIVER IMPROVEMENT ACTIVITIES

3.1 Development Policies

The Department of Public Works and Highways (DPWH) is the government agency responsible for the planning, design, construction and maintenance of flood control projects in all major river basins. It has developed policies and strategies which addresses issues, structural and non-structural, related to river improvement works as follows:

a) Mitigate flooding to tolerable levels in Metro Manila and major river basins with the additional construction/installation of flood control facilities such as dikes, river walls, levees, cut-off channels, diversion floodways, revetments and installation of pumping stations, dredging and related works.

b) Provide adequate flood control and facilities in all flood prone areas that need protection as determined under the national land use plan.

c) Coordinate the development of flood control projects with the implementation of irrigation projects.

d) Pursue comprehensive planning of major river basins and implementation of flood control structures on identified flood prone areas including proper river management.

e) Pursue the installation of flood forecasting and warning system in all river basins.

f) Relocate squatters living along the banks of rivers/esteros/creeks in coordination with other concerned government agencies.

g) Pursue maintenance of facilities against lahar and dredging/desilting activities to increase flood conveyance capacities of river channels.

h) Put up viable and effective garbage collection and disposal systems for areas near rivers/esteros/waterways used for drainage.

i) Pursue proper maintenance and up-keep of existing drainage system through the concerted efforts by the national government and LGUs.

j) Organize flood reaction teams and Bantay Estero/Ilog brigades among LGUs in coordination with the tri-media.

k) Put-up an effective flood monitoring system.

l) Establish the Flood Control and Sabo Center to conduct applied research and development and human resource development.

3.2 Flood Control Projects in Major River Basins and Urban Centers

In line with the foregoing policies, the DPWH is currently implementing major river improvement works listed in Table 3.2. Due, however, to fund limitations, the DPWH is able to implement only a few of its major flood control works with emphasis on major river basins having completed the Master Plan/Feasibility Study status, with assistance from foreign lending institution notably from the Japan Bank for International Corporation and the Japan International Cooperation Agency.

Table 3.2
FEATURES AND FLOOD CONTROL PROGRAMS OF MAJOR RIVER BASINS
As of May 2002

GENERAL INFORMATION							COMPLETED / ON-GOING PROGRAMS									FUTURE PROGRAMS		
					RIVER DESCRIPTION		STUDY					IMPLEMENTATION						
Code No.	Name of River Basin	Region	Province	Catch. A. (sq. km.)	Section	Feature	Agency	Year	Type	Title/Scope	Status	Agency	Year	Project Description	Status	Study/ Agency	Implementation Phase/Package	Priority
1	Laoag	I	Ilocos Norte	1,353		Sedimentation Problem	JICA	1996-97	MP/FS	Sabo/Flood Control	Completed	JBIC	2001	Sabo Dams River Improvement	On-going	D/D OECF	24-YL	A
2	Abra	I CAR	Abra	5,125		Sedimentation Problem												C
3	Cagayan	II	Cagayan Isabela Quirino Nueva Vizcaya	25,649	Whole	Largest River	JICA	1985-87	M / P	Water Res. Dev.	Completed							-
					Lower	Flooding Due to Narrow Sections	JICA	2000-02	F / S	Flood Control	On-going					D/D OECF	27-YL	A
					Upper											FS/DD		B
4	Abulug	II CAR	Cagayan Apayao	3,372														C
5	Agno	CAR I II	Benguet Pangasinan Tarlac	5,952	Whole	Flooding/Sedim.	JICA	1988-91	F / S	Flood Control	Completed							-
					Lower				D / D			OECF	1995	PH-1	On-going			-
					Middle	Poponto Swamp			D / D			OECF	1998	PH-2A	On-going		PH-2B / 24-YL	A
					Upper												PH-3 / 26-YL	A
					Lower-Sinocalan											FS/DD JICA		A
					Tarlac River	Lahar										PH-2B	PH-3	A
6	Pampanga	III	N. Vizcaya Pampanga Bulacan	9,759	Delta	Delta-Development w/ Opposition	JICA	1979-82	M / P	Flood Control	Completed	16-YL	1990	PH-1	Completed		PH-2 / 26-YL	A
							13-YL	1986-89	D / D	Flood Control	Completed							
					Upper											MP / FS		B
7	Pasig-Marikina Laguna Lake	NCR IV-A	Metro Manila Rizal Laguna	4,678	Metro Manila	Pumping Stations						1-YL	1973-83	10 Pumping Sta.	Completed		Rehabilitation	B
												12-YL	1984-87	2 Pumping Sta.	Completed			
												14-YL	1988-98	3 Pumping Sta.	Completed			
						Mangahan FW						4-YL	1975-88	Floodway	Completed			-
						EFCOS						11-YL	1983-93	FC Operation	Completed			-
												GOJ/GA	2000-	Rehabilitation	On-going			A
						West of Mangahan Floodway	JICA	1987-90	F/S	Flood Control	Completed	21-YL	1996	North Laguna Flood Control	On-going			-
							16-YL	1990-96	D/D	Flood Control	Completed							
						KAMANAVA	JICA	1987-90	F/S	Flood Control	Completed	SYL	2000	Flood Control	On-going		Special-YL	A
							DPWH	1998	Re-FS	Flood Control	Completed							
						Drainage						GOJ/GA	1989	Retrieval	Completed			-
						Main/Laterals						GOJ/GA	1992	Retrieval 2	Completed			-
						Esteros	JICA	2000	Pre-FS	Flood Control	Completed					F/S		A
					Pasig-Marikina River	Channel Improvement	JICA	1987-90	F/S	Flood Control	Completed						25-YL	A
							SAPROF	1997-98	F/S	Flood Control	Completed							
							23-YL	1999	D/D	Channel Improv.	On-going							
					Pasig River	Dredging						Belgium	2000-	Dredging	On-going			-
					San Juan R.	Dredging						GOP	2000-	Dredging	On-going			-

Table 3.2
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As of May 2002

GENERAL INFORMATION							COMPLETED / ON-GOING PROGRAMS									FUTURE PROGRAMS		
Code No.	Name of River Basin	Region	Province	Catch. A. (sq. km.)	RIVER DESCRIPTION		STUDY					IMPLEMENTATION				Study/ Agency	Implementation Phase/Package	Priority
					Section	Feature	Agency	Year	Type	Title/Scope	Status	Agency	Year	Project Description	Status			
8	Amnay-Patrick	IV-B	Occidental Mindoro	1,353		Sedimentation & Flooding	7-YL	1996-97	MP/FS	NFCPRDP	Completed						FCSEC - Pilot Area for FC/Sabo	A
							DPWH	1984	Pre-FS	Multi-purpose	Completed							
9	Bicol	V	Camarines Sur Albay	3,771		Flooding in Urban Area	7-YL	1978-82	M/P	NFCPRDP	Completed							B
							BRBDP	1983	F/S	Flood Control Component	Completed	DPWH	1973-91	Cut-off/Diversion Channels	Completed			
							BRBDP (ADB)	1992	D/D	& Irrigation Flood Control	Completed							
10	Panay	VI	Capiz, Iloilo	1,843		Flooding	7-YL	1978-82	M/P	NFCPRDP	Completed					FS		B
11	Jalaur	VI	Iloilo, Antique Capiz	1,503			7-YL	1978-82	M/P	NFCPRDP	Completed							C
12	Ilog-Hilabangan		Negros Occidental Negros Oriental	1,945		Flooding at Lower Reaches	7-YL	1978-82	M/P	NFCPRDP	Completed							B
							JICA	1989-91	M/P	Flood Control								
13	Agusan	CARAGA	Agusan del Norte Agusan del Sur Surigao del Sur Surigao del Norte	10,921	Lower	Flooding in Urban Area	7-YL	1978-82	M/P	NFCPRDP	Completed							-
							10-YL	1982-85	D/D	Flood control	Completed	14-YL	88-99	PH-1. West Bank	Completed			-
												21-YL	1996	PH-2. East Bank	On-going			-
					Whole	Bunawan Marsh	7-YL	1978-82	M/P	NFCPRDP	Completed					FS/JICA		A
14	Tagoloan	X	Misamis Oriental Bukidnon	1,704		Sedimentation & Flooding	7-YL	1978-82	M/P	NFCPRDP	Completed							C
15	Cagayan de Oro	X	Misamis Oriental Bukidnon	1,521		Flooding in Urban Area	LGU	1999	M/P	Flood Control & Env'l Improvt.								B
16	Tagum-Libuganon	XI	Davao	3,064		Flooding in Urban Area	NIA-DPWH		F/S	Flood Control & Irrigation	Completed	NIA		Diking-Left Bank	Completed			C
												DPWH		Diking-Right Bank	On-going			
17	Davao	XI	Davao	1,623		Flooding in Urban Area	Davao City	1998	M/P, F/S	Drainage	Completed							C
18	Buayan-Malingan	XI	South Cotabato Davao del Sur	1,434														C
19	Agus	XII	Lanao del Norte	1,645														C
20	Mindanao	XII ARMM	Maguindanao Sultan Kudarat South Cotabato North Cotabato Bukidnon	23,169	Whole	Constricted Sec. causes the flood at midstream Liguasan Marsh	7-YL	1978-82	M/P	MFCPRDP	Completed							-
							NEDA	1997	M/P	Liguasan M. Development	Completed							
							PHRD WB	1999-	M/P	Watershed Management	On-going							

Note: NFCPRDP - National Flood Control Project and River Dredging Program

Table 3.2
FEATURES AND FLOOD CONTROL PROGRAMS OF MAJOR RIVER BASINS
As of May 2002

GENERAL INFORMATION							COMPLETED / ON-GOING PROGRAMS									FUTURE PROGRAMS		
Code No.	Name of River Basin	Region	Province	Catch. A. (sq. km.)	RIVER DESCRIPTION		STUDY					IMPLEMENTATION				Study/ Agency	Implementation Phase/Package	Priority
					Section	Feature	Agency	Year	Type	Title/Scope	Status	Agency	Year	Project Description	Status			
1	Mt. Pinatubo	III	Zambales		Pasig-Potrero	Lahar	1976-78	M/P	MP/FS		Completed	T.S.-YL	1997-		On-going			-
			Pampanga		Sacobia-Bamban		1992-95	F/S			Completed	23-YL	2000-		On-going			
			Tarlac		West Side	Lahar										JICA-FS		A
2	Dalton Pass	II, III	Abra														FSEC Pilot Area	A
3	Mayon	V	Camarines Sur		Mt. Mayon		JICA	1978-81	M/P	Sabo-FC	Completed						25-YL	A
						mudflow	JICA	1982-83	M/P	Updating	Completed							
						lavaflow	JICA	1998-00	F/S	Comp. Disas. Prevention	On-going							
4	Ormoc City FC Project	VII	Ormoc City	25.2	anilao River		JICA	1993-95	MP/FS	Flood Control	Completed	GOJ/GA	1998-	River Improvement slit dams, bridges	Completed			-
				11.1	Malbasag River													
5	Iloilo City FC Project	VI	Iloilo City	412	Jaro River	Flooding in Urban Area	JICA	1993-95	MP/FS	Flood Control	Completed	25-YL	2002	River Input Flood Control	On-going		25-YL	A
				106	Iloilo River		22-YL	1999-	D/D	Jaro FW	Completed							

3.3 Solutions implemented / to be implemented :

The following are being pursued to address the key problems identified, to wit :

- Urban development within confines of river waterway and flood plain (both LWC & HWC).
  - Establishment and strict enforcement of local Government zoning regulations
- Deafforestation and resulting increased sediment runoff into river system.
  - Strict enforcement of logging bans through appropriate regulatory agencies – DENR, Police, etc.
  - Implementation of tree planting programs in river watershed areas.
- Philippine is a Volcanic region and the associated impacts of eruptions on river system.
  - Difficult to prepare for in terms of river system due to the magnitude of the event.
  - Post eruption activities very important such as :

    * Dike heightening
    * River channel dredging
    * Sabo dam construction
    * Replacement of damaged infrastructure e.g. bridges
- Philippine is in an earthquake region and the impacts of earthquakes on existing flood control.
  - Ensuring earthquake resistant designs are prepared for new / or replacement river flood control facilities.
- Lower prioritization of flood control projects in the Philippines compared to projects in other sectors.
  - Upgrade priority level of flood control.
  - Enhance in-house capability of DPWH through training and transfer of technology.

WATER RESOURCES AND RIVER MANAGEMENT FOR SUSTAINABLE DEVELOPMENT

Engr. Sofia Torio Santiago

Natural Condition

- The Philippines is an archipelago comprised of 7,100 islands
- It is bounded in the west and north by the South China Sea, on the east by the Pacific Ocean, and the south by the Celebes Sea and the coastal waters of Borneo
- Its total land area is about 300,000 km^2
- It is divided into 3 major island groups, namely:
  - Luzon (141,000 km^2)
  - Mindanao (102,000 km^2)
  - Visayas (57,000 km^2)

Natural Condition (cont'd)

Climate

- The Philippine climate is tropical and maritime
- It is relatively hot, humid, and rainy
- It has two distinct seasons:
  - Rainy Season
  - Dry Season

Natural Condition (cont'd)

Climate (cont'd)

- It has 4 climate types based on rainfall distribution:
  - Type I – Two pronounced seasons, wet (June to November) and dry (December to May)
  - Type II – No dry season with a very pronounced maximum rainfall (December, January, and February)
  - Type III – Unpronounced seasons, relatively dry (November to April) and relatively wet (the rest of the year)
  - Type IV – Rainfall more or less distributed throughout the year

Natural Condition (cont'd)
Rainfall

- Rainfall runs the gamut of intensities
  - The highest is 9,006 mm (Baguio City, 1910)
  - The lowest is 94.2 mm (Vigan, Ilocos Sur, 1948)
  - The average precipitation is 2,360 mm per year
  - It is influenced by:
    - Prevailing streams or monsoons
    - Tropical typhoons
    - The Intertropical Convergence Zone
    - Easterly waves
    - Local thunderstorms
    - Topography

Water Resources

- The Philippines is blessed with abundant water resources
  - The mean rainfall reaches 2,360 mm/yr
  - 421 rivers
  - 59 inland lakes
  - Numerous streams
  - Swamps
  - Marshes

Water Resources (cont'd)

- The Philippines was divided into 12 water resource regions (WRR) by the then National Water Resource Council (NWRC), now the National Water Resources Board (NWRB) in consideration of hydrological water boundaries they are:
  - WRR I – Ilocos Region
  - WRR II – Cagayan Valley
  - WRR III – Central Luzon

Water Resources (cont'd)

- 12 Water Resource Regions (WRR) (cont'd):
  - WRR IV – Southern Tagalog
  - WRR V – Bicol
  - WRR VI – Western Visayas
  - WRR VII – Central Visayas
  - WRR VIII – Eastern Visayas
  - WRR IX – Southwestern Mindaao
  - WRR X – Northern Mindanao
  - WRR XI – Southeastern Mindanao
  - WRR XII – Southern Mindanao

Water Resources (cont'd)
Principal / Major River Basins

- 421 river basins
- Drainage areas range from 41 km^2 to 25,649 km^2
- 60% of river basins have drainage areas ranging from 100 km^2 to 500 km^2
- 20 major rivers with catchment areas exceeding 1,000 km^2
- Cagayan River is the largest at 25,649 km^2

Major River Basins (nos. 1 to 10)

Table 2.1a

No.	River System	Region	Catchment Area (km^2)	River Length (km)
1	Cagayan	Cagayan Valley	25,649	505
2	Mindanao	Southern Mindanao	23,169	373
3	Agusan	CARAGA	10,921	350
4	Pampanga	Central Luzon	9,759	260
5	Agno	Central Luzon	5,952	206
6	Abra	Ilocos	5,125	178
7	Pasig-Marikina-Laguna de Bay	NCR. Southern Tagalog	4,678	78
8	Bicol	Bicol	3,771	136
9	Abulug	Cagayan Valley	3,372	175
10	Tagum-Libuganon	Southeastern Mindanao	3,064	89

Major River Basins (nos. 11-20)

Table 2.1b

No.	River System	Region	Catchment Area (km^2)	River Length (km)
11	Ilog-Hilabangan	Western Visayas	1,945	124
12	Panay	Western Visayas	1,843	132
13	Tagaloan	Northern Mindanao	1,704	106
14	Agus	Southern Mindanao	1,645	36
15	Davao	Southeastern Mindanao	1,623	150
16	Cagayan de Oro	Northern Mindanao	1,521	90
17	Jalaur	Western Visayas	1,503	123
18	Buayan-Malungun	Southeastern Mindanao	1,434	60
19	Laoag	Ilocos	1,353	73
20	Amnay-Patrick	Southern Tagalog	993	58

Major River Basins (cont'd)

- Rivers are commonly **short** and **steep**
- Most of the major rivers have channel gradients that range from 0.40% to 0.70%
- However, the two largest, the Cagayan and Cotabato rivers have channel gradients of 0.08% and 0.13%, respectively

Water Resources

Groundwater Resources

- The Philippines has extensive groundwater resources.
- It has an estimated storage capacity of 1.22 M cubic meters. The four major reservoirs are:
  - Angat
  - Magat
  - Ambuklao
  - Pantabangan

Water Problems

Flood Disasters

The Philippines is one of the most disaster-prone countries due to frequent typhoons and floods

- Its location and meteorological condition make it vulnerable to flood disasters
- It lies along the path of an average of **20** tropical cyclones yearly
- 9 of which directly affect the mainland and cause enormous damage to lives and property
- Damages to property, agriculture, infrastructure, and death or injury to people

Water Problems

Flood Disasters (cont'd)

- Flood disasters are due to the progressive deterioration of of rivers and streams in the flood plains and delta areas
- This results from the lack of flood control facilities, inappropriate or antiquated technology, budgetary constraints, inadequate river administration, and encroachment of natural channels

Water Problems

Sediment Disasters

- The Philippines has been experiencing sediment disasters due to its geographical conditions
  - It lies on several fault lines
  - There are 22 active volcanoes
- Sediment-related disasters often occur due to sediment movement (i.e. debris flow, slope failure, landslides, volcanic mudflow)

Water Problems

Sediment Disasters (cont'd)

- Man's activities have also contributed to the problem, such as:
  - Severe deforestation due to illegal logging resulting in easy sedimentation and debris flow amounting to riverbed aggradations, and severe flooding.
- The implementation of the appropriate measures are also hampered by the following factors:
  - Budget constraints
  - It is of low priority
  - Lack of appropriate technology

Water Problems

Water Shortages

- Although the Philippines is considered a water-rich country, there are some areas in the country which experience water shortages.
- The demand for potable water is far from being met by the supply provided by water utilities, both public and private in nature.

Water Problems

Water Shortages (cont'd)

- In a Master Plan Study in Water Resources and Management in 1998, 4 water resource regions were found to be in critical condition due to the small ratios of water resources potential to total water demand in 2025. They are the following:
  - WRR II
  - WRR III
  - WRR IV
  - WRR VII

Water Problems

Water Shortages (cont'd)

- The water scarcity problem is caused by the following:
  - Increasing population
  - Growing urbanization
  - Increasing demand
  - Watershed degradation that endangers the capacity of the natural ecosystem to sustain water
  - Water pollution
  - The growing cost of water dev't. under shortages
  - Water allocation among competing uses (domestic, irrigation, industrial and commercial, and hydropower)

Water Problems

Water Contamination and Damage to the Ecosystem

- 50 out of the 421 rivers in the country, including the four major rivers in Metro Manila are already considered biologically dead due to the indiscriminate dumping of raw sewage.
- Water quality degradation is attributed to various practices that pollute the environment, such as:
  - Direct waste dumping by domestic and industrial sources
  - Sedimentation by logging-induced soil erosion
  - Siltation by mining
  - Other ecologically-disturbing agricultural practices

Other Water-Related Problems

- Groundwater exploitation has resulted in saline water-intrusion problems
- Metro Manila and Metro Cebu has been experiencing such problems
- Exploitation of groundwater is the common cause of this problem
- Another problem is the contamination of groundwater brought about by domestic sewage, factory waste, and agricultural chemicals.

Government Efforts

- The importance of water resources and river management for sustainable development is recognized by the government
- Sustainable development has been defined as three-dimensional:
  - Economic
  - Social
  - Environmental

Government Efforts (cont'd)

- It is also supported by growth with equity, people empowerment, and the maintenance of ecological integrity.
- The Philippine Agenda 21 defines the action and intervention strategies at the ecosystem level.
- Among the identified ecosystems and critical resources are:
  - Freshwater ecosystem
  - Coastal / Marine Ecosystem

Lecture 6

Case of PAKISTAN

Mr. Zubair Emran KHAWAJA

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Communication & Works Department

Government of Punjab, Lahore

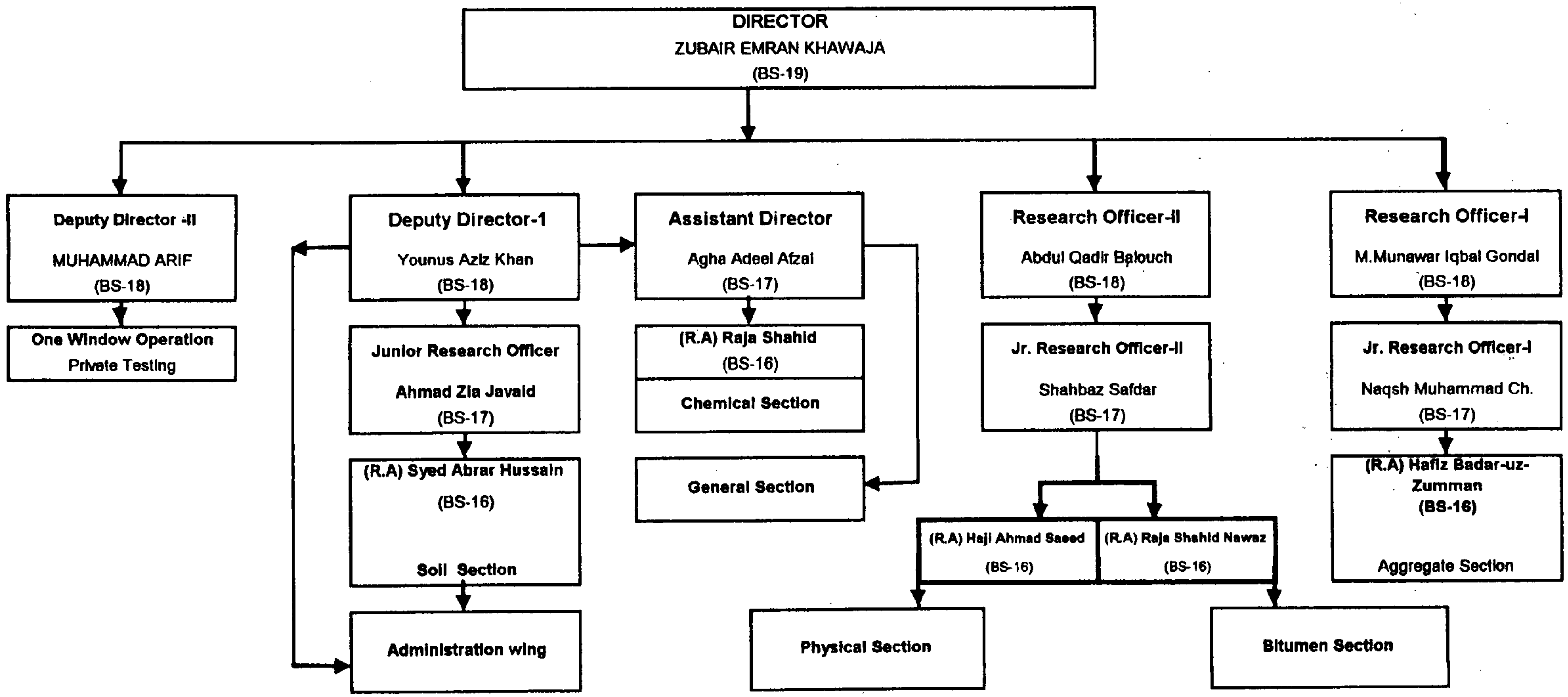
EXECUTIVES' SEMINAR
ON PUBLIC WORKS MANAGEMENT
JAPAN

COUNTRY REPORT
PAKISTAN

ROAD RESEARCH AND MATEIAL TESTING INSTITUTE/PRIVATE SECTOR PROJECTS INVESTMENT CELL. COMMUNICATION & WORKS DEPARTMENT GOVERNMENT OF THE PUNJAB, LAHORE

Zubair Emran KHAWAJA

ORGANOGRAM



TOTAL STRENGTH = 131
WORKING = 115

Subject of Common Interest

"Water Resources and River Management for Sustainable Development"

Pakistan's Economy by and large is agriculture based, and contributes 24.7% of GNP of 2000-2001 and accounts for more than 60% of foreign exchange earnings. About 68% of the rural population depends on agriculture as it employees over 46% of the labor force. Within the agriculture sector. the contribution from crop production is 52% while livestock contributes almost 44% the contribution from fishers and forestry are comparatively small, estimated at 3% and 1% respectively.

The principal objective of economic and financial policies of the Government of Pakistan is the achievement of sustained annual economic growth of around 6%, with agriculture making a significant contribution. Water has played a very significant role in the economic development of Pakistan and is likely to continue as such in future.

Total power generation capacity in Pakistan is of the order of 17,980 MW This includes hydropower generation capacity of 5,009 MW, thermal power generation capacity of 12,509 MW and nuclear power energy generated. The potential for hydropower generation is of the order of 40,000 MW. Cooling water requirements of the Chashma Nuclear Power Plant and several thermal power plants are also met from the river and canals.

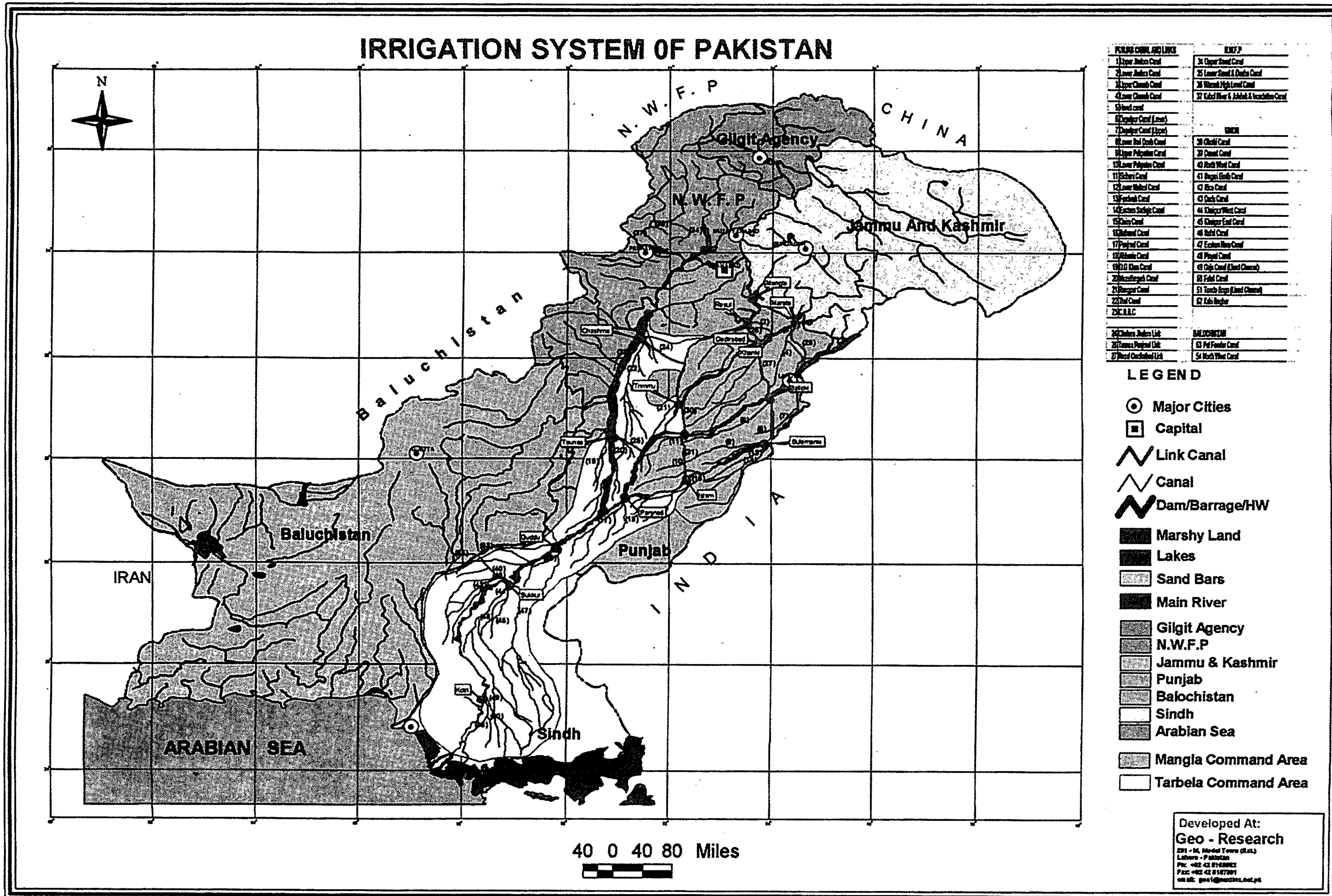
In addition to agriculture and hydropower, inland fisheries contribute reasonably to the national economy. Pakistan produced 665,000 metric tons (mt) of fish and related products in 2000 including 185,000 mt from inland water and 480,000 mt from marine fisheries. Although the share of fineries in the GDP is small, yet its contribution to national income through exports is sustainable. During the same period 84,693 mt were exported with a value of Rs.7.9 billion.

Water Resources: The total surface water available in the Indus Basin is estimated at 147.17 MAF (181.55 BCM). Additionally, in Balochistan the Makran Coastal basin has an average flow of about 3.0 MAF (3.69 BCM) and the Kharan Basin, has an average inflow of 0.79 MAF (0.97 BCM), both of which could be harnessed for use.

There is also groundwater. Recharge is from direct rainfall and infiltration through the alluvium from rivers, the irrigation system and from the irrigated fields. Estimates of groundwater recharge vary significantly but range from 40.5 to 52.7 MAF (50 to 65 BCM) annually. The groundwater supply is almost fully utilized and in some areas, notably in balochistan, groundwater tables are rapidly declining.

The water Apportionment Accord (1991) has allocated 114.35 MAF (141.1 BCM) to the provinces and another 3 MAF (3.7 BCM) for the Civil Canals in NWFP. Over the 11 years since the Accord it has never been possible to divert the full allocated amount despite above average inflows in several years. This is mainly a storage problem, as the most critical shortage occur in early Kharif when inflows are low, irrigation requirements are high and there is insufficient water in the storage reservoirs for release.

Average water abvailablity and hydropower generation from Mangla and Tarbela are declining as their combined live storage capacity reduced due to siltation. It has seen a 20% reduction in capacity to date and this will continue.


IRRIGATION SYSTEM 0F PAKISTAN
N
N. W. F. P
CHINA
Gilgit Agency
N.W.F.P
Jammu And Kashmir
Baluchistan
Baluchistan
IRAN
Punjab
INDIA
Sindh
ARABIAN SEA
LEGEND
Major Cities
Capital
Link Canal
Canal
Dam/Barrage/HW
Marshy Land
Lakes
Sand Bars
Main River
Gilgit Agency
N.W.F.P
Jammu & Kashmir
Punjab
Balochistan
Sindh
Arabian Sea
Mangla Command Area
Tarbela Command Area
40 0 40 80 Miles
Developed At:
Geo - Research

Potential for Additional Storage: There is reasonable potential for additional storage but, at present, lack of consensus among the provinces on the storage issue hampers its development. The storage option will require a strong national commitment, which satisfies the genuine concerns of the provinces and overcomes the objections of the provinces for the greater national good.

.Additional storage of 15 MAF (18.5 BCM) by 2025 is required to fulfill the water need of all sub-sectors, especially agriculture under the projected Low Demand Scenario, and to replace lost storage in the existing reservoirs. This is in addition to 6 MAF to be developed through efficiency increases in irrigation.

Recognizing the importance of water and power development in the national economy, the Pakistan Government through Water and Power Development Authority (WAPDA) has launched a water resource and hydropower development Mega-plan known as 'Vision-2025', which aims at the development of about 21 MAF (26 BCM) of new storage capacity between 2005 and 2025.

There are several possible storage sites, with a total volume of 22.5 MAF, as shown in Table 1.

Dam Site	Storage Capacity (MAF)	Power Capacity (MW)	Status	Design & Construction Period (year)	Cost (m$US (2000)
Gomal Zam Dam	1.14	17.4	OG	4	167
Mirani Dam	0.30	-	OG	4	118
Satpara Dam	0.02	0.20	OG	3	10
Munda Dam	0.68	740	FS	9	750
Kalabagh	6.10	3600	FS, DD, TD	8	5000
Sehwan Barrage	0.65	-	FS	7	610
Kurram Tangi Dam	1.20	1.20	FS	7	200
Raising Mangla Dam	3.10	180	FS	5	883
Basha Dam	5.70	3360	PF	12	6000
Sanjwal & Akhori	3.60	TBD	C	12	600
Total	**22.49**	**9498.8**	**N/A**	**N/A**	**14338**

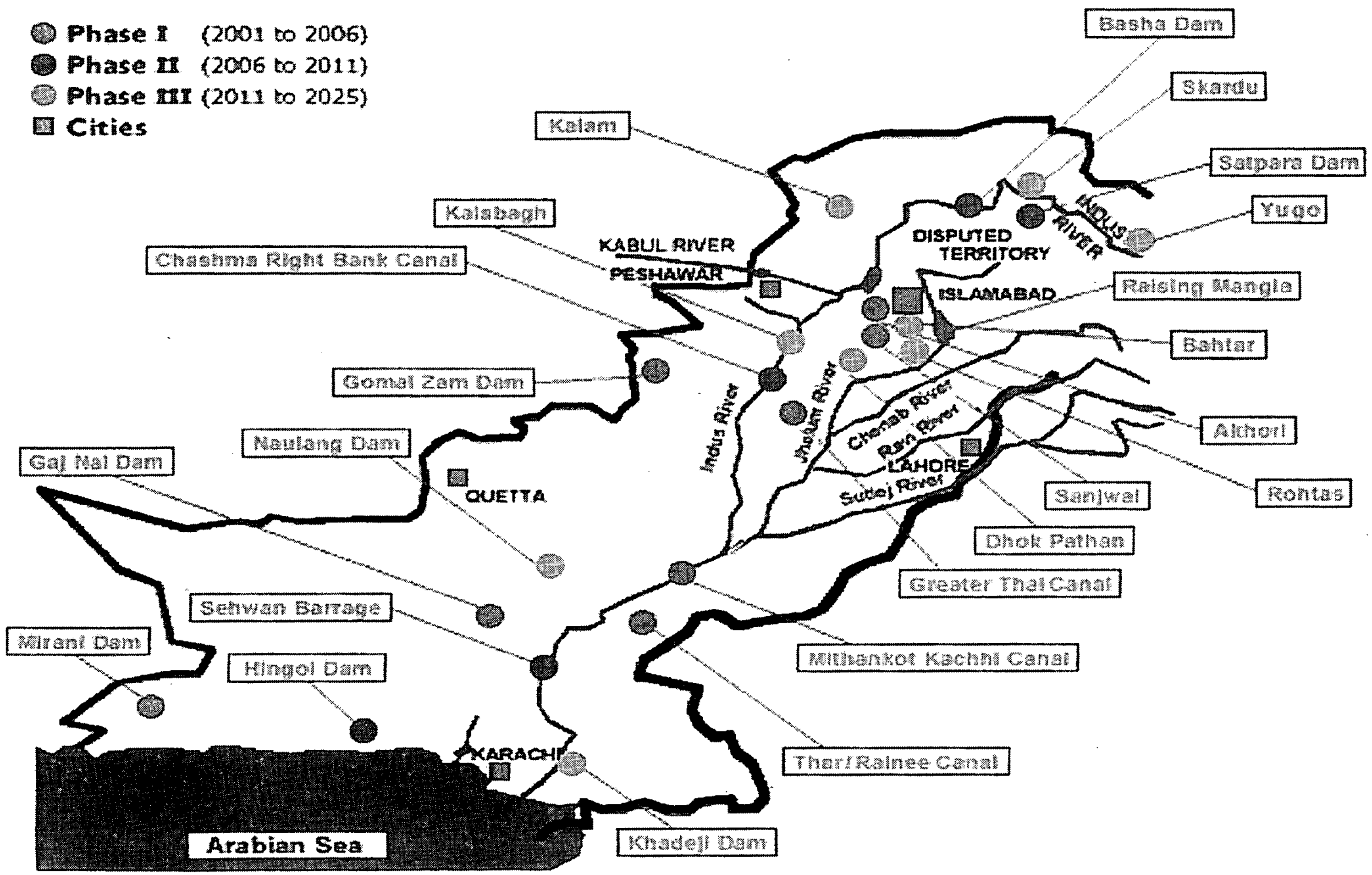
Table 1: Potential Storge Sites Presently Being Considered

Status:

OG	Construction started/likely to be stated shortly
FS	Feasibility Study ready
DD,TD	Detailed design and Tender Documents ready
PF	Pre-feasibility study ready. FS, DD& TD to be prepared
C	Concept exists, PF, FS, DD & TD to be prepared
TBD	To be determined
Costs	for most dams the costs are from the WAPDA Visions 2025 For Munda and Sewhan, costs were determined in this Study.

PAKISTAN WATER AND POWER DEVELOPMENT AUTHORITY
VISION 2025

Location Map of Water Sector Projects



Proposed Strategy for Water Resources: Population growth is the single most important driving force affecting the water sector, with the increasing demands, which it will place on irrigated agriculture production and non-agricultural water services. Pakistan's current population of 141 million people will grow to 221 million by 2025, with the resultant increased demands for water food and power.

Pakistan is now at the limit of its water resources. The long-term sustainable average annual surface water inflow is 144 MAF and there is limited potential for increasing the resources. There will be increasing competition among the various water sub-sectors as demands for non-agricultural uses increase and demands agricultural production increase. The main objective for the water resources sector is to provide sufficient water to meet the needs of the various sub sectors through several interventions, which include.

i). Water for the future will come from a combination of conservation and storage. Conservation will mainly come from the agriculture/irrigation sector through various interventions.

ii). Additional storage of 15 MAF is needed. The primary constraint in developing additional storage is the current lack of consensus between the provinces on the acceptability of such projects and the lack of national level commitment.

iii). A planning body must be instituted, which assesses overall water resources and has the authority to overcome the lack of cooperation between the provinces.

iv). A full Storage Master Plan should be undertaken with the objective of determining the best storage and water management options. Included in this must be the assessment of the actual environmental water needs downstream of Kotri.

v). Implement a Public Awareness Programme to inform the public about the water resources isues and their responsibilities in conservation and other concerns.

vi). Develop a Management Information System (MIS) for all water information at athe national level, carried out in cooperation with the provinces and federally administered areas.

vii) Develop and implements a comprehensive Water Quality Improvement Programme to improve both surface water and groundwater quality.

Urban Water Supply and Sanitation

Water Supply: Public water supply in Pakistan represent a small component of total water use, currently estimated at around 3.16 MAF (3.9 BCM) per annum of 3% of total water use. Its relative importance to the population is, however recognized in current policies and plans and its need for priority acknowledged. For the urban sector alone, the estimate is 2.76 MAF (3.4 BCM) per annum.

In terms of proportion of the population with access to piped water supplies in cities, the estimate is 55% to 90% for the large cities with a weighted average around 71%. For smaller towns the average is nearer 50%. The overall average urban coverage for piped water supply is around 60%.

The reported quality of water entering the distribution systems is generally satisfactory. Conventional treatment is provided where the raw water comes from surface sources or where ground water quality is poor. Water quality deteriorates within the distributed system as a result of depressurization of the main. Under these conditions, chlorination cannot be effective in preventing bacterial contamination.

Sanitation: Present coverage of access to sewer connections for Karachi, Lahore and Faisalabad averages 56%. For the remainder of the urban population, the coverage is between 40% to 45%. Access to piped sewerage by the whole urban population may, therefore, be in the range 45-50.

The present total sewage treatment capacity is estimated at 339 Ml/d which represents less than 1% of total domestic sewage generated in urban areas. Some of this capacity is unused due to lack of sewerage infrastructure. Most of the sewage treatment plants in Pakistan are not in working order.

RIVER MANAGEMENT:

Incidence of Flooding: Rivers forming Indus basin in Pakistan has had a long history or repeated localized and widespread flooding that has caused loss of life, substantial damage to property and infrastructure and loss of agricultural crops and lands. Despite the construction of reservoirs and major investments in flood protection, there is still a considerable flood hazard. The barrages that occupy a key place in the irrigation economy are at risk when exposed to large floods, as some of the barrages do not have adequate capacity for the passage of major discharges. Also, there are some old structures such as bridges, which cannot pass high magnitude floods, thus raising the flood levels upstream and exacerbating damage. These constraints sometimes require breaching of flood protection bunds that cause flooding in downstream areas.

Much of Pakistan is a flood prone region, with steep upper catchments and the potential for high intensity rainfall. The flood problem has been exacerbated by the progressive denudation of river catchments and the general deterioration of river channels from significantly reduced flows during non-flood seasons because of increased diversion from the rivers. Major floods have occurred in 1950, 1956, 1957, 1973, 1976, 1978, 1988, 1992 and 1995. In 2001, though the country was passing a severe drought cycle, local flooding in the Leh Nullah caused extensive damage to life and properly in Rawalpindi. It is estimated that between 1995 and 2001 direct losses from floods have been of the order of US $ 10 billion and over 6,000 lives were lost.

Despite the construction of reservoirs and major investments in flood protection, there is still a considerable flood hazard. The capacities of the dams that attenuate flooding and regulate river flows are being reduced by situation. Uncompleted or poorly planned and constructed flood protection works are at risk, as well as the lands they are intended to serve.

Flooding mainly impacts on three areas of the country:

- The main riverine areas, adjacent to the Indus and its tributaries (the Jhelum, Chenab, Ravi, Sutlej, and Kabul), where annual floods are used for irrigation purposes and which are heavily populated and suffer catastrophic damage due to high intensity floods.;
- High torrent affected areas where intense local rainfall on steep, largely denuded mountainsides can cause major flash floods. Such floods cause immense damage

communications and urban infrastructures. Large and sudden deposits of sediment from hill torrents near the confluence with main river, adversely affecting flooding and erosion conditions.;

- Areas of poor drainage where water ponds in agricultural and urban areas as a result of heavy summer (monsoon) rainfall.

Flood Protection Works

Flood protection works in Pakistan usually take the form of:

- River training works and flood protection works for barrages and bridges that usually take the form of guide bunds and spurs;
- Breaching bunds which are utilized when the flood peak exceed the capacity of barrages;
- Bunds usually with spurs to constrain the river and prevent overall onto adjacent lands; and,
- Revetments on riverbanks to protect towns and villages.

The flood problem and the strategy for flood protection vary across Pakistan. Flood protection embankments are constructed where there is a problem of flooding, whereas spurs are constructed to arrest the problem of land erosion. The existing flood management facilities in Pakistan include about 3700 miles (5920 Km) length of embankment and nearly 800 spurs.

Flood Protection Plans and Projects

i) assess the flood problem;
ii) prepare an integrated and suitably phased flood control plan comprising short and long term measures; and
iii) recommend arrangements for efficient maintenance of flood control and protection works.

The Food Commission prepared a plan for flood protection in 1970. This central Commission was later replaced by two provincial commission; i) Punjab Province Flood Commission; and ii) Indus River Commission in Sind. Following the devastation during heavy floods in 1973 and 1976 the Federal Flood Commission (FFC) was constituted by the Government of Pakistan in 1976 with the main function of;

- preparing a National Flood Protection Plan for the country;
- approving flood protection schemes prepared by the provincial/federal agencies
- ensuring proper monitoring of flood works; and
- improving the performance of flood warning system.

A comprehensive National Flood Management Plan was prepared in 1978, which contained a phased implementation plan. Phase I under this Plan was implanted during the period 1978-88. During this period 350 flood protection schemes were implemented at a cost of Rs. 1.73 billion.

The Flood Management Plan was updated and the National Flood Protection Plan-II (NDPP-II) was implemented during the period 1988-98 where in 170 schemes were completed at a cost of Rs. 2.542 billion. During the same period several foreign funded projects. Both for flood damage restoration and flood protection, where also implemented which included:

- 1988 Flood/Rain Damage Restoration Project where 2065 schemes were completed at a cost of Rs. 2.3 billion including US$ 200 million provided by ADB.
- Flood Protection Sector Project-I (FPSP-I) – 257 schemes were implemented at a cost of Rs. 4.86 billion including US $ 131 million provided by ADB.
- 1992-94 Flood/Rain Damages Restoration Project – 1980 schemes were completed at a cost of Rs. 6.67 billion including US $ 193 provided by IDA, EU, KFW and ADB.

Several facilities and services were procured under FPSP-I to improve the flood forecasting and warning capability. As a floow-up, FPSP-II is currently being implemented with the assistance of ADB in order to complete the remaining activities to strengthen the Flood Forecasting and Warning System, undertake left over sub-projects and develop certain new flood protectin schemes. The FPSPII has encountered major delay of about 55%. AS of end 2001, physical progress is 3% cumulative contracts awards 14%, and cumulative disbursement only one %. The Chief Executive of Pakistan constituted a Special Committee (namely the Flood Protection Committee) on 19 June 2001 to review the flood sector, and specifically FPSP-II. The review of FPSP-II was carried out over a four month period. The Committee completed its findings and recommendations in November 2001. The total cost of the project is proposed to be reduced from Rs. 8 billion to Rs. 4.342 billion for the reformulated Project which is designated as Phase I components of FPSP-II. The remaining sum of Rs. 3931.235 million is proposed as Unallocated Sum for Phase II of FPSP-II. After approval of the reformulation proposals by ADB the Project is likely to recommence.

FCC has also completed several feasibility studies through consultants to address the problem of flood damage caused by hill torrents in various parts of the country. The proposals from these studies are in the process of approval at the federal government level for arranging financing.

For each of the %-ages indicate whether stable, increasing or decreasing	Severe Impact	Moderate Impact	Slight impact	No impact
Area of rural floodplains in which flooding adversely affects people and/or agricultural activities.	20%	50%	20%	10%
Area of urbanized floodplains in which flooding adversely affects people, properly and/or industry.	15%	35%	30%	20%
Area of settled floodplains that has integrated structural and nonstructural flood mitigation				30%
Area of settled floodplains that has effective nonstructural flood mitigation				Negligible

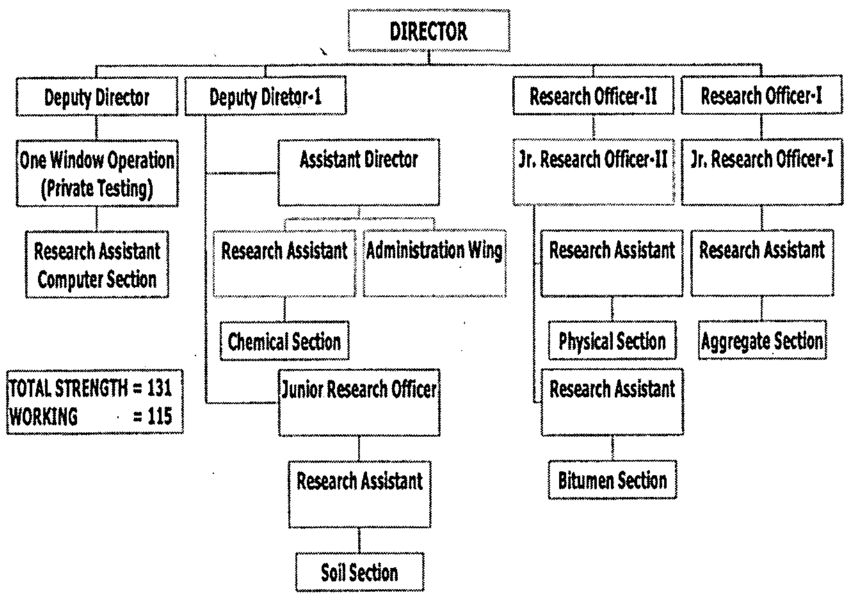
WELCOME TO PRESENTATION ON WATER RESOURCES & RIVER MANAGEMENT FOR SUSTAINABLE DEVELOPMENT

BY

ZUBAIR EMRAN KHAWAJA

WR-2

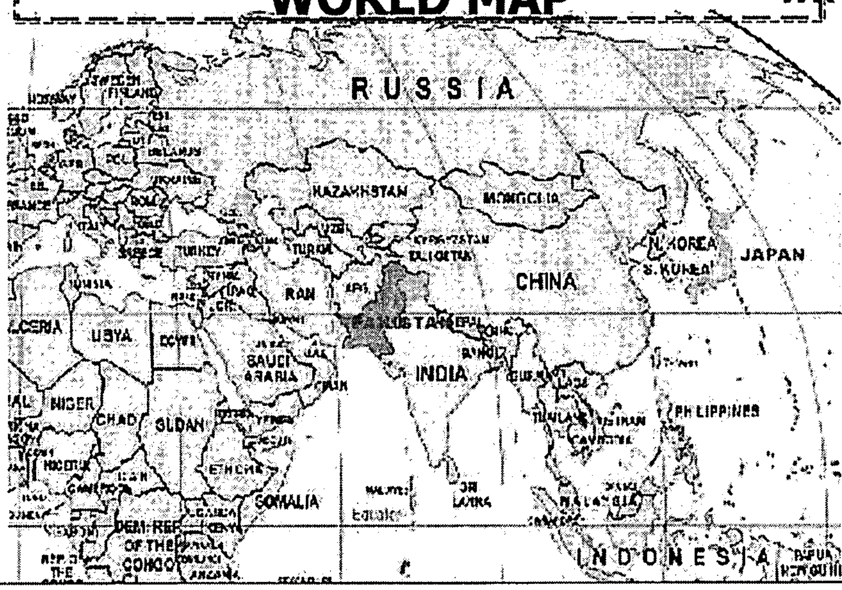
ORGANOGRAM



WR-3

WORLD MAP

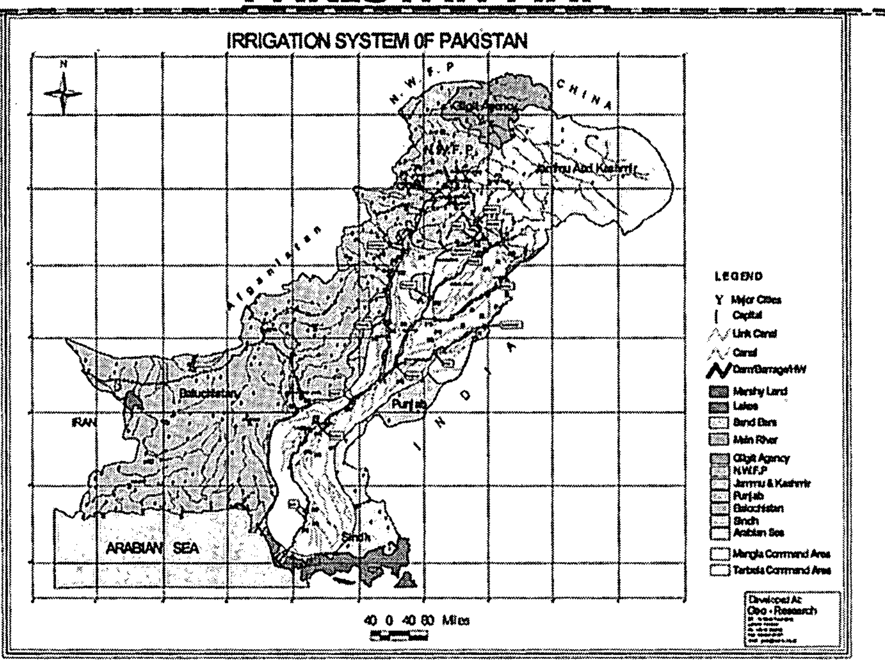
WR-4



- **ISLAMABAD (PAKISTAN): 33^0 42' N 73^0 10' E**
- **TOKYO (JAPAN): 35^0 40' N 139^0 45' E**

PAKISTAN MAP

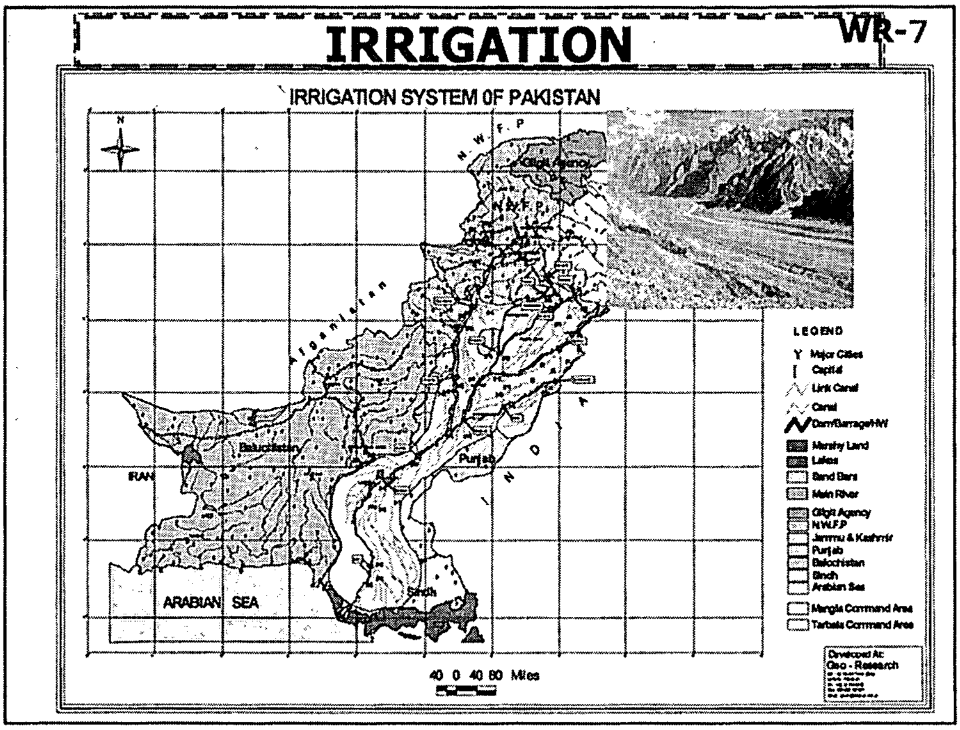
WR-5

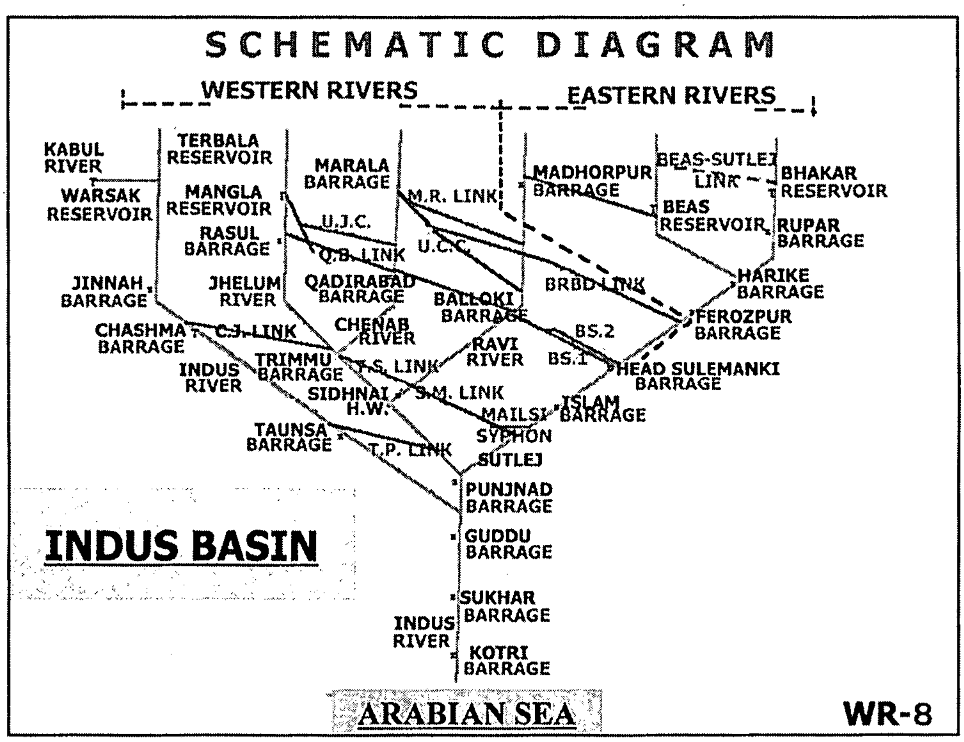


LAND USE

AREA	SQ KMS
• TOTAL AREA	1,050,000
• RUGGED MOUNTAINS, NARROW VALLEYS & FOOTHILLS	662,000
• SANDY DESERTS	79,000
• ARABLE	309,000 (30 Million Hectare)

WR-6


IRRIGATION
WR-7
IRRIGATION SYSTEM OF PAKISTAN
N.W.F.P
Afghanistan
Baluchistan
Punjab
Sindh
IRAN
INDIA
ARABIAN SEA
LEGEND
40 0 40 80 Miles


SCHEMATIC DIAGRAM
WESTERN RIVERS
EASTERN RIVERS
KABUL RIVER
WARSAK RESERVOIR
TERBALA RESERVOIR
MANGLA RESERVOIR
RASUL BARRAGE
MARALA BARRAGE
M.R. LINK
U.J.C.
Q.B. LINK
U.C.C.
MADHORPUR BARRAGE
BEAS-SUTLEJ LINK
BHAKAR RESERVOIR
BEAS RESERVOIR
RUPAR BARRAGE
JINNAH BARRAGE
JHELUM RIVER
QADIRABAD BARRAGE
BALLOKI BARRAGE
BRBD LINK
HARIKE BARRAGE
FEROZPUR BARRAGE
CHASHMA BARRAGE
C.J. LINK
CHENAB RIVER
RAVI RIVER
BS.2
BS.1
HEAD SULEMANKI BARRAGE
INDUS RIVER
TRIMMU BARRAGE
T.S. LINK
SIDHNAI H.W.
S.M. LINK
MAILSI SYPHON
ISLAM BARRAGE
TAUNSA BARRAGE
T.P. LINK
SUTLEJ
PUNJNAD BARRAGE
INDUS BASIN
GUDDU BARRAGE
SUKHAR BARRAGE
INDUS RIVER
KOTRI BARRAGE
ARABIAN SEA
WR-8

INDUS BASIN SYSTEM

- MIGHTY INDUS & DISTRIBUTORIES; KABUL, JHELUM, CHENAB, RAVI, SUTLEJ, & BEAS.

• CANAL SYSTEMS.	44 NO.
• MAJOR IRRIGATION CANALS.	60,000 KMs
• BARRAGES.	17 NO.
• IMPORTANT DAMS.	34 NO.
• LINK CANALS.	12 NO.

WR-9

CONTRIBUTION OF AGRICULTURE IN PAK ECONOMY

• CONTRIBUTION TOWARDS GNP.	24.7%
• FOREIGN EXCHANGE EARNINGS.	60%
• DEPENDANCE OF POPULATION.	68%
• EMPLOYMENT:	46%
➢CROP PRODUCTION	52%
➢LIVESTOCK	44%
➢FISHERIES	3%
➢FORESTRY	1%

WR-10

POWER GENERATION CAPACITY

• TOTAL CAPACITY	17,980 MW
➢ HYDROPOWER	5,009 MW
➢ THERMAL & NUCLEAR POWER	12,509 MW
• POTENTIAL FOR HYDRO-POWER GENERATION.	40,000 MW

WR-11

WATER RESOURCES

SURFACE WATER:	
• INDUS BASIN.	147.17 MAF (181.55 BCM)
• MAKRAN COASTAL BASIN.	3.0 MAF (3.69 BCM)
• KHARAN BASIN.	0.79 MAF (0.97 BCM)
GROUND WATER:	
• RECHARGE.	40.5 TO 52.7 MAF (50 TO 65 BCM)

WR-12

SHARING WATER RESOURCES
(As Per 1991 ACCORD)

WR-13

Province		Water Distribution (MAF)		
		Kharif	Rabi	Total
1.	Punjab	37.07	18.87	55.94
2.	Sind	33.94	14.82	48.76
3.	NWFP	3.48	2.30	5.78
4.	Balochistan	2.85	1.02	3.87
TOTAL (MAF):		77.34	37.01	114.35
TOTAL (BCM):		(95.36)	(45.63)	(141.0)

ROLE OF WATER
IN ECONOMIC GROWTH

- TARGET: 6.0% ANNUAL ECONOMIC GROWTH
- WATER/ IRRIGATION IS MAIN STAY FOR
  - AGRICULTURAL PRODUCTION
  - FOOD SECURITY
  - EMPLOYMENT
  - EXPORT EARNINGS
  - HYDROPOWER PRODUCTION
  - RURAL WATER SUPPLY ETC.

WR-14

WATER REQUIREMENTS WR-15				
	HIGH DEMAND		LOW DEMAND	
UNIT	2010	2025	2010	2025
MAF (BCM)	170.44 (210.16)	155.0 (191.11)	135.74 (167.35)	134.07 (165.28)
IR.EF.	42.5%	50%	42.5%	45%
SHORT.	39%	33%	23.5%	22.6%
MAF (BCM)		134.07 (165.28)		
IR.EF.		45%		
SHORT.		22.6%		
ADDITIONAL STORAGE REQUIRED:				18.0 (22.2)

INDUS BASIN WATER BALANCE (Average Condition) WR-16			
Description		Discharge	
	INFLOW	MAF	BCM
1.	Western Rivers Inflow	143.18	176.54
2.	Eastern Rivers Inflow	8.40	10.36
3.	System Losses	-9.90	-12.21
4.	Net Inflow	141.68	174.69
	OUTFLOW		
5.	Provision for Future Use by INDIA on Eastern & Western Rivers	8.40	10.36
6.	Average Canal Diversions	103.84	128.03
7.	Net Outflow	112.24	138.39
8.	Available Surplus:	29.44	36.30

WEAKNESSES

- VERY LITTLE INVESTMENT IN NEW WATER STORAGE PROJECTS.
- INABILITY TO MAKE DECISIONS ON WORKS WHICH BENEFIT THE COUNTRY.
- INTER-PROVINCIAL RIVALRY.
- ABSENCE OF A NATIONAL BODY WHICH HAS OVER-RIDING AUTHORITY ON WATER ISSUES.

WR-17

TRANS BORDER ISSUES

- SCRAPING OF INDUS BASIN TREATY BY INDIA.
- CONSTRUCTION OF WOLLER BARRAGE ON JHELUM.
- BAGLIHAR HYDRO ELECTRIC PROJECT ON CHENAB.

(IT WOULD ADVERSELY AFFECTS INFLOWS FROM CHENAB & JHELUM RIVERS. SPECIALLY IN LOW FLOW PERIOD.)

- REDUCED SUPPLIES FROM EASTERN RIVERS.
- ABSENCE OF TREATY ON SHARING OF KABUL RIVER FLOW.

WR-18

PROPOSED STRATEGY FOR WATER RESOURCES

- **CONSERVATION**
  - ➢ LINING OF CANALS
  - ➢ ON-FARM MANAGEMENT LEADING TO INCREASE CROP EFFICIENCY.

WR-19

STRATEGY : WATER RESOURCES (Contd.)

- **ON-FARM MANAGEMENT (CROP YIELD)**

Year	2000	2010	2025
Crops	Existing	Projected	Projected
Wheat	2.49	2.64	3.23
Rice	3.07	3.54	3.93
Maize	1.66	2.08	2.55
Cotton	0.64	0.68	0.73
Sugarcane	47.00	54.65	64.39

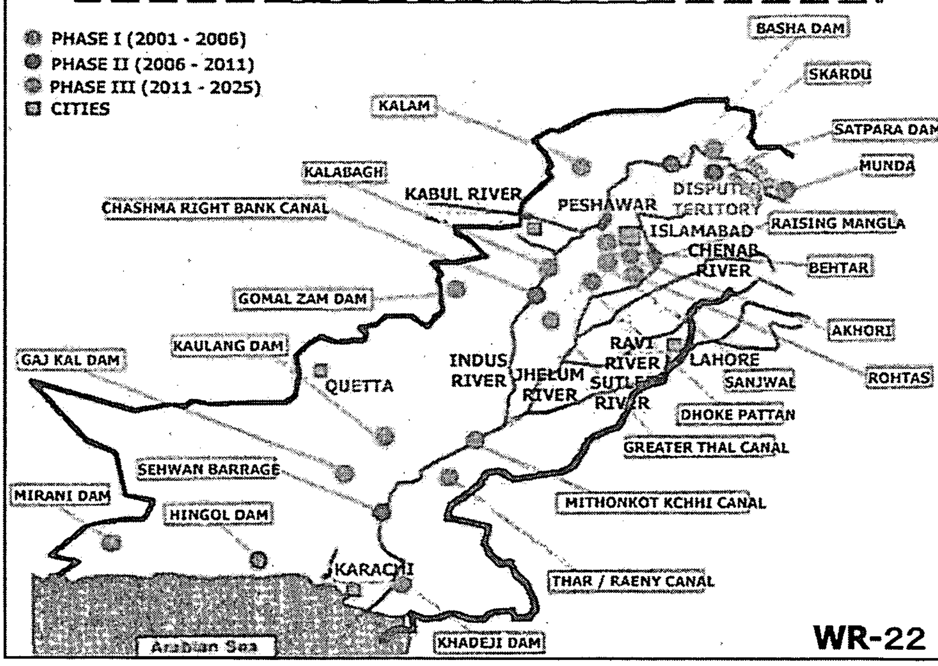
WR-20

STRATEGY : WATER RESOURCES (Contd.)

- **CONSERVATION**
  - ➢ **LINING OF CANALS**
  - ➢ **ON-FARM MANAGEMENT LEADING TO INCREASE IN CROP EFFICIENCY.**
- **FUTURE VISION.**

WR-21

WAPDA VISION



WR-22

STRATEGY : WATER RESOURCES (Contd.)

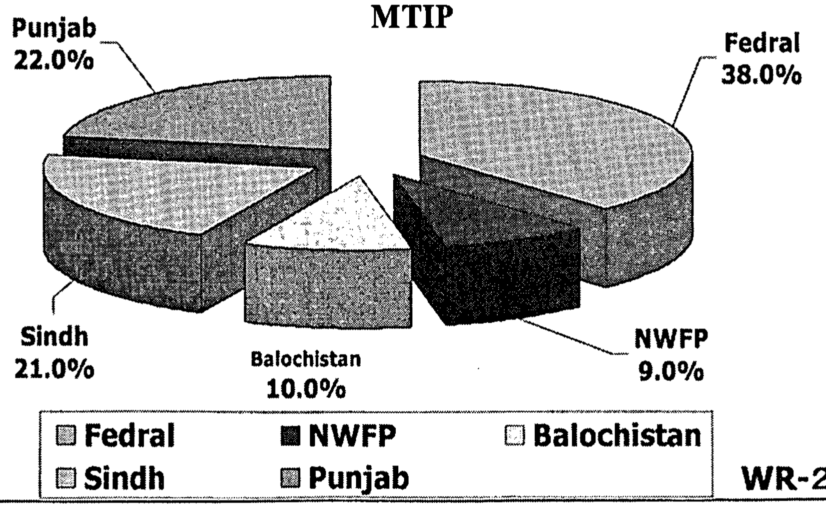
- CONSERVATION
  - ➢LINING OF CANALS
  - ➢ON-FARM MANAGEMENT LEADING TO INCREASE IN CROP EFFICIENCY.
- FUTURE VISION.
- ADDITIONAL ALLOCATIONS.

WR-23

STRATEGY : WATER RESOURCES (Contd.)

- ALLOCATION FOR MEDIUM TERM INVESTMENT PLAN-1

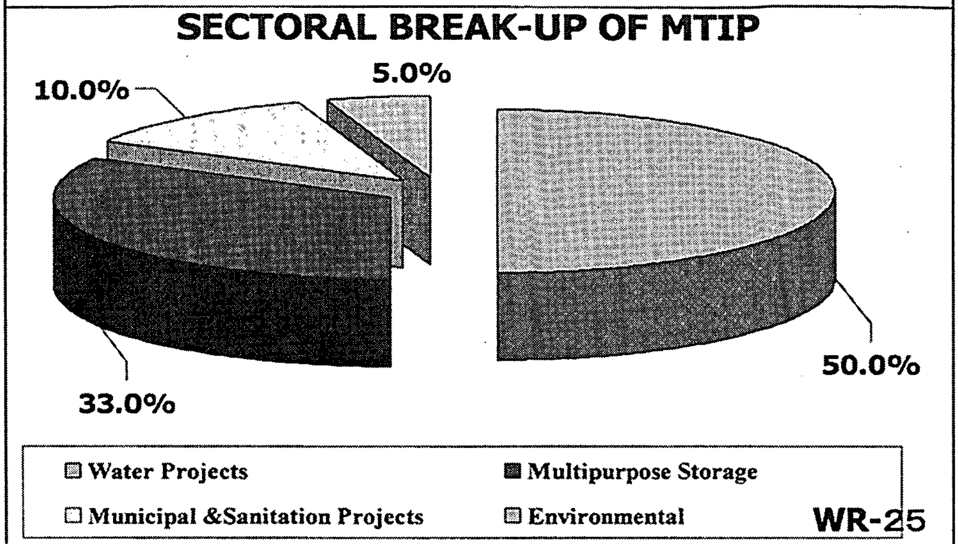
FEDERAL / PROVINCIAL BREAK DOWN OF MTIP



WR-24

STRATEGY : WATER RESOURCES (Contd.)

- ALLOCATION FOR MEDIUM TERM INVESTMENT PLAN-2



WR-25

STRATEGY : WATER RESOURCES (Contd.)

WR-26

- CONSERVATION
  - ➢LINING OF CANALS
  - ➢ON-FARM MANAGEMENT LEADING TO INCREASE CROP EFFICIENCY.
- FUTURE VISION.
- ADDITIONAL ALLOCATIONS
- NOMINATION OF PLANNING BODY.
- STORAGE MASTER PLAN.
- PUBLIC AWARENESS PROGRAM.
- DEVELOPMENT OF MIS.
- WATER QUALITY IMPROVEMENT PROGRAM.

RIVER MANAGEMENT

AREAS OF FLOOD IMPACT:

- **THE MAIN RIVERINE AREAS.**
- **HILL TORRENT AFFECTED AREAS.**
- **AREAS OF POOR DRAINAGE.**

WR-27

FLOOD PROTECTION OBJECTIVES

- **AREAS OF MAJOR HUMAN HABITATION & ECONOMIC IMPORTANCE.**
- **FLOOD MANAGEMENT STRATEGIES FOR CITIES, TOWNS & INFRA STRUCTURES.**
- **PROMOTE THE DELINEATION OF FLOOD PLANNING & REGULATORY ZONES.**
- **DEVELOP FLOOD FORECASTING, WARNING & PREPAREDNESS STRATEGIES.**
- **IMPLEMENT EFFECTIVE RECOVERY OF OPERATION & MAINTENANCE COSTS FROM BENEFICIARIES.**

WR-28

FLOOD PROTECTION WORKS

- **RIVER TRAINING WORKS.**
- **PROTECTION WORKS FOR BARRAGES & BRIDGES i.e. GUIDE BANKS & SPURS.**
- **BREACHING DIKES/ BUNDS.**
- **DIKES & REVETMENTS ON RIVER BANKS TO PROTECT TOWNS & VILLAGES.**

  ❖ **THE EXISTING FLOOD MANAGEMENT FACILITIES;**

  EMBANKMENT LENGTH = 5920 KM

  SPURS = 800

WR-29

FUNCTIONS OF FEDERAL FLOOD COMMISSION

- **PREPARING NATIONAL FLOOD PROTECTION PLAN FOR COUNTRY.**
- **APPROVING FLOOD PROTECTION SCHEMES PREPARED BY PROVINCIAL/ FEDERAL AGENCIES.**
- **ENSURING PROPER MONITORING OF FLOOD WORKS.**
- **IMPROVING THE PERFORMANCE OF FLOOD WARNING SYSTEM.**

WR-30


THANKS

Lecture 7

Case of OKINAWA

—Integrated Dam Management and the Development of Okinawa's Water Resources—

Mr. Tamio SHIMOGAMI

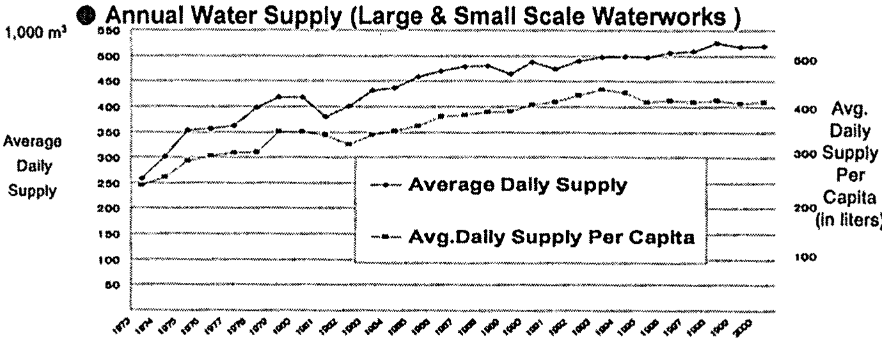
Deputy Director

Okinawa General Bureau

Integrated Dam Management and the Development of Okinawa's Water Resources

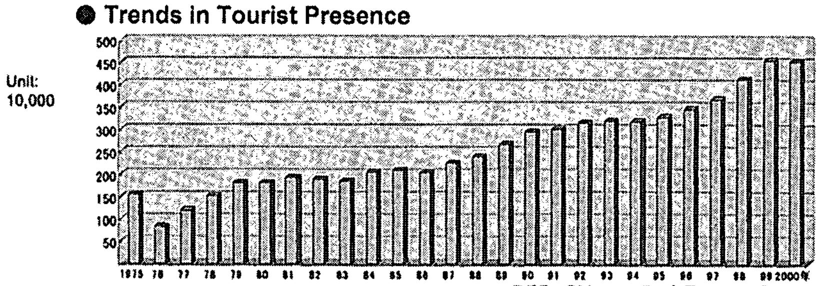
Tamio SHIMOGAMI
Deputy Director, Okinawa General Bureau
Cabinet Office, Government of Japan

● Annual Water Supply (Large & Small Scale Waterworks)



REF: Outline of Okinawa Pref. Water System

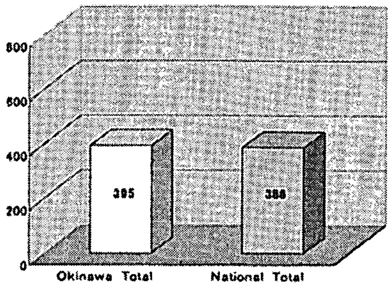
● Trends in Tourist Presence



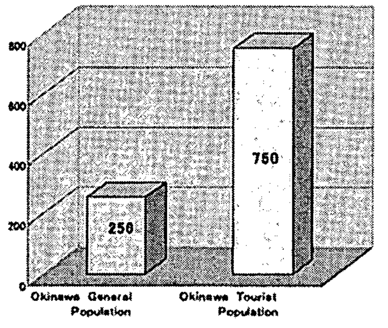
REF: Okinawa Pref. Tourism Overview

Per Capita Water Consumption

**Okinawa vs.
National Consumption**

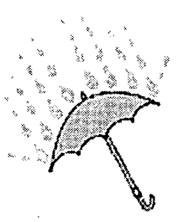


**Okinawa General Population
vs. Tourist Consumption**

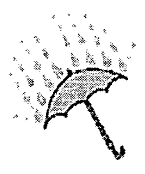


Approx. liter/per capita/per day

Average Annual Rainfall

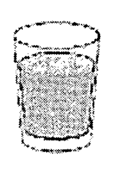


Okinawa Island
2,037 mm/year
(Naha Average)

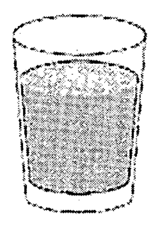


Nationwide
1,714 mm/year

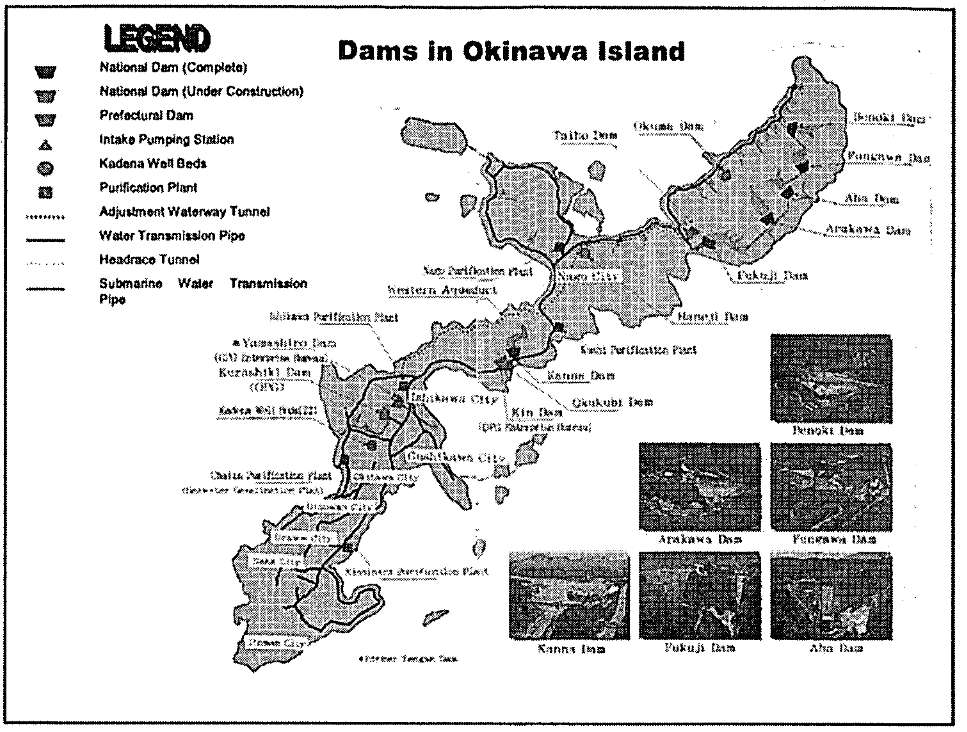
Average Per Capita Rainfall



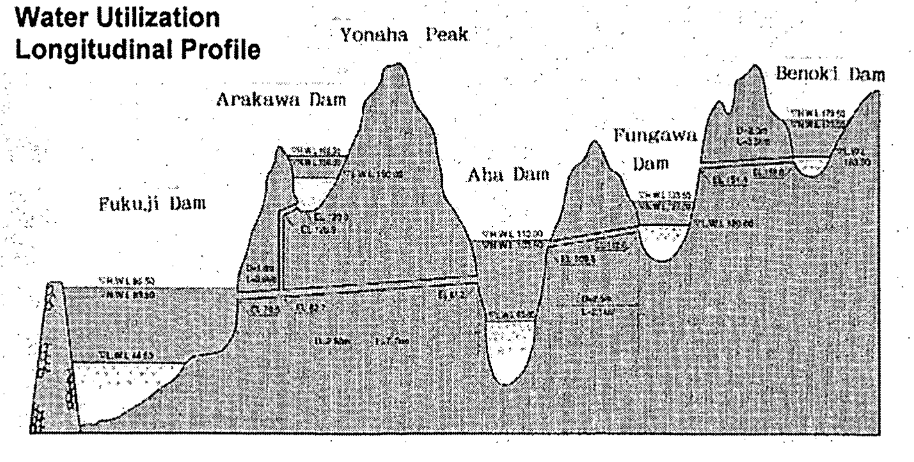
Okinawa Island
2,880 m^3
per capita
per year



Nationwide
5,150 m^3
per capita
per year



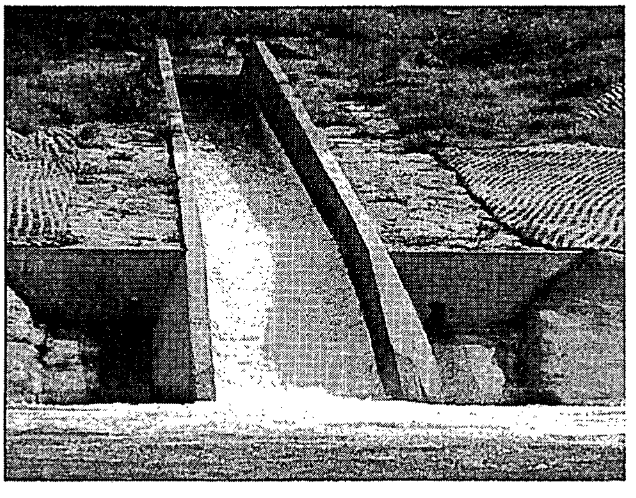
Integrated Operation of Northern Dams



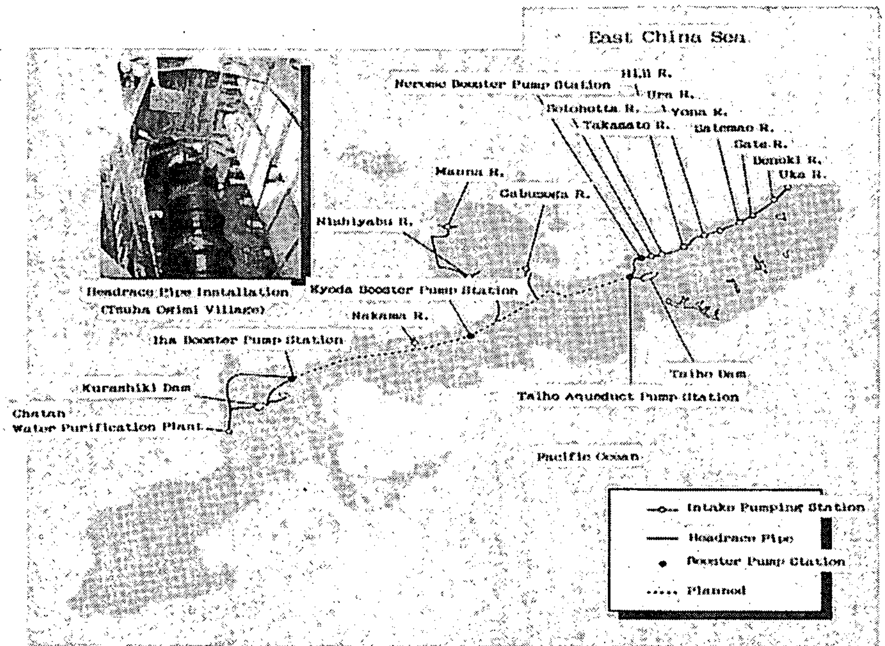
Water Available Through the Northern Dams

Name of Dam		Urban Water Utilization Volume (thousand m^3)	Urban Use Water Development (m^3/day)		
			Independent Operations	Combined 5 Dam Operations	Increase from combined Operations
Fukuji Dam	(Existing)	37,000	100,000	100,000	
	(Redeveloped)	5,700	6,000	18,000	
Arakawa Dam		500	5,000	18,000	
Aha Dam		12,400	75,000	75,000	
Fungawa Dam		800	12,000	27,000	
Benoki Dam		1,450	18,000	21,000	259000-216000
TOTAL		57,850	216,000	259,000	=43000

Urban Water Utilization Volume = Drinking Water + Industrial Water

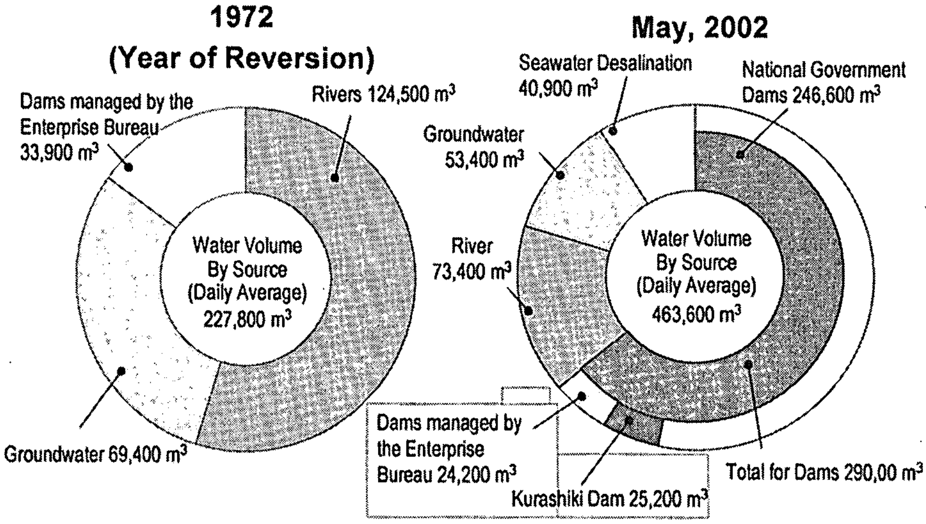


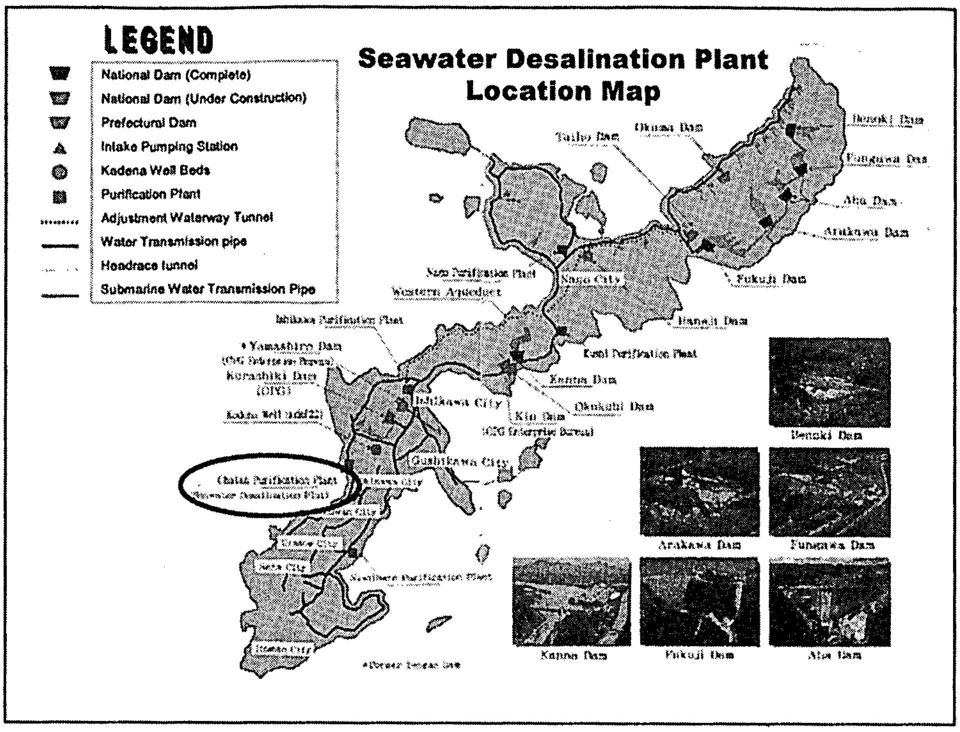
Adjustment Waterway Tunnel



Western Okinawa Water Resource Development

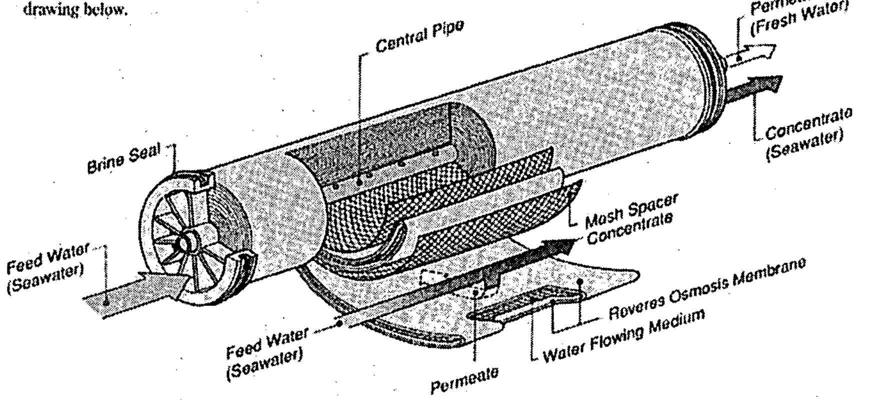
Daily Intake Volume by Water Source

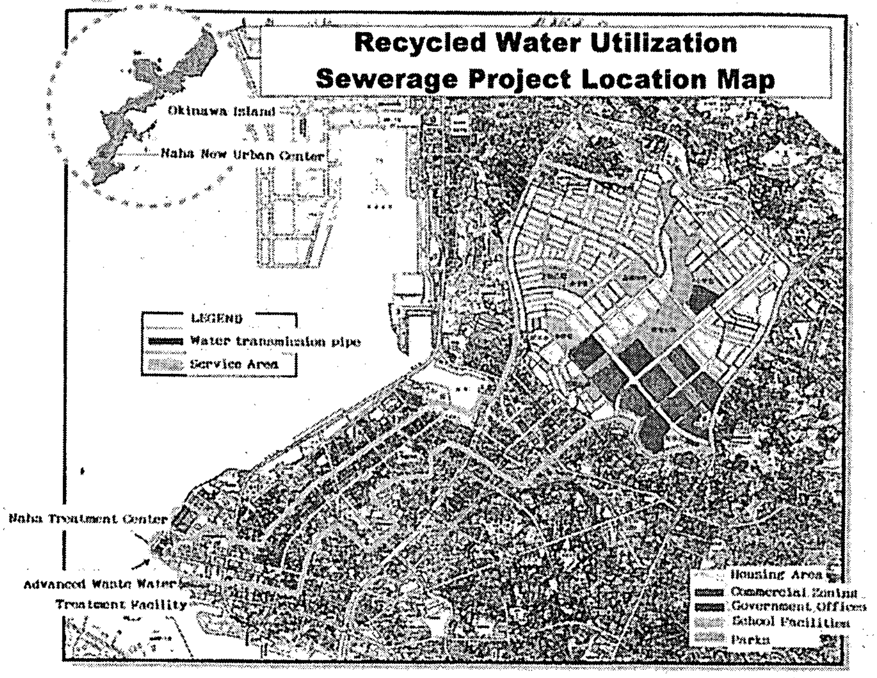


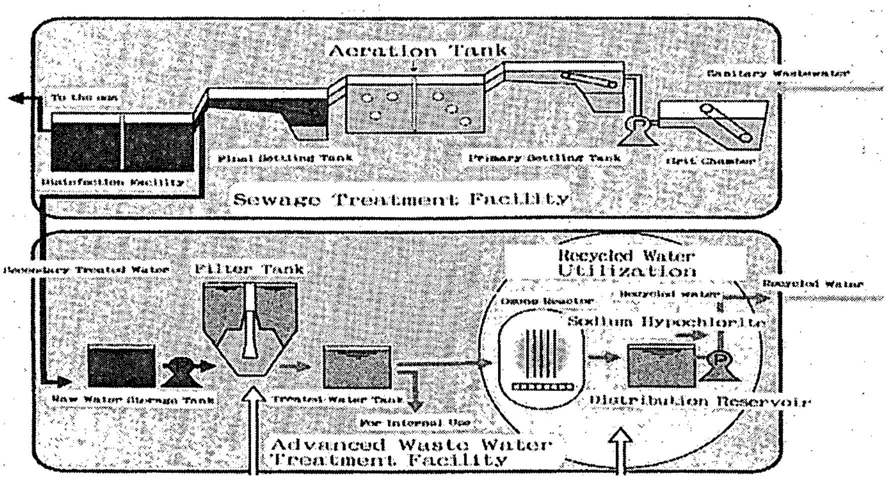


Structure of Reverse Osmosis Membrane Element

A reverse osmosis membrane element consists of reverse osmosis membranes, water flowing mediums, and spacers, which are rolled in layers to form a spiral-wound type module as shown in the drawing below.







Uses microorganisms to remove contaminants

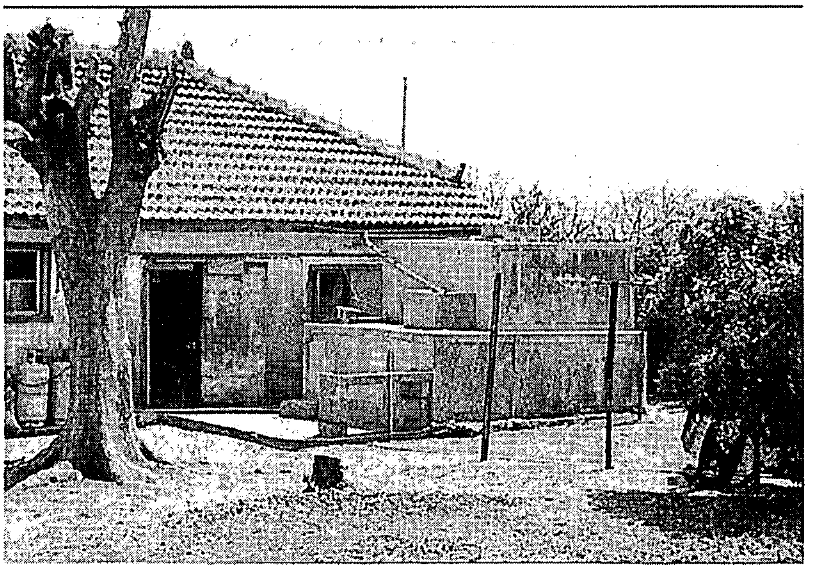
Decolorization, deodorization and disinfection are achieved by the chemical reaction of ozone and chlorine.

Recycled Water Utilization Sewerage Project
Advanced Wastewater Treatment Facility Flow Diagram

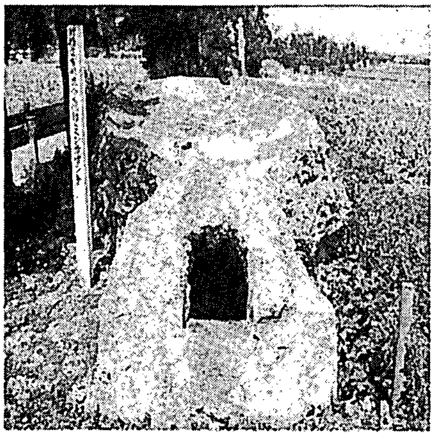
Quality of Recycled Water

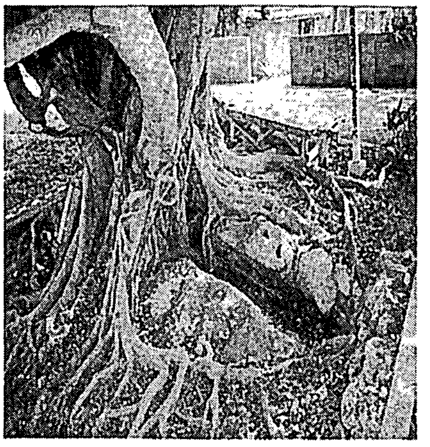
After advanced treatment, recycled water meets the following standards and is considered safe to use.

- **PH Value: 5.8 – 8.6**
- **Residual Chlorine: Less than 0.4 mg/liter**
- **Bacteria Count: Non detectable**
- **Odor: Non discernable**
- **Color: Non discernable**



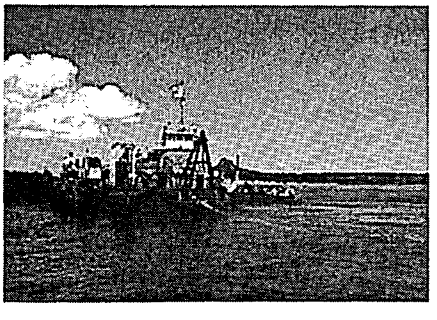
Huge water tanks made of concrete are found in all homes

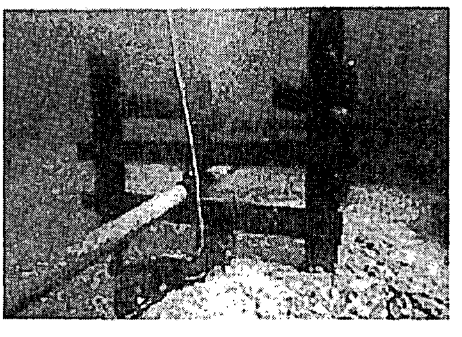




Rainwater is collected and stored as drinking water for farmers (Minkazanto).

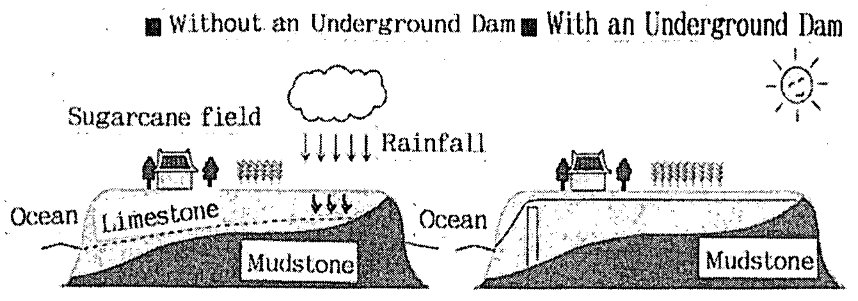
The caved rock is used to collect the rainwater that fell on the tree.





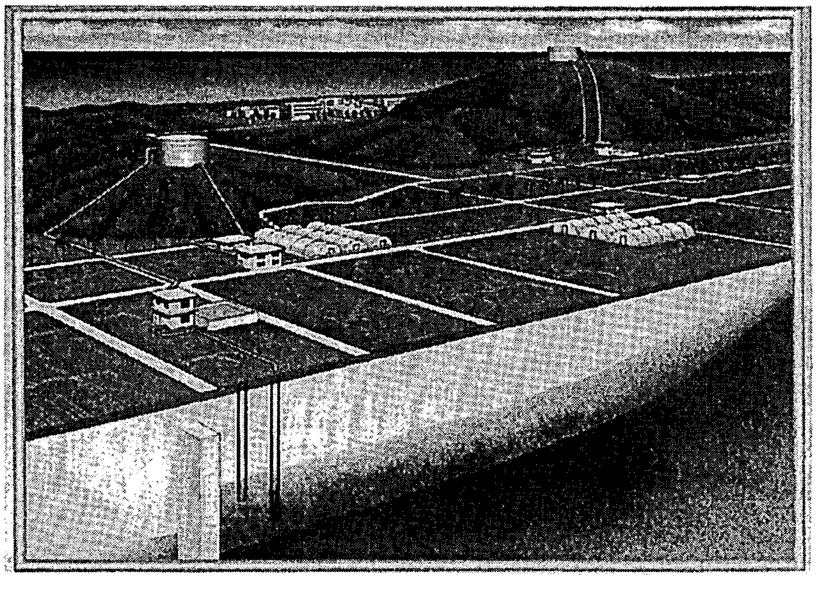
Laying of the Submarine Water Transmission Pipe

Protective Works for the Submarine Water Transmission Pipe



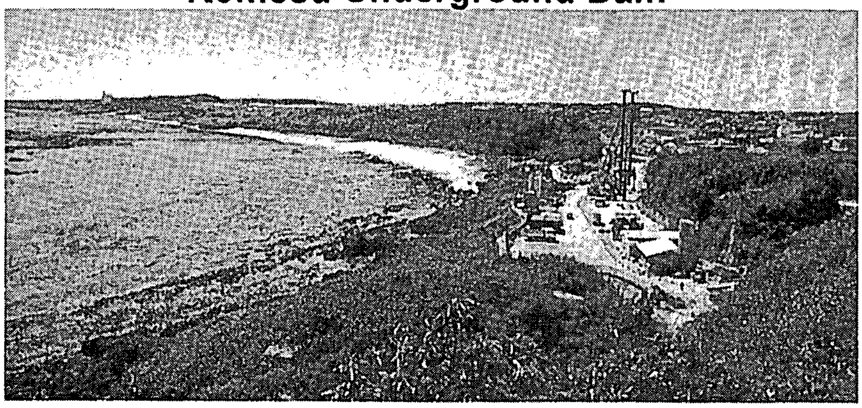
After permeating through the limestone layer, the underground water hits the mudstone and runs off into the open seas. Placing an underground dam at the open end contains the underground water reserves.

Underground Dam Conceptual Drawing



Artist's Rendition of the Underground Dam

Komesu Underground Dam



Construction Method: In-situ Mixing Method
Dam Height: 69 m
Crest Length: 2320 m
Reservoir Capacity: 3,460,000 m^3
Active Storage Capacity: 1,810,000 m^3

F. ON-SITE TOUR REPORT

October 19 (Sat), 2002

Ohtsu Auxiliary Conduit

Some eight rivers flow through the megalopolis of densely concentrated population south of Ohtsu City. Water flow is directed via a tunnel set under the urban areas directly to an outlet provided by the Seta River. This auxiliary water supply conduit is a tunnel system 4,700 meters long built using conventional NATM tunnel construction standards and the Shield Method. The internal flow area provides an extensive 170 m^2 of space. After the briefing, the group inspected the internal area of the conduit tunnel. There was notable interest with several questions on filtering of the converged waters, environmental impact, and the financial benefit of the system.

Seta River Weir (Outlet Flow Control)

The Seta River Weir controls the outflow from Lake Biwa. Rain limited the tour group to a view of the site from the office. System construction began in 1900, and numerous repairs effected in the ensuing years gave rise to the current structure. One former problem was that manual opening of all the locks on the old weir took a full day, and closing took two full days. Today, closing the locks requires a simple half hour, prompting questions from the group on what systems were used to modernize and upgrade the weir and how it is maintained and managed.

Amagase Dam

Rain forced the site tour to be conducted from inside the bus. The Amagase Dam is a multi-purpose dam providing flood control, power generation, and water supplies. The group asked about operating multi-purpose dams, and areas of service. A shared view was that hydropower generation should be emphasized as a way to preserve the quality of the environment.

October 20 (Sun), 2002

Drainage of Lake Biwa and the Incline

The ancient capital of Kyoto has a history going back some 1,200 years. Its water source is Lake Biwa, where during the Meiji Era, the commitment of and the hardship endured by the people led to establishment of the water system. The Lake supplies Kyoto with two million cubic meters of water each day. While use of the water has changed along with the era, the canals and aqueducts efficiently provide not only potable water, but water for hydropower generation, navigable canals for freight transport, irrigation, fire fighting, and industrial consumption. Of these, particularly significant is the volume of drinking or potable water provided. The group were enthralled by the flow of water in the Nanzenji Aqueduct and showed great interest in the construction methods used.

October 21 (Mon), 2002

Legacy of Sayama Pond

The Sayama Pond levee is the oldest dam levee in Japan, having been created around the 7th Century. Repairs and renovations of the reservoir system have been successively carried out by the greatest engineers of each era. With a history going back some 1,400 years, the Museum preserves some of the wooden pipes, and a cross section of the levee that tell the tale of the development of Japan's industrial legacy. The cross section of the levee in the Sayama Pond Museum, the exhibit and preservation systems and the matrix of pipes were interesting to the members of the delegation, and prompted several questions. Most impressive was the preservation of civil engineering legacy.

The Urban Monorail System

Surface transportation in Okinawan is overwhelming dependent on automobile traffic. In particular, the heavy congestion in Naha City, the political and economic center of Okinawa, has contributed to a lowering of quality of life and reduced urban functionality. It was therefore decided to establish a swift and dependably operating monorail that would allow development of new commuter routes. In conjunction with a re-mapping of bus service routes, this will permit a highly convenient and practical form of public transportation. The delegation visited the construction site of the monorail system. Particularly those who come from nations with dense urban concentrations came questions of land acquisition, comparison and competition with other forms of mass transport, and expected consumer profiles.

October 23 (Wed), 2002

Ie Village

Although poor weather affected the ferry passage to Ie Island, the Village Office provided an explanation on how the Office and local citizens worked to secure supplies of water. While Ie Island has an annual precipitation of some 2,000 mm, the coral limestone soil makes it difficult to cache water, and lack has always been a serious aspect of life on the island. Precipitation carefully gathered into tanks from roadways and from the airfield surface is used for irrigation with some portion for potable water. A stable supply of water ensured via a pipe running over the ocean bottom began in January 1977, proved to be a lasting solution to the problem of lack of potable water. At this time, there is a 10-year program to construct an underground dam to secure water for irrigation. During the delegation tour of the island, questions arose about the total costs, how costs were to be shared, how the facilities would intersect with sewage and waste management sanitation programs and issues, how the reservoir and pump facilities were to be managed, how red soil erosion came into play, and whether the mosquito population would contribute to malaria or dengue fever.

Haneji Dam

Built as a multipurpose dam, Haneji's levees were completed in 1999. Pilot operations commenced in FY 2000, with the first gateless air locks ever used in Japan. The water discharge control and river flow controls pioneered Japan's first use of tension radial gates. The briefing was carefully considered, and questions came in rapid succession on the development of the technology, the status of the patent, and applications outside Japan. Additionally, the professional engineers were impressed by the attractive physical layout and compatibility with the surrounding environment of the dam's construction and technology.

Taiho Dam

To allow a better comparison with the already completed Haneji Dam, the delegation visited the future site of the main body of Taiho Dam. Taiho Dam is a multipurpose facility that helps ensure stable water supplies, regular river flow, and provides for continuous irrigation of the down stream areas. The delegation was briefed on the environmental preservation measures underway at the dam construction site, and questions involved who is responsible for and who conducts environmental surveys, questions on the sand and soil of the biotope, wildlife habitat, and how felled trees were utilized.

TECHNICAL NOTE of NILIM
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