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of PWRI No.3274

THE SECOND CONFERENCE ON PUBLIC WORKS RESEARCH AND DEVELOPMENT IN ASIA

Proceedings

March, 1994

Public Works Research Institute
Ministry of Construction
JAPAN

Technical Memorandum
of PWRI No.3274

THE SECOND CONFERENCE ON PUBLIC WORKS RESEARCH AND DEVELOPMENT IN ASIA

Proceedings

Synopsis

This report is the proceedings of "The Second Conference on Public Works Research and Development in Asia" held in November 1993.

Key Words: ASIA, IMPROVEMENT OF INFRASTRUCTURE, DISASTER PREVENTION, ENVIRONMENT, INTERNATIONAL RESEARCH COOPERATION

FOREWORD

"The Second Conference on Public Works Research and Development in Asia (Executive's Seminar on Public Works Research and Development)" was held from November 15 to 26, 1993 at Public Works Research Institute, Ministry of Construction, in Tsukuba. The aim of this Conference is to develop optimum technology of public works for specific natural and socio-economic conditions in Asia nations in an effort to realize efficient utilization of natural and human resources. The First Conference held in February 1993.

The Conference had an attendance of seven executive members in the field of public works research and development representing seven countries that are very close to Japan in many ways, politically, economically and culturally, namely China, Indonesia, Korea, Malaysia, Philippines, Singapore and Thailand.

For better understanding of current situations and problems in each country as well as past experiences, the Conference consisted of three keynote lectures, presentations of country reports from each participating country, discussions on "Disaster and Disaster Prevention" and "Harmony between Environment and Improvement of Infrastructure" and discussions on each specific subject followed by the final synthesis discussion, where it was unanimously agreed that sharing the accumulated experiences is vital for infrastructure development of each country concerned. The significance of this Conference and the importance of its successive development were also recognized. It is expected that this Conference will eventually function as a continuous network creating strong ties among Asian countries through technical exchanges.

During the Conference the participants had an inspection tour from November 20 to 26. The tour was mainly in Shikoku-Chugoku, Kyushu, which had seen a considerable development in infrastructure. As a part of activities of the Conference, "The Second Symposium on Public Infrastructure and Civil Engineering in Asia" hosted by Public Works Research Institute and Kyushu Regional Construction Bureau of Ministry of Construction, held on November 22 with participation of 200 experts from governmental and private organizations as well as universities. More exchanging research information and expectation of technical cooperation for Asia by Japan was expressed at the Symposium.

The proceedings of the Conference has been compiled from the country reports submitted from each participating country, supplementary data, summaries of lectures and discussions including foreign information, which is not easily available. I believe the publication of the minutes of the advancement and then its diffusion will greatly contribute to the advancement and technical improvement of infrastructure development in Asia.

Finally I'd like to express my sincere gratitudes to all those concerned for their support and dedicated efforts for organizing and opening of this Conference, for the further development of which I am determined to do my best, thus to meet the wide expectations.

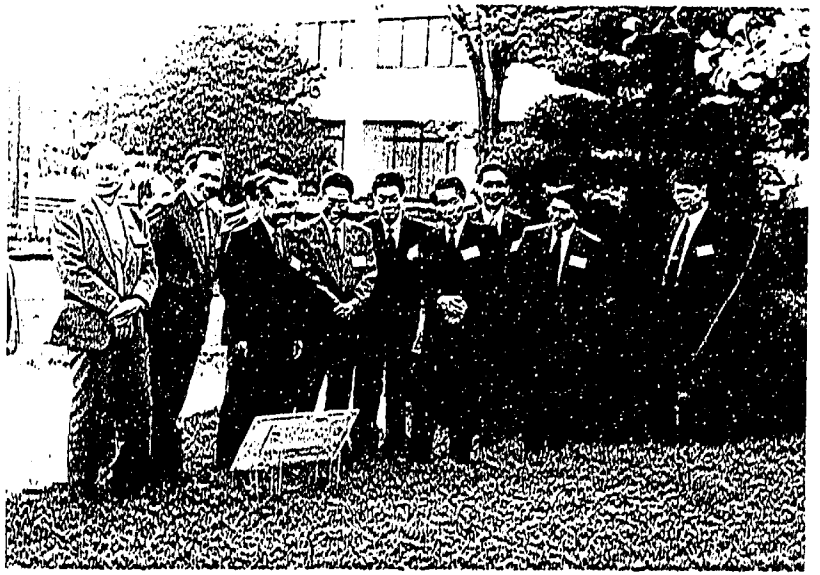
Yukihiko Sumiyoshi
Chairman,
The Second Conference on Public Works Research and Development in Asia



Participants of Opening Ceremony, The Second Conference on Public Works Research and Development in Asia (November 15, 1993)



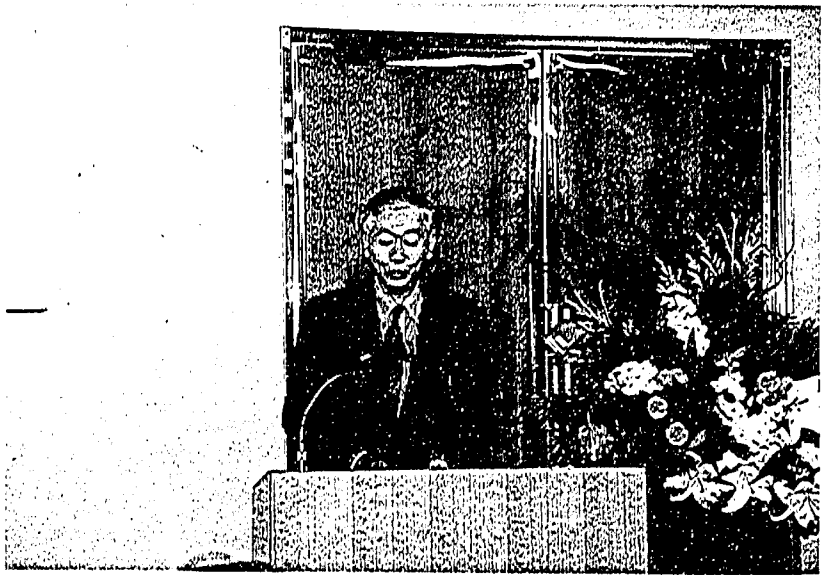
Opening Ceremony (November 15, 1993)



In front of Newton's apple tree (November 15, 1993)



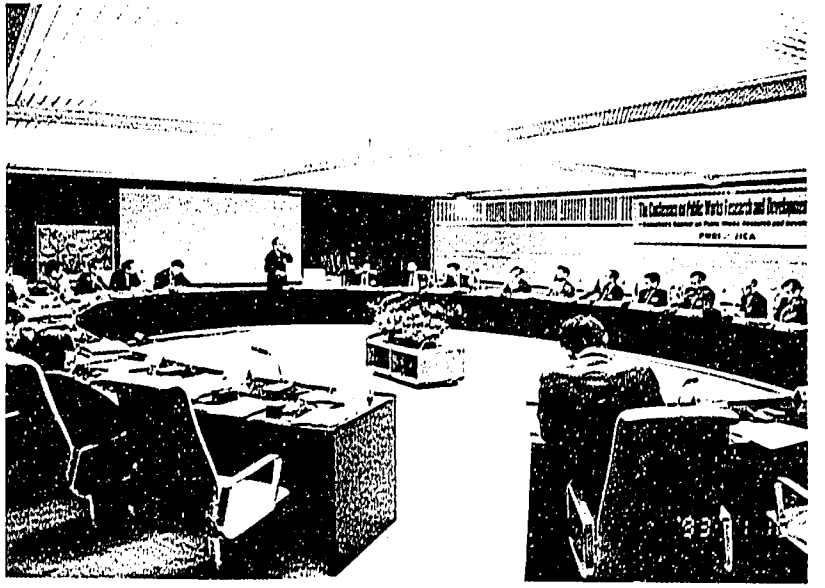
Mr. Atsushi Hamamori (Keynote Lecture) (November 15, 1993)



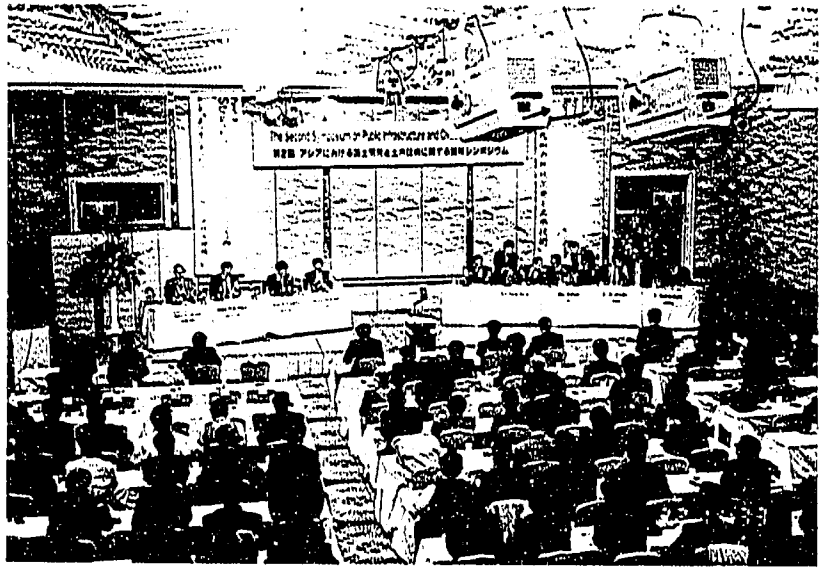
Prof. Hiroyoshi Shi-igai (Keynote Lecture) (November 15, 1993)



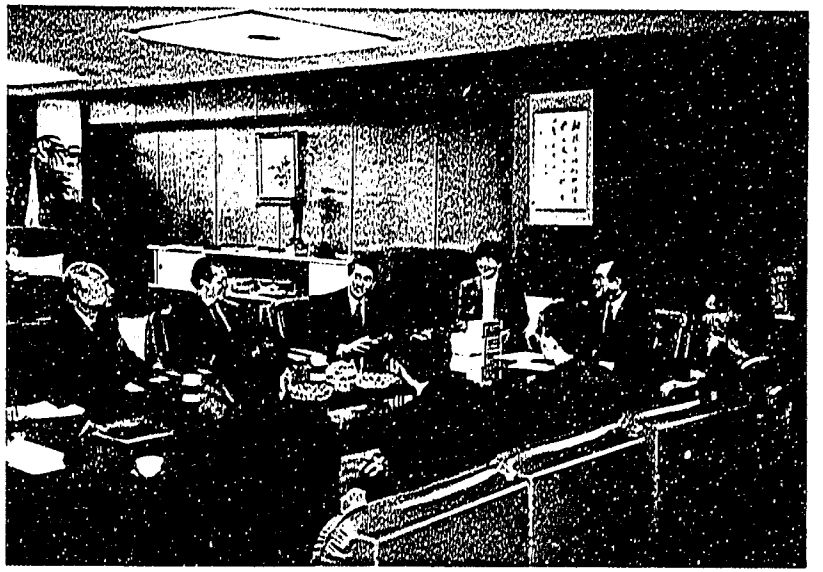
Reception (November 15, 1993)



Presentation and Discussion (November 16 ~19, 1993)



"The Second Symposium on Public Infrastructure and Civil Engineering in Asia" in Fukuoka (November 22, 1993)



Courtesy Call on Minister of Construction (November 25, 1993)

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Public Works Research Institute, Ministry of Construction
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Coordinator : Mr. Yukihiko Sumiyoshi, Director-General, PWRI, MOC, Japan
Panelists : Mr. Eiki Aramaki, Director-General, Kyushu Regional Construction Bureau, MOC, Japan
Mr. Wu Jishan, Director, IMHE, CAS, China
Mr. Soedarmanto Darmonegoro, Secretary, ARD, MPW, Indonesia
Dr. Keung Hwan Kim, Director, P&C Div., KICT, Korea
Mr. Teh Siew Keat, Director of River Engineering, DID, Malaysia
Mr. Jose H. Espiritu, Director, BRS, DPWH, Philippines
Mr. Khor Poh Hwa, Chief Civil Engineer, PWD, MND, Singapore
Mr. Anusornant Mahavinichaimontri, Director of Materials and Research Div., DPW, MOI, Thailand

(A) PROGRAM

I. Program

I. Program

1. Schedule of the Conference

November 8 (Mon) : Arrival in Japan (Tsukuba)
9 (Tue) ~14(sun) : JICA Orientation, (ditto)
Tour of Public Works Research Institute
15 (Mon) : Opening Ceremony (ditto)
Keynote Lecture
Reception (Hosted by Mr. Haruho Fujii, Vice-Minister of Construction for Engineering Affairs, Ministry of Construction)
16 (Tue) : Presentation of Country Reports (ditto)
17 (Wed) : Subjects of Common Interests (ditto)
18 (Thu) : Discussion on Specific Subjects (ditto)
19 (Fri) : Program Coordinating Meeting (ditto)
20 (Sat) : Study Tour [Tsukuba→Tokyo→Takamatsu→Okayama] (Okayama)
Seto-Ohashi
21 (Sun) : Study Tour [Okayama→Fukuoka] (Fukuoka)
Umino-Nakamichi Seaside Park, Fukuoka Tower etc.
22 (Mon) : Study Tour (ditto)
PC Factory
The Second Symposium on Public Infrastructure and Civil Engineering in Asia
23 (Tue) : Study Tour [Fukuoka→Nagasaki] (Nagasaki)
Yoshinogari Historical Park, Rokkaku River, Kyushu Express Highway, Nagasaki-City
24 (Wed) : Study Tour [Nagasaki→Tokyo→Tsukuba] (Tsukuba)
Mt.Unzen
25 (Thu) : Synthesis Discussion / Final Resolution (ditto)
Closing Ceremony
Courtesy Call on Tsukuba International Center, JICA
26 (Fri) : [Tsukuba→Tokyo] (Tokyo)
Courtesy Call on Minister of Construction
Trans-Tokyo Bay Highway
Farewell Party (Hosted by Mr. Yukihiko Sumiyoshi, Director-General, PWRI, MOC)
27 (Sat) : Preparation for Leaving (ditto)
28 (Sun) : Leaving

2. Opening Ceremony

1.Time : Monday, November 15, 1993 (10:00-10:50)

2.Place : 8th Floor Conference Room, Public Works Research Institute, Ministry of Construction

3.Program :

Call to order by Mr. Masahide Tamura, Director of Planning and Research Administration Department, Public Works Research Institute, Ministry of Construction

Address by Mr. Yukihiko Sumiyoshi, Director-General, Public Works Research Institute, Ministry of Construction

Address by Mr. Haruho Fujii, Vice-Minister of Construction for Engineering Affairs, Ministry of Construction

Address by Mr. Keiji Iimura, Management Director, Tsukuba International Center, Japan International Cooperation Agency

Address by Mr. Anusornant Mahavinichaimontri, Director of Materials and Research Division, Department of Public Works, Ministry of Interior

Introduction of Executives of Public Works Research Institute, Ministry of Construction

Introduction of Participants from Foreign Countries

Closure by Mr. Masahide Tamura

Group Photograph

3. Session Program of the Conference

Monday, November 15

Place : 8F Conference Room
Chairman : Masahide Tamura

9:00～ Registration
10:00～10:50 Opening Ceremony
10:50～11:00 Break
11:00～12:00 Keynote Lecture 1
「Role of Civil Engineers for Sustainable Development」
by Mr. Atsushi Hamamori, President, Japan Overseas Consultants Co. Ltd.
12:00～13:30 Lunch
13:30～14:30 Keynote Lecture 2
「Socio-Economic Development and Construction Technology Transfer」
by Mr. Yukihiko Sumiyoshi, Director-General, Public Works Research Institute (PWRI), Ministry of Construction (MOC)
14:30～14:40 Break
14:40～15:40 Keynote Lecture 3
「Research in Japan - Focusing Civil Engineering -」
by Prof. Hiroyoshi Shi-igai, Institute of Engineering Mechanics, University of Tsukuba
15:40～15:50 Break
15:50～16:30 Meeting of how to proceed the Conference for Foreign Participants
17:00～18:00 Move (PWRI → Tsukuba Dai-ichi Hotel → Hotel Sunroute Tsukuba, by Bus)
18:00～20:00 Reception
(Hosted by Haruho Fujii, Vice-Minister of Construction for Engineering Affairs, Ministry of Construction)
(Hotel Sunroute Tsukuba, Tel. 0298-52-1151)
Stay at Tsukuba Dai-ichi Hotel
(Tel. 0298-52-1112, Fax. 0298-52-5623)

Tuesday, November 16

Place : 8F International Conference Room
Chairman : Yukihiko Sumiyoshi

9:20～ 9:30 Report of the Activities since the First Conference
by Dr. Takashi Iijima, Assistant Director-General, PWRI, MOC
9:30～10:10 Presentation of Country Report of Japan
by Dr. Takashi Iijima, Assistant Director-General, PWRI, MOC
10:10～10:50 Presentation of Country Report of China
by Mr. Wu Jishan, Director, The Institute of Mountain Hazards and Environment, Chinese Academy of Sciences

10:50～11:00 Break
11:00～11:40 Presentation of Country Report of Indonesia
by Mr. Soedarmanto Darmonegoro, Secretary, Agency for Research and Development, Ministry of Public Works
11:40～12:20 Presentation of Country Report of Korea.
by Dr. Keung Hwan Kim, Director, Planning & Coordination Division, Korea Institute of Construction Technology
12:20～13:20 Lunch
13:20～14:00 Presentation of Country Report of Malaysia
by Mr. Teh Siew Keat, Director of River Engineering, Department of Irrigation and Drainage, Ministry of Agriculture
14:00～14:40 Presentation of Country Report of the Philippines
by Mr. Jose H. Espiritu, Director, Bureau of Research and Standards, Department of Public Works and Highways
14:40～14:50 Break
14:50～15:30 Presentation of Country Report of Singapore
by Mr. Khor Poh Hwa, Chief Civil Engineer, Public Works Department, Ministry of National Development
15:30～16:10 Presentation of Country Report of Thailand
by Mr. Anusornant Mahavinichaimontri, Director of Materials and Research Division, Department of Public Works, Ministry of Interior
16:10～16:30 Conclusion

Stay at Tsukuba Dai-ichi Hotel
(Tel. 0298-52-1112, Fax. 0298-52-5623)

Wednesday, November 17

Place : 8F International Conference Room

I. Subject of Common Interests on "Disaster and Disaster Prevention"

9:30～10:45 Discussion on "Comprehensive Countermeasure against Floods"
[Chairman : Mr.Tadahiko Nakao, Director of River Dept., PWRI, MOC]
Presentation of Japan
by Mr. Minoru Kuriki, Head of Urban River Div., PWRI, MOC
Presentation of Korea
by Dr. Keung Hwan Kim, Director, Planning & Coordination Division, Korea Institute of Construction Technology
Presentation of Malaysia
by Mr. Teh Siew Keat, Director of River Engineering, Department of Irrigation and Drainage, Ministry of Agriculture
Discussion and Conclusion

10:45～10:55 Break
10:55～12:10 Discussion on "Countermeasure against Highway Slope Failure"
[Chairman : Mr. Masashi Ikemura, Director of Material and Construction Method Dept., PWRI, MOC]
Presentation of Japan
by Mr. Hiroshi Miki, Head of Soil Mechanics Div., PWRI, MOC
Presentation of China
by Mr. Wu Jishan, Director, The Institute of Mountain Hazards and Environment, Chinese Academy of Sciences
Presentation of Indonesia
by Mr. Soedarmanto Darmonegoro, Secretary, Agency for Research and Development, Ministry of Public Works
Discussion and Conclusion
12:10～13:30 Lunch
13:30～14:00 (Confirmation of the Minutes of the Yesterday Session)
II. Subject of Common Interests on "Harmony between the Environment and Improvement of Infrastructure"
[Chairman : Mr.Toshinori Mizutani, Director of Environment Dept., PWRI, MOC]
14:00～15:15 Discussion on "Measures for Water Quality Control of Reservoirs and Rivers"
Presentation of Japan
by Mr. Kaoru Niwa, Head of Environmental Planning Div., PWRI, MOC
Presentation of the Philippines
by Mr. Jose H. Espiritu, Director, Bureau of Research and Standard, Department of Public Works and Highways
Presentation of Thailand
by Mr. Anusornant Mahavinichaimontri, Director of Materials and Research Division, Department of Public Works, Ministry of Interior
Discussion and Conclusion
15:15～15:25 Break
15:25～16:25 Discussion on "Countermeasures against Air Pollution and Noise caused by Road Traffics in Urban Areas"
Presentation of Japan
by Mr. Minoru Ishida, Head of Traffic Environment Div., PWRI, MOC
Presentation of Singapore
by Mr. Khor Poh Hwa, Chief Civil Engineer, Public Works Department, Ministry of National Development
Discussion and Conclusion
18:00～20:00 Dinner at the Kenshu-Kaikan (Tel.0298-64-2844)
Stay at Tsukuba Dai-ichi Hotel
(Tel.0298-52-1112, Fax.0298-52-5623)

Thursday, November 18

9:30～12:00 Discussion on Specific Subject

(1) Debris Flow	(room 8F)
(2) Materials of the Highway Bridge - Concrete -	(room 531)
(3) Flood Control	(room 524)
(4) Care for the Rivers	(room 532)
(5) Utilization of the Underground Space	(room 627)
(6) Air Pollution	(room 526)

12:00～13:30 Lunch

13:30～14:00 (Confirmation of the Minutes of the Yesterday Session)

14:00～16:30 Discussion on Specific Subject

(1) Debris Flow	(room 8F)
(7) Materials of the Pavement	(room 531)
(8) Environment Improvement -Water Quality Control-	(room 526)
(9) Creation of the River Environment	(room 532)
(10) Traffic Management	(room 627)

Stay at Tsukuba Dai-ichi Hotel
(Tel.0298-52-1112, Fax.0298-52-5623)

Friday, November 19

Place : 8F International Conference Room
Chairman: Yukihiko Sumiyoshi

10:30～12:00 Program Coordinating Meeting on "Future Plan"

12:00～13:30 Lunch

13:30～14:00 (Confirmation of the Minutes of the Yesterday Session)

14:00～15:00 Pre-Meeting on Final Resolution (Draft)

15:00 Move (PWRI → Tsukuba Dai-ichi Hotel, by Bus)

17:30 Move (Tsukuba Dai-ichi Hotel → PWRI, by Bus)

18:00～20:00 Party
(Hosted by Mr. Yukihiko Sumiyoshi, Director-General, PWRI, MOC)
(PWRI 1st Floor Conference Room, Tel.0298-64-2211)

Stay at Tsukuba Dai-ichi Hotel
(Tel.0298-52-1112, Fax.0298-52-5623)

Program of Discussion on Specific Subjects (11/18)

	China	Indonesia	Korea	Malaysia	Philippines	Singapore	Thailand	
9:30								
	(1) room 8F Debris Flow (Erosion Control Div.)	(2) room 531 Materials of the Highway Bridge - Concrete - (Concrete Div.)	(3) room 524 Flood Control (River Hydraulics Div.)	(4) room 532 Care for the Rivers (Urban River Div.)	(1) room 8F Debris Flow (Erosion Control Div.)	(5) room 627 Utilization of the Underground Space (Tunnel Div.)	(6) room 526 Air Pollution (Traffic Environment Div.)	
12:00	12:00~13:30 Lunch							
	13:30~14:00 Confirmation of the Minutes of the Yesterday Session							
14:00	(1) room 8F Debris Flow (Erosion Control Div.)	(7) room 531 Materials of the Pavement (Pavement Div.)	(8) room 526 Environment Improvement - Water Quality Control - (Wastewater System Div.)	(9) room 532 Creation of the River Environment (River Environment Div.)	(1) room 8F Debris Flow (Erosion Control Div.)	(10) room 627 Traffic Management (Advanced Transportation Div.)	(8) room 526 Environment Improvement - Water Quality Control - (Wastewater System Div.)	
16:30								
C/P	Erosion Control Div.	Environmental Planning Div.	Construction Method Div.	Urban River Div.	Research Coordinator for Dam & WR	Traffic Safety Div.	Wastewater System Div.	

Saturday, November 20

8:20 Lv. Tsukuba Dai-ichi Hotel (Tel.0298-52-1112, Fax.0298-52-5623)
Move (Hotel→Tsuchiura St., by Bus)
9:14 Lv. Tsuchiura St. (by JR : Hitachi 106)
10:04 Ar. Ueno St.
Move (Ueno St.→Hamamatsu-Cho St.→Haneda Airport, by JR and Monorail)
11:00 Ar. Haneda Airport
Lunch
13:00 Lv. Haneda Airport (by JAS 393)
14:20 Ar. Takamatsu Airport
Move (Takamatsu Airport→Sakaide→Okayama, by Bus)
15:00～17:00 Inspection on Seto-Ohashi
18:00 Ar. Okayama Terminal Hotel
Stay at Okayama Terminal Hotel
(Tel.086-233-3131, Fax.086-233-3144)

Sunday, November 21

9:00 Lv. Okayama Terminal Hotel (Tel.0862-33-3131, Fax.0862-33-3144)
9:30 Lv. Okayama St. (by JR : Shinkansen Hikari 153)
11:50 Ar. Hakata St.
Lunch
13:00～17:00 Inspection in Fukuoka City (by Bus)
(Umino-Nakamichi Seaside Park, Fukuoka Tower etc.)
18:00 Ar. Hyatt Regency Fukuoka (Tel.092-412-1234, Fax.092-414-2490)
18:00～20:00 Dinner

Stay at Hyatt Regency Fukuoka
(Tel.092-412-1234, Fax.092-414-2490)

Monday, November 22

8:00 Lv. Hyatt Regency Fukuoka (Tel.092-412-1234, Fax.092-414-2490)
Move (by Bus)
9:10～10:10 PC Factory
Move (by Bus)
11:30 Ar. Soralia Nishitetsu Hotel (Tel.092-752-5555, Fax.092-781-1211)
11:30～12:30 Lunch
12:30～14:00 Meeting on the Panel Discussion of the Symposium with Interpreter
14:00～17:00 The Second Symposium on Public Infrastructure and Civil Engineering in Asia
(Soralia Nishitetsu Hotel, Tel.092-752-5555, Fax.092-781-1211)
17:30～19:30 Reception
(Hosted by Mr. Eiki Aramaki, Director-General, Kyushu Regional Construction Bureau, MOC)

Stay at Hyatt Regency Fukuoka
(Tel.092-412-1234, Fax.092-414-2490)

Tuesday, November 23

8:00 Lv. Hyatt Regency Fukuoka (Tel.092-412-1234, Fax.092-414-2490)
Move through the Kyushu Expressway (by Bus)
9:10～10:30 Inspection on Yoshinogari
Move (by Bus)
11:40～12:30 Lunch
Move (by Bus)
12:30～15:30 Inspection on Rokkaku River
Move through the Kyushu Expressway (by Bus)
16:30～17:30 Inspection in Nagasaki City
18:00～20:00 Dinner

Stay at Nagasaki Grand Hotel (Tel.0958-23-1234, Fax.0958-22-1793)

Wednesday, November 24

8:00 Lv. Nagasaki Grand Hotel (Tel.0958-23-1234, Fax.0958-22-1793)
Move (by Bus)
10:00～11:00 Inspection on Mt. Unzen
Move (by Bus)
13:00 Ar. Nagasaki Airport
Lunch
14:20 Lv. Nagasaki Airport (by ANA 666)
15:50 Ar. Haneda Airport
Move (Haneda Airport→Tsukuba, by Bus)
19:00 Ar. Tsukuba Dai-ichi Hotel
Stay at Tsukuba Dai-ichi Hotel
(Tel. 0298-52-1112, Fax.0298-52-5623)

Thursday, November 25

Place : 8F Conference Room
Chairman : Yukihiko Sumiyoshi

10:00～11:40 Synthesis Discussion
Adoption of Final Resolution
11:40～12:00 Closing Ceremony
12:00～13:30 Lunch
14:00 Move (PWRI→Tsukuba Dai-ichi Hotel, by Bus)
16:00 Move (Tsukuba Dai-ichi Hotel→Tsukuba International Center of JICA, by Bus)
16:30～17:00 Courtesy Call on Tsukuba International Center of JICA
17:00～18:00 Party
(Hosted by Tsukuba International Center of JICA)
(Tsukuba International Center, Tel.38-1111)

Stay at Tsukuba Dai-ichi Hotel
(Tel. 0298-52-1112, Fax.0298-52-5623)

Friday, November 26

8:30 Lv. Tsukuba Dai-ichi Hotel (Tel. 0298-52-1112, Fax.0298-52-5623)
Move (Hotel→Tsuchiura St., by Bus)
9:14 Lv. Tsuchiura St. (by JR : Hitachi 106)
10:04 Ar. Ueno St.
11:00～11:30 Courtesy Call on Minister of Construction
12:00～13:30 Lunch
13:30～16:00 Inspection on Trans-Tokyo Bay Highway
18:00～20:00 Farewell Party
(Hosted by Mr. Yukihiko Sumiyoshi, Director-General, PWRI, MOC)
(Toranomon Pastoral, Tel.03-3432-7261)

Stay at Diamond Hotel (Tel. 03-3263-2211, Fax.03-3263-2222)

Saturday, November 27

Preparation for Returning
Stay at Diamond Hotel (Tel. 03-3263-2211, Fax.03-3263-2222)

Sunday, November 28

Returning

4. Closing Ceremony

1. Time : Thursday, November 25, 1993 (11:40～12:00)

2. Place : 8th Floor International Conference Room,
Public Works Research Institute, Ministry of Construction

3.Program :

Call to Order by Mr. Masashi Taguchi, Director of General Affairs Department, Public Works Research Institute, Ministry of Construction

Address by Mr. Yukihiko Sumiyoshi, Director-General, Public Works Research Institute, Ministry of Construction

Address by Mr. Teh Siew Keat, Director of River Engineering, Department of Irrigation and Drainage, Ministry of Agriculture

Closure by Mr. Masashi Taguchi

5. List of Participants

Foreign Countries

People's Republic of China
Mr. Wu Jishan, Director, The Institute of Mountain Hazards and Environment, Chinese Academy of Sciences

Republic of Indonesia
Mr. Soedarmanto Darmonegoro, Secretary, Agency for Research and Development, Ministry of Public Works

Republic of Korea
Dr. Keung Hwan Kim, Director, Planning & Coordination Division, Korea Institute of Construction Technology

Malaysia
Mr. Teh Siew Keat, Director of River Engineering, Department of Irrigation and Drainage, Ministry of Agriculture

Republic of the Philippines
Mr. Jose H. Espiritu, Director, Bureau of Research and Standards, Department of Public Works and Highways

Republic of Singapore
Mr. Khor Poh Hwa, Chief Civil Engineer, Public Works Department, Ministry of National Development

Kingdom of Thailand
Mr. Anusornant Mahavinichaimontri, Director of Materials and Research Division, Department of Public Works, Ministry of Interior

Japan

Mr. Yukihiko Sumiyoshi, Director-General, Public Works Research Institute (PWRI)
Mr. Tokuji Tomaru, Deputy Director-General, PWRI
Dr. Takashi Iijima, Assistant Director-General, PWRI
Mr. Kei Ichikawa, Geotechnical Counsellor, PWRI
Mr. Masahide Tamura, Director of Planning and Research Administration Dept., PWRI
Mr. Toshinori Mizutani, Director of Environment Dept., PWRI
Mr. Tadahiko Nakao, Director of River Dept., PWRI
Mr. Kunio Ichimura, Director of Water Quality Control Dept., PWRI
Mr. Seizo Takebayashi, Director of Dam Dept., PWRI
Mr. Akio Yazawa, Director of Erosion Control Dept., PWRI
Mr. Hiroo Kanzaki, Director of Road Dept., PWRI
Mr. Masashi Ikemura, Director of Material and Construction Method Dept., PWRI
Dr. Minoru Fujiwara, Director of Structure and Bridge Dept., PWRI
Mr. Yutaka Iida, Director of Earthquake Disaster Prevention Dept., PWRI
Mr. Tadahiko Fujisawa, Research Coordinator for Advanced Technology, Planning and Research Administration Dept., PWRI
Dr. Yasuyuki Koga, Research Coordinator for Underground Development, Planning and Research Administration Dept., PWRI
Mr. Koichi Yamamoto, Research Coordinator for Hydraulic Structures, River Dept., PWRI
○ Mr. Hozumi Nishida, Research Coordinator Dam and Water Resources, Dam Dept., PWRI (C/P of the Philippines)
Mr. Yutaka Anzaki, Research Coordinator for Road Traffic, Road Dept., PWRI
Mr. Masafumi Fukuda, Research Coordinator for Construction Management Engineering, Construction Management Engineering Center, PWRI
Mr. Ryutaro Oishi, Coordinator for International Research Cooperation, Planning and Research Administration Dept., PWRI
Mr. Takenobu Yamashita, Dam Instructor, Planning and Research Administration Dept., PWRI
Mr. Nobuhiko Taniguchi, Bridge Instructor, Planning and Research Administration Dept., PWRI
Mr. Kozaburo Horiuchi, Tunnel Instructor, Planning and Research Administration Dept., PWRI
○ Mr. Kaoru Niwa, Head of Environmental Planning Division, Environment Dept., PWRI (C/P of Indonesia)
Mr. Yukihiro Shimatani, Head of River Environment Div., Environment Dept., PWRI
Mr. Minoru Ishida, Head of Traffic Environment Div., Environment Dept., PWRI

○ Mr. Minoru Kuriki, Head of Urban River Div., River Dept., PWRI
(C／P of Malaysia)
○ Mr. Shuji Tanaka, Head of Wastewater System Div., Water Quality Control Dept., PWRI (C／P of Thailand)
○ Dr. Yoshiharu Ishikawa, Head of Erosion Control Div., Erosion Control Dept., PWRI (C／P of China)
Mr. Harutoshi Yamada, Advanced Transportation Div., Road Dept., PWRI
○ Mr. Takuya Seo, Head of Traffic Safety Div., Road Dept., PWRI
(C／P of Singapore)
Mr. Toshiyuki Nakamura, Head of Pavement Div., Road Dept., PWRI
Dr. Akira Inokuma, Head of Tunnel Div., Road Dept., PWRI
○ Mr. Shozo Naemura, Head of Construction Method Div., Materials and Construction Method Dept., PWRI (C／P of Korea)
Mr. Hiroshi Miki, Head of Soil Mechanics Div., Material and Construction Method Dept., PWRI
Mr. Hirotaka Kawano, Head of Concrete Div., Material and Construction Method Dept., PWRI
Mr. Masanori Nakano, Head of Foundation Engineering Div., Structure and Bridge Dept., PWRI
Mr. Osamu Matsuo, Head of Soil Dynamics Div., Earthquake Disaster Prevention Dept., PWRI

Note) ○ : Counter Part

II. Objectives and Details

Ⅱ. Objectives and Details

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

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

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

2. Details : The Conference has been held once per year in Japan since FY1992.

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

The First 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, 7)River (China, Japan) Philippines, Japan) 8)Water Quality (Korea, Japan) 9)Soil Mechanics and Foundation Engineering, Traffic Engineering (Malaysia, Thailand, 10)Pavement (Philippines, Singapore, Thailand, Japan) 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 Second 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 First Symposium on Public Infrastructure and Civil Engineering in Asia

Date	February 22, 1993
Place	Sapporo Grand Hotel
Host	Public Works Research Institute, Civil Engineer Research Institute
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, Japan Panelists : Yukihiko Sumiyoshi, Director-General, PWRI, Japan Chen Bing Xin, Director, IWHR, China Badruddin Machbub, Director, RIWRD, 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 Second Symposium on Public Infrastructure and Civil Engineering in Asia

Duration	November 22, 1993
Place	Soralia Nishi-Tetsu Hotel
Host	Public Works Research Institute, Kyushu Regional Construction Bureau
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, Japan Panelist : Eiki Aramaki, Director-General, Kyushu Regional Construction Bureau, Japan Wu Jishan, Director, IMHE, China Soedarmanto Darmonegoro, Secretary, Agency for R&D, MPW, Indonesia Keung Hwan Kim, 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 of Materials and Research Div., DPW, Thailand
Participants	200

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(B) MINUTES

I. Address of Opening Ceremony

Address of Opening Ceremony

Mr. Yukihiko Sumiyoshi, Director-General, PWRI, MOC

Good morning, honorable guests, ladies and gentlemen.

It is with great pleasure and honor to express our sincere thanks and welcome to all of you here today, especially those of you who took time and effort to come all the way to Japan, your Excellencies from embassies, staff of Japan International Cooperation Agency which has fully supported this Conference and Mr. Nakaoka, Deputy Director General for Engineering Affairs, Economic Affairs Bureau, Ministry of Construction. I feel highly honored to say a few words at this opening of "The Second Conference on Public Works Research and Development in Asia" here at the Public Works Research Institute.

All during 71 years of history Public Works Research institute has constantly and widely contributed to the national development of infrastructure in the field of research and development of technology. As a main research Institute directly under the Ministry of Construction it is responsible for approximately 70% of Japan's public works.

Under the increasing internationalization we have been actively engaged in promoting exchange programs with foreign countries. We host regularly about ten of international conferences with U.S. and European countries, notably "Japan-U.S. Conference on Development and Utilization of Natural Resources Panel on Wind and Seismic Effects", which has a history of 25 years, "Japan-U.S. Workshop on Advanced Technology in Highway Engineering" and "Japan-Germany Workshop on Waste Water and Sludge Treatment". Recently exchanges have been even wider and more productive and the importance of international exchanges has gained further momentum. With Asian partners exchanges have been promoted through technical cooperation and acceptance of researchers and visits of investigation teams in the field of infrastructure development.

In this connection a conference on public works research and development at the management level was organized and convened for the first time in February, 1993 to discuss the significance and need of an establishment of infrastructure as a basis of socio-economic development of each nation. Discussions mainly focused on the problems of common interest to all participating countries and on the current situations of public works in Asia, which led to a unanimous agreement on the importance of this kind of conference. To our greatest delight the Second Conference has hereby been convened.

The aim of this Conference is to promote exchanges in research and development for an establishment of optimum public works technology for each different natural and socio-economic condition as well as an effective utilization of natural and human resources available in each country in Asia. We do hope that this conference will be successfully continued and eventually serve as a network closely linking the Asian nations through research exchanges.

It is our wish that understanding and cooperations among Asian nations will be greatly enhanced through the keynote addresses, presentations of country reports, discussions on specific subjects, a symposium in Fukuoka and also through visits and inspections of various public works sites.

Finally I would like to express once again our gratituteds for all the cooperation extended to us for the opening of this conference.

Thank you for your kind attention.

Mr. Haruho Fujii, Vice Minister of Construction for Engineering Affairs, MOC
(read by Mr. Tomonobu Nakaoka, Deputy Director-General for Engineering Affairs, Economic Affairs Bureau, MOC)

Good morning, honorable guests, ladies and gentlemen.

I would like to read the speech for Mr. Haruho Fujii, who most regrettably can not be here because of an unavoidable engagement.

It is a great honor for me to be given the opportunity to say a few words of congratulations on the opening of "The Second Conference on Public Works Research and Development in Asia." I understand here we have an attendance of highly qualified executive members in the field of public works research and development from seven countries, China, Indonesia, Korea, Malaysia, Philippines, Singapore and Thailand, the seven countries which are all closely related to Japan not only politically, economically, culturally but also in every possible way.

As you may very well know, infrastructure is the most important basis for socio-economic activities, thus indispensable for national prosperity and happiness of people. In Japan a ten-year plan of public works investment was launched in 1991 with a budget of 430 trillion yen, while 8.6 trillion yen is allocated for infrastructure development out of the overall expenditure of 40 trillion yen in the fiscal 1993 national budget. The growth rate of infrastructure budget is 5.8%, which is quite high compared to the increase of 3.1% in the overall expenditure. On the other hand, with the coming 21st century in view the Ministry of Construction is vigorously pursuing various construction projects such as Akashi-Kaikyo Bridge, Trans Tokyo Bay Highway, so as to develop land conservation facilities to ensure safety and amenity of the living environment. Efforts are also being made to meet the demand for land and quality housing as well as to develop a nature-friendly technology to be applied to the river works and a recycling technology of construction by-product in an effort to tackle the increasingly important environmental problems. Development of labor saving technology is given a top priority to create efficient and safe working conditions. All through its 71-year history Public Works Research Institute, as a main research organ, has been actively and importantly engaged in research and development, which is an essential element for innovation and diffusion of construction-related technology in general.

Now when we look at the world, we find many problems and issues waiting to be solved, local development, disaster prevention and environment to name a few. These issues all call for an establishment of infrastructure, which in turn requires a development of public works technology most appropriate to natural and socio-economic conditions of each country. In this light multi lateral cooperation through research exchange among neighboring countries will be most important.

This is the conference where executive members in the public works research and development come together from seven Asian countries, discuss issues each country now faces and share experiences. I believe that this conference is most relevant and that it will greatly contribute to the prosperity of Asia at large and therefore significant to our country, too.

The season here now is edging toward a cold winter. I would like to ask you, especially those of you from warm countries, to take very good care of yourselves and not to catch cold. Finally I do hope that this conference will be highly successful not only in exchanges of information and in discussions but also as an occasion of mutual understanding and friendship.

Thank you for your kind attention.

Mr. Keiji Iimura, Management Director, Tsukuba International Center, JICA

Honourable guests, Attendants from overseas countries, Ladies and Gentlemen.

On behalf of the Japan International Cooperation Agency. I am very much honoured to have the opportunity of saying a few words of greeting at this auspicious opening ceremony of the Executive's Seminar on Public Works Research and Development.

First of all I would like to extend a hearty welcome to you all who came a long way to Japan to participate in this seminar and it is with great pleasure to have an attendance of such highly qualified members as you to this seminar.

As you may know, the Japan International Cooperation Agency was established in August, 1974 for the purpose of promoting closer and better relationship between your countries and ours through technical cooperation.

In an attempt to realize the above purpose, the Japan International Cooperation Agency has organized this seminar with valuable cooperation from Public Works Research Institute to efficiently contribute to the improvement of infrastructure and public works, which in turn will be a driving force for the national development of each country. In the course of presentations and discussions we do hope that current situations and technology of the public works in Japan will be fully introduced and analyzed, while opinions and views may be widely exchanged on the problems commonly found and pursued in participating countries.

Although your stay in Japan is very short, you may encounter difficulties such as unfamiliar climate, different customs and living conditions and so forth. However I hope that you will enjoy your stay in Japan and obtain results expected. At the same time I believe that this seminar will be an occasion to establish a better communication and closer relationship between your countries and ours.

We are always ready to help you not only in regard to the seminar itself but also your personal matters. We would like to do our best to make your stay in Japan a most pleasant and fruitful one in every possible way.

JICA would like to express its deepest appreciation to the distinguished guests present here today who have offered us their kind support and cooperation in organizing this seminar.

In closing, let me extend once again our sincere wishes to all of you for a successful seminar.

Thank you.

Anusornant Mahavinihaimontri, Director of Materials and Research Division, Department of Public Works, Ministry of Interior, Thailand

Ladies and Gentleman,

On behalf of the Participants from China, Indonesia, Korea, Malaysia, Phillipines, Singapore, and Thailand who join "The Second Conference on Public Works Research and Development in Aisa" here in Japan, I would like to express my gratitude to Public Works Research Institute, Ministry of Construction, Tsukuba International Center, JICA, Government of JAPAN and all people who dedicate and participate which make this Conference possible and we can be here as the participants.

First of all, I would like to acknowledge you for some of my points of view. As we know, all countries in the world may classified into 3 categories, that is under developed countries, developing countries and developed countries. We know that, only the way, successively to be developing or developed countries should step first from developing their technologies.

This Conference is focus on technical contribution from your country by means of transfer of technologies to the participant countries in order that, they can be able to stand on their legs, there after. So by this means, people in the world should have so their better environment and better standard of their living. Some of my point of view about Japanese people to do. Some Japanese people told me that [when he offer or donate something to other people, it make him more happier. I think, this may be his culture and also for all Japan culture. So Japan today is very Lovely. I would like to say you have also your attractive policy and respective characters

Lastly, as some of my point of view, I would like to say, all of you gave us very warm, honourable and hospitality welcome, that I may we obtained from you just at the beginning of our steps to Japan, here. Again, I would like to take this opportunity to say that, I appreciate and would like to thanbk for Public Works Research Institute, Ministry of Construction, Tsukuba International Center, JICA, Government of JAPAN and all people here, who dedicate and participate for this Conference.

DOMO ARIGATO KOZAIMASHITA.

THANK YOU.

II. Minutes

1. COUNTRY REPORT

The country reports of all participating countries were presented on November 16 from 9:30 to 16:30 in the order of Japan, China, Indonesia, Korea, Malaysia, Philippines, Singapore and Thailand. The outline of each country, current situation of public works, outline of research organizations, major research and development activities and international research exchange activities were reported. Questions and answers followed each country's presentation.

SUMMARY OF DISCUSSION:

(1) Japan

Dr. Takashi Iijima, Assistant Director-General, Public Works Research Institute (PWRI), Ministry of Construction, reported on outline of Japan, the current situation of public works, outline of PWRI, its major research & development projects and the international research exchange. The report emphasized on researches pertaining to seismic disaster prevention measures and ways to promote co-research with other organizations/researchers.

Further explanations were made on the management of public works research and development activities in Japan, troubles caused by the joint researches with private sectors and the ways of utilization of the products of researches. Japanese participant clarified the framework of research budget, 5-year plan of PWRI, joint researches in progress and method of coordination at PWRI and the diffusion of the products of the researches.

(2) China

Mr. Wu Jishan, Director, Institute of Mountain Hazards and Environment (IMHE), Chinese Academy of Sciences & Ministry of Water Conservancy, reported on outline of China, the current situation of public works, outline of IMHE, its major research & development projects and the international research exchange. The report emphasized "Three Gorges Project" and studies on measures against debris flow and landslides.

Questions about regional development projects and population problem in mountaneous areas were asked. Mr. Wu explained that IMHE is conducting researches on risks in mountaneous areas and effects on development. He also pointed out a faster population growth witnessed in mountaneous areas compared to that of urban areas.

(3) Indonesia

Mr. Soedarmanto Darmonegoro, Secretary, Agency for Research and Development (ARD), Ministry of Public Works, reported on outline of Indonesia, the current situation of public works, outline of ARD, its major research & development projects and the international research exchange. The report emphasized the role of the ARD and the tasks in international research exchange in Indonesia.

Questions were raised on the management of three institutes that is, road, human settlement and water resources, the co-researches with private sectors/universities

and research system for earthquakes. Mr. Soedarmanto explained the coordination system at the Ministry of Public Work's directorate generals level. He also presented some examples of co-researches with private sectors and universities as well as co-research activities for earthquakes among the three institutes.

(4) Korea

Dr. Kim Keung Hwan, Director, Planning and Coordination Division, Korea Institute of Construction Technology (KICT) reported on outline of Korea, national development and public works, research & development concerning public works of Korea, outline of KICT, its major research & development projects and international research exchange. The report emphasized the system for infrastructure development and newly established Construction Technology Information Center.

A question on budgeting/funding for researches regarding public works was asked. Dr. Kim explained the budget system of KICT, which is financed by government, public corporation and private sectors. He explained the way in which co-researches with private laboratories and universities are conducted as well as with other research organizations in Korea.

(5) Malaysia

Mr. Teh Siew Keat, Director of River Engineering, Department of Irrigation and Drainage (DID), Ministry of Agriculture, Malaysia, reported on outline of Malaysia and the current situation of public works in Malaysia, outline of DID, major research & development projects and international research exchange of DID. The report emphasized utilization of river, introduction of major projects such as "Flood Mitigation Project in Kuala Lumpur", and National Hydraulic Research Institute which is to be established.

Discussions on comprehensive coordination, utilization of the rivers, tidal-bore phenomenon were made, and it was explained that Ministry of Agriculture is mainly in charge of the coordination and utilization of rivers. Establishment of a more integrated coordinating organization is under consideration.

(6) Philippines

Mr. Jose H. Espiritu, Director, Bureau of Research and Standards, Department of Public Works and Highways of the Philippines (DPWH/BRS) reported on outline of the Philippines and the current situation of public works in the Philippines, outline of DPWH/BRS, its major research & development projects and international research exchange. The report emphasized problems in infrastructure development and researches on construction materials such as the use of fly ash as admixture in concrete mix.

Discussions on the budget allocation for highway construction planning and transportation system connecting islands were made. It was explained that high percentage of the budget for Public Works is allocated to Manila Metropolitan Area. Current road planning to connect main islands and ferry boat system were also explained.

Then it was pointed out that the contents of R & D conducted by respective countries might be overlapped. It was argued that overlaps in public works research are unavoidable and sometimes necessary to some extent. Concerning R & D, it was also discussed that exchange of information on the research topics executed by research institutes in respective countries is necessary and agreed to discuss the said topic in the future conference.

(7) Singapore

Mr. Khor Poh Hwa, Chief Civil Engineer, Public Works Department(PWD), Ministry of National Development, reported on outline of Singapore and the current situation of public works in Singapore, outline of PWD, major research & development projects and international research exchange of PWD. The report emphasized on the land use plan of Singapore which will cater for future population of four million and the road network plan.

In response to a question of how road transport demand was managed, Mr. Khor said that restraint measures on both ownership and usage of private cars in Singapore were implemented including COE (certificate of entitlement) and ALS (area licensing scheme). He also stated PWD has joint research programmes with the local universities, the Nanyang Technological University and the National University of Singapore.

(8) Thailand

Mr. Anusornant Mahavinichaimontri, Director, Materials and Research Division, Public Works Department (PWD), Ministry of Interior of Thailand, reported on outline of Thailand and the current situation of public works in Thailand, outline of PWD, and also on research & development projects of PWD. The report emphasized three research subjects as main research activities of PWD.

Questions were raised on the situation of research on hydraulic study in Thailand, on the studies of underground roads in Bangkok and so forth. Studies on modulation technique applied for Maekhong river-bank protection project by PWD as well as the researches in progress at AIT were explained as an answer to the first question. To the second question, the outline of highway projects and studies on underground roads were explained.

Reports are summarized as follows:

1)Through introduction of the country's natural and socio-economic condition, understanding was deepened on common issues and tasks as well as on specific issues facing each country.

2)Importance of public works research and development was pointed out, emphasizing requirements of infrastructure improvement such as roads, rivers, dams, erosion control and sewerage systems for the development of each country.

3)Current situations of public works research and development were reported, through

which it was understood that each country is eagerly involved in research activities. Common tasks and implementation methods were also pointed out. Through interesting reports on unique and specific issues each country faces, mutual understanding was deepened on this matter.

4)The attitude toward international research exchanges seems to be positive in each country. Through the discussion, importance and necessity of promoting international research exchanges were confirmed.

2. SUBJECT OF COMMON INTERESTS

Discussion on the Subjects of Common Interests was made on Nov. 17 from 9:30 to 17:20 with an attendance of the representatives of all the eight participating countries.

Based on the content of the country report each participant had prepared, subjects were selected as follows;

I Disaster and Disaster Prevention

I −1 Comprehensive Countermeasures against Floods

I −2 Countermeasures against Highway Slope Failure

II Harmony between the Environment and Improvement of Infrastructure

II −1 Measures for Water Quality Control of Reservoirs and Rivers

II −2 Countermeasures against Air Pollution and Noise caused by Road Traffic in Urban areas

For each of the four subjects, discussion session was held.

The first session was chaired by Mr. Nakao, Director, River Department PWRI, the second by Mr. Ikemura, Director, Material and Construction Method Department PWRI and the third and the fourth were chaired by Mr. Mizutani, Director, Environment Department PWRI. Q & A and discussion followed the presentations on the subject.

Country reports were mainly used for presentations. Hand−outs distributed during the session are to be included in the country report as addendum.

I Subject of Common Interests on "Disaster and Disaster Prevention"

I −1 Comprehensive Countermeasures against Floods

Mr. Nakao, Chairman of the session explained the objects and the details of the session as well as the general concept of comprehensive flood control. Then presentations were made by participants from Japan, Korea and Malaysia, followed by discussions.

1) PRESENTATION

Japan

Mr. Kuriki, Head, Urban River Division, River Department, PWRI made the following presentation.

1.Background of adopting the concept of comprehensive flood control

2.Measures taken under the "Comprehensive Flood Control Projects for Specific Rivers."

3.Technical support of the PWRI

4.Characteristics of comprehensive flood control measures in Japan and the universality of the approach

Korea

Dr. Kim Keung Hwan, Director, Planning and Coordination Division, Korea Institute of Construction Technology made the following presentation.

1.Characteristics of flood disasters in Korea

2.Institutional framework for natural disaster prevention and preparedness in Korea

3.Long-term countermeasures as well as short-term plans/programs for disaster prevention and temporary actions for disaster mitigation and relevant research work

4.Projects for flood control in the KICT

Malaysia

Mr. Teh Siew Keat, Director, River Engineering, Department of Irrigation and Drainage, Ministry of Agriculture, made the following presentation.

1.Characteristics of flood disasters in Malaysia and their history

2.Role of Department of Irrigation and Drainage with respect to flood alleviation

3.Establishment of the Permanent Flood Control Commission and a Flood Disaster Relief Machinery

4.River basin studies, structural measures and non-structural measures

2) DISCUSSIONS

Following the presentations from three countries, discussions were made on the following items.

1.Efficiency of small scale dams in comprehensive flood control project

2.Purification of river water and beautification consideration in flood control project

3) SUMMARY

The presentations and the discussions led to the following summaries.

1.Effectiveness and necessity of non-structural measures of flood control were confirmed.

2.Though dams and levees are fundamental measures of flood control, they are not completed at once. Even after the completion non-structural measures are necessary to ensure effective countermeasures against floods.

3.Further research on the subject is important.

I –2 Countermeasure against Highway Slope Failure

Mr. Ikemura, Chairman of the session explained the background of this subject. Then presentations were made by participants from Japan, China and Indonesia, followed by discussions.

1) PRESENTATION

Japan

Mr. Miki, Head, Soil Mechanics Division, Material and Construction Method Department, PWRI made the following presentation.

1.Actual cases of road slope disasters

2.Present conditions of road slope disaster prevention measures

3.Future tasks of road slope disaster prevention measures

4.Research activities of PWRI

China

Mr. Wu Jishan, Director, The Institute of Mountain Hazards and Environment, Chinese Academy of Sciences & Ministry of Water Conservancy made the following presentation.

1.The harm situation of debris flow and landslide along highways

2.Integrated control program of debris flow and landslide

3.Examples of individual control program for debris flow and landslide

Indonesia

Mr. Soedarmanto Darmonegoro, Secretary, Agency for Research and Development, Ministry of Public Work made the following presentation.

1.Administrative organizations for disasters

2.Summary of topographic and geological conditions in Indonesia

3.Distribution of landslide areas in west Java, Indonesia as an example

4.Examples of landslide disasters and prevention measures

2) DISCUSSION

Discussions and comments were made on the following items after the presentations.

1.Present situation in preparing road hazard maps in Japan

2.Examples of slope failure monitoring systems in Japan

3.Data base of road slope inventory, related to slope failures for road administration and disaster prediction

4.New vegetation slope protection method in Japan, i.e. thick seed–mud mixture spraying method, etc.

3) Summary

The following is the summary of presentations and discussions.

1.Exchange of information on actual cases of slope failures, prevention measures and research tasks were beneficial for all participating countries.

2.Road hazard maps, data base related to road slope and slope failures, and prevention methods were eagerly discussed.

II Subject of common Interests on "Harmony between the Environment and Improvement of Infrastructure"

Mr. Mizutani, Chairman of the session explained the international trend concerning environmental issues and the summary of the previous conference. The presentations were made by participants from Japan, Philippines, Singapore and Thailand.

II −1 Measures for Water Quality Control of Reservoirs and Rivers

1) PRESENTATION

Japan

Mr. Niwa, Head, Environmental Planning Division, Environment Department, PWRI, made the following presentation.

1.Role of water quality preservation in overall water environment management

2.Historical development and administrative jurisdiction regarding water quality problems

3.Water quality enhancement measures for rivers and dam reservoirs

Philippines

Mr. Jose H. Espiritu, Director, Bureau of Research and Standard, Department of Public Works and Highways made the following presentation.

1.Water classification, water quality criteria, and water quality monitoring

2.Pollution load assessment/inventory, effluent standards, pollution control technology and strategy, current sewerage techniques

3.Water quality management programs and policies

Thailand

Mr. Anusornant Mahavinichaimontri, Director, Materials and Research Division, Department of Public Works, Ministry of Interior, made the following presentation.

1.Issues regarding sewerage management

2.Water quality related projects already completed or under progress

3.Problems caused by insufficient sewerage infrastructure

2) DISCUSSION

The following are the items discussed after the presentations.

1.Relation between current state of sewerage infrastructure and river water quality in Japan

2.Reuse of treated water

3.Recycling of industrial waste water

3) SUMMARY

Presentations and discussions are summarized as follows;

1.Discussion was useful for the enhancement of mutual understanding of current situation of sewerage in respective countries.

2.Countermeasures against water pollution are to be adopted in accordance with varying conditions of participating countries. Consequently, merits of the exchange of related information regarding sewerage and water recycling, which is effective in enhancing water environment, were recognized.

3.Further information exchange is important in order to find solution to various problems discussed.

II −2 Countermeasures against Air Pollution and Noise caused by Traffic in Urban Areas

1) PRESENTATION

Japan

Mr. Ishida, Head, Traffic Environment Division, Environment Department, PWRI, made the following presentation.

1.Laws, Environmental Quality Standards(EQS), Environmental Impact Assessment(EIA)

2.Measures against air pollution caused by automobile exhaust gas;
1)Improvement of car itself, 2)Improvement of road networks, 3)Road structure, 4)Absorption of NOx by vegetation in buffer zones, etc.

3.Measures against traffic noise;
1)Improvement of car itself and road structure, 2)Installation of noise barrier, 3) Low noise pavement, etc.

Singapore

Mr. Khor Poh Hwa, Chief Civil Engineer, Public Works Department, Ministry of National Development, made the following presentation.

1.Measures against air pollution caused by automobile exhaust gas;
1)Emission Standards, 2)Unleaded petrol, 3)Integrated transport policy, etc.

2.Measures against traffic noise;
1)Control at the source, 2)Urban planning and development control along the roads, 3)Low noise road surface, 4)Noise barriers, 5)Tunnels or depressed roads, etc.

2) DISCUSSION

After the presentations of the two countries, discussions were made on the following items.

1.Air pollution
a)Level of R & D in Japan of the low concentration denitration equipment and its possible cost when brought to practical use
b)Necessity and background for R & D efforts for such equipments in Japan
c)Assessment on air pollution from flat roads and elevated roads
d)Effect of vehicle speed on emission

2.Traffic noise
a)Maintenance cost for cleaning of transparent noise barrier in Korea
b)Ongoing researches in Japan for development of automated cleaning maintenance equipment and materials of easy maintenance
c)Psychological effects of noise barrier on the drivers

3.Causes of traffic-induced ground vibration in Japan

4.Explanation of laws and regulations for environment in Japan

3) SUMMARY

The following is the summary of presentations and discussions.

1.The importance of air pollution and noise caused by traffic in the conservation of living environment in urban areas were recognized.

2.Exchange of information on the current situations and countermeasures against air pollution and noise caused by traffic is beneficial for all the participating countries in promoting research and development for the improvement of the environment. Further exchange of information is necessary.

CONCLUSION

The following are the main conclusions through the presentations and discussions on Subjects of Common Interests.

1)Through exchanges of information on current situations of disasters and disaster prevention works and projects to harmonize environment and infrastructure improvement, and researches on related subjects in respective countries, mutual understanding was deepened. These exchanges will be even more important in the future.

2)Though dams and levees are fundamental measures of flood control, they are not completed at once. Even after the completion non-structural measures are necessary to ensure effective countermeasures against floods.

3)Road slope failures are serious problems to cause traffic interruption. Consequently, road hazard maps, data base of road slope and slope failure inventory, and development of slope failure prediction system and countermeasures are awaited.

4)Countermeasures against water pollution in rivers and dam reservoirs are to be adopted in accordance with varying conditions of participating countries. Consequently, merits of the exchange of related information regarding sewerage and water recycling, which is effective in enhancing water environment, were recognized.

5)Air pollution and noise caused by traffic are important issues in the conservation of living environment in urban areas. Consequently, it is useful to exchange information on current situation and countermeasures of these phenomena in order to enhance research for environment management in respective countries. Further information exchange is necessary.

3. Discussion on Specific Subjects

For each specific subject in public works, participants who have the similar problems in public works met and discussed, taking time from 9:30 to 16:30 on Nov. 18.

Summary of discussion in each subject is as follows;

(1)Debris Flow — China, Philippines, Japan(Erosion Control Dept.)

Each country presented and discussed status of disasters caused by debris flows and countermeasures, and investigation and studies being undertaken. It is clearly recognized that the research cooperation among China , Philippines and Japan is very important to promote studies on production, flow down and deposition of debris flows and countermeasures. Each country agreed to exchange information on debris flow.

(2) Materials of the Highway Bridge —Concrete— — Indonesia, Japan(Material and Construction Method Dept., Structure and Bridge Dept., International Institute of Seismology and Earthquake Engineering (BRI))

Indonesia side presented the problems of materials, mainly of aggregate for concrete, for road structures in several places and a topic on R & D of artificial light weight aggregate (ALWA). Japan side explained the research activities on ALWA, durability of concrete bridges and non–destructive diagnosis method for scouring under bridge foundation. It was agreed that both sides start exchange of information.

(3) Flood Control — Korea, Japan(River Dept.)

Both sides explained the present status and trend of river improvement works in each country. Japan side outlined the bank protection technology concerning the conservation/creation of river environment. Korea side outlined research subjects concerning river channelization techniques and river environment management. Both sides agreed to promote researches on river works concerning the conservation/creation of river environment and confirmed the continuation of information exchange.

(4) Care for the Rivers — Malaysia, Japan(River Dept.)

Following a visit to the Kokai River in Shimozuma City, where a flower belt was being developed, attempts of river creation with participation of general public in Japan and "Love Our River" campaign in Malaysia were introduced. It was mutually recognized that further research is necessary to promote care for rivers by bringing rivers closer to our everyday life. Both sides agreed to exchange research output and related information on care for the rivers.

(5) Utilization of the Underground Space — Singapore, Japan(Planning and Research Administration Dept., Road Dept.)

Both sides presented and discussed status on design method of tunnelling with near-by buildings and underground space utilization. Both sides agreed to exchange the information of the new domestic technical development and case histories of the tunnelling with near-by building and MRT tunnels and also try to investigate ways for further cooperation.

(6) Air Pollution Control — Thailand, Japan(Environment Dept., Structure and Bridge Dept.)

Both sides presented and discussed serious situation on air pollution, its countermeasure and noise and vibration control. It was recognized that countermeasures against air pollution, noise and vibration were very important for Thailand and Japan, and both sides would exchange information, if necessary.

(7) Materials of the Pavement — Indonesia, Japan(Road Dept., Material and Construction Method Dept.)

Artificial Light Weight Aggregate used as experimental pavement material was explained by Indonesia side and present pavement technology(RCCP, pavement recycle, drainage asphalt pavement) was explained by Japan side, followed by discussion on them. It was agreed to exchange technical information.

(8) Environment Improvement —Water Quality Control— — Korea, Thailand, Japan(Water Quality Control Dept.)

Each country explained its up-dated interests on wastewater system development and fruitful discussion followed. Also, Japan side gave the information on five-year program for wastewater system construction. Each country agreed on exchange of reports among them.

(9) Creation of the River Environment — Malaysia, Japan(Environment Dept.)

Both sides introduced present status and information on river environment. It was recognized that the research cooperation is very important for effective studies on the method concerned with preservation and creation of aquatic eco-system and river landscape and the method of water purification, in order to solve the problem both in Malaysia and Japan. Both sides agreed to exchange information of River Environment.

(10)Traffic Management — Singapore, Japan(Road Dept., International Institute of Seismology and Earthquake Engineering (BRI))

Japan side introduced status of traffic congestion in Japan and then explained the traffic management policies both already implemented and under investigation. Singapore side explained the road pricing system implemented in the city. Both sides reached the recognition that traffic management will play a more important role in road transportation policy and agreed that technical information and results of research should be exchanged, if necessary.

Through the above discussions participants achieved a better mutual understanding on relevant problems and current research activities in each participating country. At the same time necessity for further cooperation including exchange of detailed information in each public works field was recognized.

(1) SUMMARY OF DISCUSSION (DEBRIS FLOW)

DATE : November 18 (Thu), 1993 9:30–12:00, 14:00–16:30

PLACE: PWRI, Rm 8F

PARTICIPANTS:

China		
	Wu Jishan	Director, Institute of Mountain Hazards and Environment, Chinese Academy of Sciences & Ministry of Water Conservancy
Philippines		
	Jose H. Espirutu	Director, Bureau of Research and Standard, Department of Public Works and Highways
Japan		
	Akio Yazawa	Director, Erosion Control Department
	Yoshiharu Ishikawa	Head, Erosion Control Division
	Ou Guogiang	Overseas Researcher
	Takashi Yamada	Research Engineer, Erosion Control Division
	Hiroyuki Yoshimatsu	Head, Landslide Division
	Ryosuke Tsunaki	Head, Slope Failure Diovision

1. CONTENTS OF DISCUSSION

Japan side, China side, and Philippines side discussed eagerly to promote cooperative activities aimed for mutual supportive research activities to understand sediment disasters caused by debris flow, landslide, and slope failure, and their countermeasures.

Japan side explained the research activities related sediment disasters and their countermeasures conducted by Erosion Control Division, Landslide Division, Slope Failure Division and Niigata Experimental Laboratory. The topics are as follows ;

1) Countermeasures against debris flows
2) Field observation of debris flows
3) Designation methods of areas of debris flow risk using numerical simulation
4) Countermeasures against landslides
5) Field observation of landslides
6) Countermeasures against steep slope failures
7) Status of steep slope failures

In addition to them, the PWRI presented and explained outline of research activities on pyroclastic flow disasters due to the eruption of Mt. Unzen since 1991 using some slides and experimental facilities.

China side explained the research activities concerning debris flows. The main topics are as follows ;

1) Field observation of debris flows
2) Status of ressearch activities concerning debris flows
3) Study on mechanism of debris flow movement

Philippines side explained the need of studies on disasters caused by debris flows produced by the eruption of Mt. Pinatubo in 1991. The main topics are as follows ;

1) Generation of debris flows from the deposition area of pyroclastic materials.
2) Field observation on debris flows at Mt. Pinatubo
3) Proposal of field observation of debris flows in near future
4) Research on the design methods for countermeasures engineering facilities against debris flows and test of newly-developed countermeasure facilities
5) Characteristics of lahar, flow-down, and deposition of debris flow

2.FUTURE RESEARCH TOPICS

Investigation on production, flow down, and deposition of debris flow and countermeasures is worth to consider as a subject for cooperative research.

China side continues to carry out the field observation and research on debris flow in the Dongchuan River ,Yunnan Province.

Philippines side will conduct the field observation and research on debris flow which was generated in the deposition area of pyroclastic materials at Mt. Pinatubo.

Japan side continues field investigation and observation on debris flow at Mt.Unzen where pyroclastic flows have frequently occurred since 1991.

Prediction methods of debris flow occurrence, estimation methods of discharge of debris flow, and design methods for countermeasures against debris flows will be examined using the observation data.

3. WAYS OF FUTURE RESEARCH COOPERATION

1) Informtion on debris flow and its countermeasures should be mutually exchanged.
2) Determination of specific subjects to be studied through the above exchange of information.
3) Researchers will be dispatched if necessary and budget allows.

4. AGREEMENTS

Each country will exchange research output and related materials concerning the debris flow.

(2)SUMMARY OF DISCUSSION (MATERIALS OF THE HIGHWAY BRIDGE –CONCRETE–)

DATE November 18,1993(Thu) 9:30 ~ 12:00
PLACE PWRI Rm.531
PARTICIPANTS

Indonesia

Soedarmanto Darmonegoro
Secretary, Agency for Research and Development, Ministry of Public Works

Japan

Masashi Ikemura	Director, Material and Construction Method Department
Hirotaka Kawano	Head, Concrete Division
Hiroshi Watanabe	Senior Research Engineer, Concrete Division
Youichi Funai	Received Researcher
Yoshitomi Kimura	Research Engineer, Fundation Engineering Division
Yoshitaka Motoda	Building Research Institute, MOC

1.CONTENTS OF DISCUSSION

Indonesia side presented the problems on materials, mainly on aggregate for concrete, for road structures in several places and a topic on R&D of artificiallight weight aggregate.

Japan side explained the research activities of related materials for road bridges conducted by the Concrete Division as well as the following topics on concrete and bridges in Japan.

1)Artificial Light Weight Aggregate in Japan.
2)Problems on Aggregate for Concrete in Japan.
3)Durability of Concrete Bridges.

The Foundation Engineering Division gave an outline of their current research on non–destructive diagnosis method for scouring under bridge foundation.

They also discussed the way to promote cooperative activities.

2.FUTURE RESEARCH TOPICS

It is important to promote studies on proper use of artificial light weight aggregate and etc.

3.WAYS OF FUTURE RESEARCH COOPERATION

1)Exchange of information on the materials for road bridges and non–destructive diagnosis method
2)Dispatching researchers to each other if necessary and if financially possible

4.AGREEMENTS

Both sides will start to exchange research output and related material concerning the materials for road bridges, in a form of abstract written in English.

(3)SUMMARY OF DISCUSSION(FLOOD CONTROL)

DATE : November 18, 1993 (Thu.) 9:30–12:00

PLACE : The Meeting Room of the River Department, PWRI

PARTICIPANTS;

Republic of Korea	
Kim Keung Hwan	Director, Planning & Coordination Division, KICT
Japan	
Tadahiko Nakao	Director, River Department, PWRI
Katsura Hirabayashi	Research Engineer, River Hydraulics Division, PWRI
Atsushi Hattori	Research Engineer, River Hydraulics Division, PWRI
Masato Fujii	Research Engineer, River Hydraulics Division, PWRI

1. CONTENTS OF DISCUSSION

1–1. Present Status on River Improvement Works in Each Country

Japan side explained the trend of the river improvement works in Japan. The topics are listed below;

1)Disaster Prevention Works due to Exceptional Flood
2)Channelizations in Suburban Areas
3)River Improvement Works concerning the Conservation/Creation of River Environment

Korea side explained the present status of river improvement works in Korea. The topics are listed below;

1)The Aims of River Improvement Work
2)Current Status of Rivers
3)Present and Past River Improvement Work
4)Statistics of Urban Rivers

1–2. Present Status on R&D in Each Country

Japan side explained the outline of riverbank protectoin technology concerning the conservation/creation of river environment, which are now being conducted at the River Hydraulics Division of PWRI. The indices are as follows;

1)Research on the design method for vanes as a countermeasure against local scour at the curvature of rivers
2)Research on the erodivility of riverbanks with vegetation
3)Research on the development of a method for the creation of natural river banks

Korea side explained the present status on R&D concerning river works which are being conducted in KICT. Major topics are as follows;

1)Research on River Channelization Techniques
- −River Sediment Transport
- −River Course Change
- −Reservoir Sedimentation
- −Contaminated Sediment Management

2)Research on River Environment Management
- −Water Quantity Conservation
- −Water Quality Conservation
- −Riverain Space Management
- −River Habitat Conservation
- −River Scenery Improvement

2. FUTURE RESEARCH TOPICS

Research on the river works concerning the conservation/creation of river environment will be promoted strongly.

3. WAYS OF FUTURE RESEARCH COOPERATION

1)Exchange of information on the latest research achievements.

2)Determination of specific subjects to be studied through the exchange of information.

4.AGREEMENT

Information exchange will be continued in a way above mentioned.

(4)SUMMARY OF DISCUSSION (CARE FOR THE RIVERS)

DATA:November 18, 1993 (Thu) 9:30–12:00
PLACE:Kokai River (Shimozuma City), PWRI Rm.532
PARTICIPANTS

Malaysia

Teh Siew Keat, Director, River Engineering, Department of Irrigation and Drainage, Ministry of Agriculture

Japan (PWRI, Ministry of Construction)

Minoru Kuriki, Head, Urban River Division,River Department

1.CONTENTS OF DISCUSSION

Prior to the discussion, a visit was made to the Kokai River, where a flower belt was being developed.

Japan side explained present situation of care for the rivers in Japan focusing on the river creation with participation of general public in the Kinu and Kokai Rivers. Main topics included the followings:

Kinu and Kokai Expo
Kinu and Kokai River Coordinator
Kinu and Kokai River Constitution
Kinu and Kokai Clean Action Plan
Kokai River Flower Canal
Kinu and Kokai River Flower Belt
Love River Institution

Malaysia side explained the 'LOVE OUR RIVER' campaign which took place in Malaysia in 1993. He talked about the various activities carried out during the campaign. He expressed keenness in knowing more about the 'LOVE RIVER MONTH' in Japan. It could be a useful reference for Malaysia, as the country plans to start a 'follow up' campaign in 1994 and in the years after.

2.FUTURE RESEARCH TOPICS

Care for the rivers is likely to be well supported. Further research would be necessary to promote care for rivers by bringing rivers closer to our everyday life.

3.WAYS OF FUTURE RESEARCH TOPICS

1)Exchange of information on the related activities and research work
2)Exchange of visits when fund is available

4.AGREEMENTS

Both sides agreed to exchange research output and related information on care for the rivers.

(5)SUMMARY OF DISCUSSION (UTILIZATION OF THE UNDERGROUND SPACE)

DATE: Nobember 18, 1993(Thu) 9:30 ~ 12:00
PLACE: PWRI Rm627
PARTICIPANTS:

Singapore (Ministry of National Development)

Khor Poh Hwa	Chief Civil Engineer Public Works Department

Japan (PWRI, Ministry of Construction)

Yasuyuki Koga	Research Coordinator for Undergrouud Development
Takuya Seo	Head, Traffic Safety Division
Akira Inokuma	Head, Tunnel Division
Hideto Mashimo	Senior Research Engineer, Tunnel Division

1.CONTENTS OF DISCUSSION

Japan side and Singapore side discussed eagerly to promote cooperative activities of urban tunnelling and utilization of underground space, the Singapore underground Road system in particular.

Japan side explained the present state of Japanese design method and examples in the field of tunnelling with near-by buildings and utilization of underground space. The topics are as follows ;

1)The basic design method of tunnelling with near-by buildings, countermeasures, Japanese way to investigate and find out the best design of such tunnels

2)The present state of Japanese underground space utilization

3)The way to cooperate internationally on a specific subject

Singapore side explained the present state, plans and problems of the tunnel execution and underground utilization.

1)Underground utilization, future road network plan including tunnels

2)Design conditions of tunnels with near-by buildings and existing MRT tunnels

2.FUTURE RESEARCH TOPICS

The problem in urban tunnelling is worth taking up as a subject for cooperative research. This problem includes design and execution method of tunnelling with near-by building and MRT tunnels and utilization method of underground space.

3.WAYS OF FUTURE RESEARCH COOPERATION

1)Exchange of information

2)Dispatching researchers if necessary and fund is available

4.AGREEMENTS

Both sides will exchange the information of the new domestic technical developments and case histories of the tunnelling with near-by buildings and MRT tunnels and also try to investigate the proper way of further international cooperation.

(6)Summary of Discussion (Air Pollution Control)

DATE November 18,1993(Thu) 9:30–12:00
PLACE PWRI Rm.526
PARTICIPANTS

Kingdom of Thailand

Anusornant Mahavinichaimontri	Director, Materials and Research Division, Public Works Department, Ministry of Interior

Japan

Toshinori Mizutani	Director, Environment Department
Minoru Fujiwara	Director, Structure and Bridge Department
Minoru Ishida	Head, Traffic Environment Division
Katsumi Uesaka	Research Engineer, Traffic Environment Division
Futoshi Inazaki	Research Engineer, Traffic Environment Division
Hisashi Konno	Research Engineer, Structure Division

1.CONTENTS OF DISCUSSION

Japan side explained the outlines of countermeasure related air pollution in Japan. The topics are as follows ;

1)Improvement to Control Automobile Exhaust Gas
2)Improvement of Traffic Congestion Countermeasures
3)Improvement of Buffer Zone and Fixation of NOx by Plants

Japan explained the outlines of vibration on construction and traffic by request. The topics are as follows ;

1)The causes and evaluation value of road traffic vibration
2)Regulation of vibration in construction
3)Situation of development of construction machine

Thailand side explained the outlines concerning air pollution problems and road works. The main topics are as follows ;

1)Air Pollution from Transport
2)Air Pollution from Industry
3)Air Pollution from Electricity Generation

In addition to them, Thailand side presents and explained some papers on the expected effects for living environment.

After that, both sides made a sturdy tour to Air Pollution Laboratory and Noise Experiment Laboratory.

2.FUTURE RESEARCH TOPICS

Air pollution control by motor vehicle exhaust gas is a fundamental measure. But both sides think that it is necessary to control air pollution by road structure as well. Researches will be continued extensively.

3.WAYS OF FUTURE RESEARCH CO-OPERATION

Exchange of information on these subjects

4.AGREEMENTS

If there are research outputs or materials concerning these subjects, at least abstract of which written in English, both sides will exchange them.

(7)Summary of Discussion (Pavement)

Date November 18,1993(Thu) 14:00 ~ 16:30
Place PWRI Room531
Participants Indonesia
Soedarmanto Darmonegoro
Secretary of Agency for Research and Development
Ministry of Public Works
Japan (PWRI, Ministry of Construction)

Toshiyuki Nakamura	Head, Pavement Division
Takaharu Kiriyama	Research Engineer, Pavement Division
Syuuji Mori	Research Engineer, Pavement Division
Kazushi Komoriya	Engineer of Pavement Division
Iwao Sasaki	Research Engineer, Chemical Division

1.Contents of Discussion

Indonesia side explained about Artificial Light Weight Aggregate used as pavement material, its production procedure, its quality standard, its property when used in asphalt mixture.

Japan side explained present pavement technology, RCCP, recycling and drainageasphalt pavement.

Main contents of discussion are the following.

1)In case of asphalt mixture using artificial aggregate, optimum asphalt content is more, marshall stability is high, dynamic stability is the same as ordinary mixture.

2)As a countermeasure to prevent rutting on heavy traffic road, gap−graded mixture is used in Japan, but it has little effect in Indonesia.

3)Specification of pavement design method in Indonesia is based on AASHTO and BS.

4)In Indonesia, pavement recycling is started.

5)The present main project in Indonesia is a construction of toll road between Djakarta and Bandon.

2.Future Research Topics

Proper use of artificial aggregate and mix design method of asphalt mixture onheavy traffic road should be studied.

3.Ways of Future Research Cooperation

Information exchange. Cooperative research is to be discussed in the future.

4.Agreements

It is agreed to promote technical cooperation through information exchange.

(8) SUMMARY OF DISCUSSION (ENVIRONMENT IMPROVEMENT –WATER QUALITY CONTROL–)

DATE November 18, 1993(Thu) 14:00 – 16:30
PLACE PWRI, Room 526
PARTICIPANTS

Republic of Korea

Kim Keung Hwan	Director, Planning & Coordination Div., Korea Institute of Construction Technology

Kingdom of Thailand

Anusornant Mahavinichaimontri	Director, Materials and Research Div., Public Works Department, Ministry of Interior

Japan(Water Quality Control Department, PWRI, Ministry of Construction)

Kunio Ichimura	Director, Water Quality Control Department
Kazuaki Sato	Research Coordinator for Wastewater Treatment
Syuji Tanaka	Head, Wastewater System Div.
Masahiro Takahashi	Head, Advanced Waste Treatment Div.
Haruki Watanabe	Head, Sludge Management Div.
Hiroaki Tanaka	Head, Water Quality Div.
Katsuhisa Shioji	Senior Research Engineer, Wastewater System Div.

1. CONTENTS OF DISCUSSION

Each side explained its up–dated interests on wastewater system development in its country. Challenges on wastewater system development in each country were clarified with these explanations and subsequent fruitful discussion. Also, Japanese side gave the information of five–year programs for wastewater system construction. All sides recognized the importance of information exchange among them.

2. FUTURE RESEARCH TOPICS

1) Development of wastewater treatment technology for the tropical and subtropical zones
2) Removal of nutrients

3. WAYS OF FUTURE RESEARCH COOPERATION

1) Exchange of reports
2) Dispatch of Japanese engineer(s) to Thailand as JICA expert.

4. AGREEMENTS

All countries agreed to exchange reports and other related information on the subjects stated above in the section of 2.

(9)SUMMARY OF DISCUSSION (CREATION OF THE RIVER ENVIRONMENT)

DATA NOVEMBER 18, 1993(Thu) 14:00−16:30

PLACE Matajizawa river (Rsukuba city),
PWRI Rm.532

PARTICIPANTS

Malaysia

Teh Siew Keat Director, River Engineering, Department of Irrigation and Drainage, Ministry of Agriculture

Japan(PWRI,Ministry Construction)

Okimichi Suzuki Senior Research Engineer, River Environment Division

1.CONTENT OF DISCUSSION

Japan side presented a paper entitled "Effect of Naturally Diverse Construction Methods" and explained the river modifiation considering aquatic eco−system,the method related to preservation and creation of landscape of river and the method of water purification,which is carried out by River Environment Division in PWRI. Main contentis as follows;

1)Study on the impact of river modification on aquatic eco−system
2)Study on Naturally Diverse River Construction Method and biotope (including examples of public works)
3)Study on method related to preservation and creation of river landscape using computer graphic system and so on.
4)Present situation of the water purification and study on development of water purification system.

In addition to them, the PWRI explained the feature of river,aquatic livings and water quality.

Malaysia explained present situation of river environment in urban area and the future plan concerned with the river environmental improvement.

2.FUTURE RESEARCH TOPIC

The development of water purification method using the natural function, preservation method of aquatic eco−system combined with the water purification system and preservation and creation method of river landscape are worth adopting as subjects for cooperative research. These problems are developed earnestly by PWRI. In future PWRI will carry out further research on the function and the design as mentioned above, and intend to apply these methods to various aquatic place such as rivers and lakes.

3.WAYS OF FUTURE RESEARCH COOPERATION

1)Exchange of information on the creation of river environment

2)Determination of specific subjects to be studied through the above exchange of information

3)Exchange of researchers and visit if fund is available

4.AGREEMENTS

Both sides will start to exchange research output and related material concerning the river environment problem and improvement method.

(10)Summary of Discussion (Traffic Management)

Date: November 18, 1993(Thu.) 14:00 – 16:30
Place: PWRI Rm627
Participants:

Singapore		
	Khor Poh Hwa	Chief Civil Engineer, Public Works Department, Ministry of National Development
Japan		
	Tetsuo Matsumura	Research Coordinator for Traffic Safety, PWRI
	Harutoshi Yamada	Head, Advanced Transportation Division, PWRI
	Takuya Seo	Head, Traffic Safety Division, PWRI
	Yoshitaka Motoda	Head, Civil Engineering Division, BRI

1. Contents of Discussion

Japan side introduced the state of traffic congestion in Japan and then explained the traffic management policies already implemented and under investigation. The topics dealt with are as follows:

(1) Present condition of traffic congestion and countermeasures
① Present condition of road transportation
② Present condition of traffic congestion
③ Impact of traffic congestion
- Cost of lost time
- Energy conservation and environmental impact
- Traffic accidents and traffic congestion

④ Traffic congestion countermeasures in recent years
(2) Future demand management measures in Japan
① New traffic congestion countermeasures program
② Major measures under investigation
- Traffic assessment system
- Logistics
- Restricting the amount of traffic through pricing

③ Examples of past efforts
- Buses operating on dedicated lanes
- Traffic control through the opening and closing of Metropolitan Expressway ramps
- Flextime

Singapore side explained the road pricing system implemented in the city. The topics are as follows:

(1) Area licensing scheme
(2) Experimental electronic road pricing scheme

2. Future Research Topics
(1) Implementation methodologies of traffic demand management
(2) Estimation of effects of traffic demand management

3. Ways of Future Research Cooperation
Information will be exchanged when necessary.

4. Agreements
Both sides agreed that technical information and results of research related to the research topics listed above should be exchanged, if necessary.

4. Future Direction of the Conference

Future direction of the Conference was discussed on Nov. 19 from 10:30 to 11:40, chaired by Mr. Sumiyoshi, Director-General of PWRI.

The summary of the discussion is as follows :

Participants voiced the signficance and importance of continuation and development of this Conference in the future. It was agreed that this Conference should function as a network for public works research and development in Asia through exchanges of research information and personnel in an effort to find solutions to technical problems each country faces. Participants agreed on the items below for the third conference and after.

(1)Keynote Lecture

Keynote lectures will be continued, and number of lectures will be two to three.

An appropriate subject will be adopted as a topic for keynote lecture.

(2)Country Reports

Since outline of the country and public works had been reported at the First and Second Conference, brochures published shall be utilized for it at the future conference. Presentation on the role of research organizations in public works, R & D activities, specific topics, research management, ways of dissemination and diffusion of the research products is to be made.

(3)Subject of Common Interests

Number of Subjects of Common Interests should be about 2. Possible subjects are listed below. Selection of the subject for the next conference will be determined in consideration of the participants to the next conference. An appropriate subject will be adopted as a topic for keynote lecture. It is possible that the subjects covering wide area of research such as environment and disaster prevention will be selected.

Possible subjects for the future are;

1. Environment
   1) Infrastructure development for the improvement of environment.
   2) Infrastructure development in consideration of environment.

2. Materials and Construction Technology
   1) Public works technology well utilizing regional resources.
   2) New materials and advanced construction technology.

3. Disaster Prevention
   1) Disaster prevention measures such as prediction, warning system,

evacuation, etc.

2) Emergency measures for provisional restoration works at the time of disaster.

3) Restoration work plan to prevent the repetition of the disaster.

4. Highway

1) Road construction, maintenance and management

2) Traffic management, traffic safety measures

5. Tasks and Current Status of Joint Researches in Asia.

6. System of Research Information Exchange.

7. Diffusion of Technology, Establishment of Technical Standards and Role of Research Institutes.

8. Quality Management

9. Others

(4) Specific Subjects

Discussion on Specific Subjects should be continued.

(5) Other Details for the Third Conference

1) Time

in October, 1994

2) Duration

Two weeks

3) Place

Japan, Tsukuba, PWRI

4) Participating countries

Possible increase in number of participating countries.

5) Participants

Director–General of the institutes and Director of Bureau in the Ministry directly responsible for R & D are the qualified members. Qualification of the field in public works of participants should be specified in General Information.

III. Conclusion

Conclusion of The Second Conference on Public Works Research and Development in Asia

The Second Conference on Public Works Research and Development in Asia was held in PWRI, Ministry of Construction, Japan from Nov. 15 (Mon), to Nov. 26 (Fri), 1993. The participants of this Conference were officials from government agencies in Asia responsible for infrastructure research and development and its promotion, including those from China, Indonesia, Korea, Malaysia, Philippines, Singapore, Thailand and Japan. Based on the country reports prepared by participants of each country, presentations and discussions were carried out with common interests for better understanding of problems faced in each country as well as making the best use of experience in every country.
The results of the Conference are as follows.

1. Keynote Lecture

Prior to the presentation of country report and discussion three keynote lectures were given. The first keynote lecture entitled "Role of Civil Engineers for Sustainable Development" was given by Mr. Atsushi Hamamori, President, Japan Overseas Consultants Co. Ltd. In his lecture Mr. Hamamori discussed the relation between economic growth and infrastructure development, environmental considerations in large-scale development and challenges toward the coming 21st century. Then Mr. Yukihiko Sumiyoshi, Director-General, PWRI, Ministry of Construction, gave an lecture "Socio-Economic Development and Construction Technology Transfer", in which he talked about economic growth after Meiji Restoration and infrastructure improvement in Japan, current status of infrastructure development in various Asian countries and current status of technology transfer in ASEAN countries. Third speaker was Prof. Hiroyoshi Shi-igai, Institute of Engineering Mechanics, University of Tsukuba. His lecture entitled "Research in Japan – Focusing Civil Engineering –", clarified characteristics of science and technology of Japan and the role of PWRI as well as important factors in research work.

2. Country Report

The outline of each country, current status of public works, research institute of public works, principal research program, and international research cooperation issues were presented and discussed.
Reports are summarized as follows :

1) Through introduction of the country's natural and socio-economic condition, understanding was deepened on common issues and tasks as well as on specific issues faced in each country.
2) Importance of public works research and development were pointed out with emphasizing requirements of infrastructure improvement such as roads, rivers, dams, erosion control and sewerage systems for the development of each country.

3) Current situations of public works research and development were reported, through which it was understood that each country is eagerly involved in research activities. Common tasks and implementation methods were also pointed out. Through interesting reports on unique and specific issues each country faces, mutual understanding was deepened on this matter.
4) The attitude toward international research exchanges seems to be positive for each country. Through the discussion, importance and necessity of promoting international research exchanges were confirmed.

3. Subjects of Common Interests of All Countries

The following are the main conclusions through the presentations and discussions associated with "Comprehensive Countermeasures against Floods", "Countermeasures against Highway Slope Failure", "Measures for Water Quality Control of Reservoirs and Rivers" and "Countermeasures against Air Pollution and Noise caused by Road Traffic in Urban Areas" on Subjects of Common Interests.

1) Through exchanges of information on current situations of disasters and disaster prevention works and projects to harmonize environment and infrastructure improvement, and researches on related subjects in respective countries, mutual understanding was strengthened. These exchanges will be even more important in the future.
2) Though dams and levees are fundamental measures of flood control, they are not completed at once. Even after the completion non-structural measures are necessary to ensure effective countermeasures against floods.
3) Road slope failures are serious problems to cause traffic interruption. Consequently, road hazard maps, data base of road slope and slope failure inventory, and development of slope failure prediction system and countermeasures are awaited.
4) Countermeasures against water pollution in rivers and dam reservoirs are to be adopted in accordance with varying conditions of participating countries. Consequently, merits of the exchange of related information regarding sewerage and water recycling, which is effective in enhancing water environment, were recognized.
5) Air pollution and noise caused by traffic are important issues in the conservation of living environment in urban areas. Consequently, it is useful to exchange information on current situation and countermeasures of these phenomena in order to enhance research for environment management in respective countries. Further information exchange is necessary.

4. Specific Subjects

The concerned participants gathered to discuss the specific subjects of public works. At the present conference, the following ten subjects were selected according to the interest of the participants among the many fields of construction technology and discussed separately :

Debris Flow (China, Philippines and Japan), Materials of the Highway Bridge –

Concrete – (Indonesia and Japan), Flood Control (Korea and Japan), Care for the Rivers (Malaysia and Japan), Utilization of the Underground Space (Singapore and Japan), Air Pollution Control (Thailand and Japan), Materials of the Pavement (Indonesia and Japan), Environment Improvement – Water Quality Control – (Korea, Thailand and Japan), Creation of the River Environment (Malaysia and Japan), Traffic Management (Singapore and Japan). Several problems of each country in the individual field of civil engineering technology and situation of research were understood mutually by participants through this discussion. Moreover the necessity of further technical cooperation, such as future exchange of detailed information, in specific field of civil engineering was recognized.

5. Future Direction of the Conference

Participants voiced the signficance and importance of continuation and development of this Conference in the future. It was agreed that this Conference should function as a network for public works research and development in Asia through exchanges of research information and personnel in an effort to find solutions to technical problems each country faces. Participants agreed items below for the third conference and after.

1) Keynote Lecture and Discussion on Specific Subjects should be continued.
2) Country Report Presentation should be made on the role of research institute in public works, R & D activities in respective research institutes, specific topics, research planning and management, ways of dissemination and diffusion of the research products.
3) As the topics for Discussion on Common Interests, the followings were proposed: environment, materials and execution technology, disaster prevention, road construction, maintenance and traffic management, cooperative research work, system of research information exchange, diffusion and standardization of technology, R & D for quality management. Among above–cited subjects 2 or 3 will be selected as Common Interests for the Third Conference, considering the specificity of the future participants.
4) The Third Conference on Public Works Research and Development in Asia will be held in October, 1994 with the duration of two week at PWRI. Qualification of the field in public works of participants should be considered.

6. Symposium

As a part of the Conference, "The Second Symposium on Public Infrastructure and Civil Engineering in Asia" held in Fukuoka City on Nov. 22 (Mon) hosted by PWRI and Kyushu Regional Construction Bureau, MOC, with an attendance of approximately 200 people from government and private organization as well as universities. The summary is as follows.

1) Keynote Lecture entitled "Regional Development and Civil Engineering Technology in Kyushu" was given by Prof. Takeshi Chishaki, Faculty of Engineering, Kyushu University. In his lecture, he spoke about the role that public works technology has

played ever since ancient times up to today and the future direction of public works development expected in Kyushu.

2) Panel Discussion with the theme "Striving for a Better Environment – Regional Developments Projects, Disaster Prevention, Environmental Issue –" was held with Mr. Sumiyoshi, Director–General of PWRI as a coordinator and seven overseas participants and Mr. Aramaki, Director–General of Kyushu Regional Construction Bureau as panelists. Through presentations and discussions on each country's projects for improvement of living environment, mutual understanding on the current situation of each country was strengthened. Under the present situation where efforts for infrastructure development in harmony with the environment and public works research and development technology are ever more needed, importance of mutual exchange of research information and expectations of technical cooperation from Japan to Asian countries were expressed.

7. Conclusion

1) Through the presentation of the country report, the participants deepened their understanding on current situation, their problems, research and development and perspectives, etc. of other participating countries.

2) Through the discussion on subjects of common interests in all countries, it is agreed to promote the exchange of information in order to pursue research and development on Disaster and Disaster Prevention and Harmony between the Environment and Improvement of Infrastructure.

3) Through the discussions participants achieved a better mutual understanding on relevant problems and current research activities in each participating country. At the same time necessity for further cooperation including exchange of detailed information in each public works field was recognized.

4) The topics for Discussion of Common Interests such as environment, materials and execution technology, system of research information exchange etc., were proposed, 2 or 3 subjects of which will be selected as Common Interests for the Third Conference.

5) Recognizing the importance of sharing the accumulated experiences and the efforts of research and development among the countries to promote and ensure further development of infrastructures, it was unanimously agreed through the discussion that this conference was productive, and it would be important to continue and develop the conference.

IV. Address of Closing Ceremony

Address of Closing Ceremony

Mr. Yukihiko Sumiyoshi, Director-General, PWRI, MOC

It is with great pleasure to say a few words on behalf of the Japanese participants on this occasion of closing ceremony of "The Second Conference on Public Works Research and Development in Asia".

We are now on the 11th day today since the conference started on Nov. 15. The Conference and the inspection tour gave us a chance to exchange views and opinions with the executive members in the field of public works research and development on various topics, among which are main projects of each country, current status of research and development as well as tasks and problems. I believe all this will lead to a better understanding and a promotion of further exchange with one another as good neighbours with similar challenges, and an eventual establishment of a new framework for cooperation.

In the program of the conference were keynote addresses, each country's report on the current status of public works and its research and development as well as future tasks and also discussions on the subjects "Disaster and Disaster Prevention" and "Harmony between the Environment and Improvement of Infrastructure". Also we could discuss on specific subjects each country now faces. Then as a conclusion of all the sessions we have come up with a final resolution.

The greatest achievement, i think, is that importance of international cooperation among those concerned was once again most clearly recognized. It is my conviction that further development of this conference will activate international exchange at a higher level not only in public works research and development field, but also in a wider framework. This will surely bring about a further improvement of infrastructure which is the very basis of economic development of Asian countries.

Tomorrow a courtesy call on the Ministry of Construction and then an inspection of Trans-Tokyo Bay Highway are scheduled. I hope all of you will take very good care of yourselves and enjoy the rest of your stay in Japan.

Finally I would like to extend my utmost appreciation to all the staff members who have successfully managed the conference.

Thank you very much.

Mr. Teh Siew Keat, Director of River Engineering,
Department of Irrigation and Drainage, Ministry of Agriculture, Malaysia

It is my pleasure to be given this opportunity to speak a few words on behalf of my fellow participants from overseas, on this occasion of the closing of "The Second conference on Public Works Research and Development in Asia".

We wish to first say that the Conference is a great success. It was most efficiently organised. It provided very good opportunity for all of us both from overseas and from Japan, to share and exchange information and experience. The interactions were free, active and constructive. We must all agree that the Conference has produced very good results, which are important to promote further progress in public works in the Asian Region, and thereby contribute to its growth and prosperity.

All of us have come to this conference with a common anticipation is to be able to share our information and our views, and at the same time to be able to learn and be an agent of transfer from this conference back to our respective home country. We shall leave Tsukuba, and very soon Japan, feeling satisfied that our anticipation has become a reality. We hope that conference of this nature will continue for a long time to come, and we are happy to note consideration is being given to extend the participation to other Asian countries. We firmly believe in the positive role of this conference in uplifting the standard of public works in our respective country and the Asian Region as a whole. It is indeed a very good platform for mutual cooperation. In this respect, we recognise the leading role played byJapan. You have attained great advancement in public works research and development. And we also recognise your willingness and generality to share your expertly find to import your knowledge.

Further, you have been excellent host to us, making our stay here most comfortable and enjoyable. Our trip to Shikoku and Kyushu has been most pleasant and educational. We are happy that in Fukuoka we were able to participate in "The Second Symposium on Public Infrastructure and Civil Engineering in Asia," the visit also gave us the opportunity to visit many of your excellent engineers in that region and to witness some of your impressive engineering works including the Honshu-Shikoku Bridges.

At this point, please allow us to speak a little of our mind. We shall leave Japan with very pleasant memories. And to you Mr. Sumiyoshi, your staff, the JICA personnel and the regional personnel, and others, we want to say this: your diligence is apparent to us. All of you have shown to us once again the Japanese efficiency commitment to hard work and respect for order and discipline.

Finally, we want to say: we shall leave Japan feeling good over

Firstly, the successful conclusion of a very fruitful conference.

Secondly, the fact that we know Japan much better now.

Thirdly, the fact that we have made many new friends in the process.

All these are on going well for future cooperation.

And let me once again our behalf of all my overseas friends say thank you to the PWRI, Ministry of Construction and JICA for the opportunity to attend the Conference.

Arigato Gozaimashita.

(C) KEYNOTE LECTURE

I. Role of Civil Engineers for Sustainable Development

Mr. Atsushi Hamamori, President,
Japan Overseas Consultants Co. Ltd.

Role of Civil Engineers for Sustainable Development

Atsushi Hamamori, President
Japan Overseas Consultants, Co., Ltd.

1. Foreword

I am highly honored to have this opportunity to make a keynote speech here at "The Second Conference on Public Works Research and Development in Asia". I worked for the Ministry of Construction, Japan, for 30 years as a civil engineer specializing in the fields of river engineering, water resources development and disaster prevention measures. During the period of my service with the Ministry, I was once assigned to the Public Works Research Institute, where I had the chance to participate both in planning for the construction of the present facilities and also to participate in international cooperation activities. In overseas countries, I met a great many people while participating, since 1961, in the International Course in Hydraulic Engineering in Holland, through services with the water resources development planning in Sri Lanka for three years as an expert dispatched from the United Nations Food and Agriculture Organization, and serving for six years as an expert on typhoon damage reduction with the Typhoon Committee Secretariat in Manila while I was employed by the United Nations Economic and Social Commission for Asian and the Pacific (ESCAP). In addition, I served with the Ministry of Public Works, Indonesia, as a JICA expert for five years, immediately before I retired from the Ministry of Construction.

After the Ministry of Construction, I worked for the International Engineering Consultants Association for ten years. During that period, I was engaged in the finding and promotion of socio-economic infrastructure improvement projects for many developing countries and also engaged in project appraisals and preparation of documents such as environmental consideration guidelines at the request of JICA and the Overseas Economic Cooperation Fund.

Today, I would like to address the topic "The Role of Civil Engineers" based on my experiences in preparation of infrastructure projects in many countries, as mentioned earlier. In this regard, the keywords "development

" and " sustainability " are most important. As widely known, civil engineering projects cannot be completed without large investments and large work forces. The centralization of administrative power has been one of the minimum requirements for the success of civil engineering projects ever since ancient times. The description of projects varied depending on the political intention of the top of government. For example, the Pyramids of the ancient Egypt were symbols of power, and the Great Wall of China and the great number of castles constructed at various places throughout the world during the Middle Ages were used as national defense facilities. Many of these projects bore very little relation to development or sustainable development. Even today, civil engineering has an attribute that can be used for political purposes, but its preliminary objective is to contribute to the growth of the economy and provide for the public welfare with improved infrastructure. To sustain the prosperity of a country by peaceful means is the civil engineering to be compared to military engineering providing defense.

For the period of a half century after the end of World War II, new countries achieved great success with their development efforts, but these efforts also had some undesirable effects, such as failures of some projects and environmental problems. As a result, the word "sustainability" became trendy with the public. I presume that this trendy word, "sustainability," has been used in two different ways. In the first case, it has a meaning of sustainable development in a broad sense, and what types of projects can sustain development is the major concern. In the next case, project sustainability is the major concern. In this case, how a project can successfully be completed is the problem to be discussed. These two cases are common because the results of development efforts can be obstructed or discounted by factors that could not be foreseen at earlier stages of planning. It can be envisioned that higher engineering techniques and the role of civil engineers in the planning of projects will increase, to eliminate unfavorable conditions and for making corrections required when something unfavorable comes up. Next, let us take a look at the role of engineers who have been involved in improvement and development of the infrastructure, and at some environmental problems based on actual examples. In this paper I would like you to understand that the term "civil engineers" is not limited to those who took a course in civil engineering, but means all people who are involved with projects of infrastructure improvement.

2. Economic Growth and Infrastructure Improvement

Mutual Sustenance

The term "infrastructure" can be understood to mean physical facilities constructed in the natural environment to sustain the existence of people and their activities. Infrastructure facilities are called by different names depending on their objective. While those used to prevent natural disasters or assure comfortable and convenient life are called social infrastructure facilities, those facilities used sustain the distribution of products and the supply of energies are often called the economic or industrial infrastructure. It is difficult to strictly distinguish the differences and most infrastructure facilities have these two functions. In all cases, the infrastructure consists of large facilities that can assure great benefits for many people in a wide area. Therefore, proper plans, backed up by optimum engineering and a large investment, are required for its completion. The Waterworks of the Roman Empire and the Great Canal in China were completed only because enormous funds and labor were invested by rich nations under centralized administrative powers. The land reclamation projects of Holland, where 40% of the nation's land was reclaimed from the sea through the most difficult and costly civil engineering works, was completed because of advanced civil engineering, polished through bitter experience with reclaimed land destroyed by repeated storm surges, and with the aid of the great wealth accumulated through spice trading.

The infrastructure requires a large investment, not only for construction, but also for its maintenance. A good example which is often referenced; innavigable water channels clogged by sediment deposits remain in the ruins of old countries, left over from ancient times. It can be pointed out that a well maintained infrastructure is a good indicator that a country has been rich and is still rich.

Taking a look at Indonesia as an example of what can happen with steady economic growth; as soon as the Jakarta-Cikampek Expressway was completed, construction started on a number of factories along the expressway. On the other hand, electric power has become short and serious traffic congestion is occurring in the city of Jakarta. Water shortages are experienced in dry seasons and some enterprises are giving up their plans for extending business. The government is directly facing problems of pushing forward projects for improving the infrastructure, including roads, water resources,

electric power generation and others, to sustain this momentum towards development. It is said that this is the after effect of the government policy of limiting infrastructure improvements to avoid the accumulation of debts when the international trade balance became a deficit because of rapid fall of oil prices. It can be presumed that it will be difficult for a country to make investments for development while they are suffering from economic problems.

The relationship between economic growth and infrastructure improvement in catching up and passing each other can be seen in the comparison, shown in figure 1, made between the gross domestic product (GDP) of Thailand, a country that has recently achieved rapid economic growth, and government expenditures for the transportation and communication systems, which are typical economic infrastructure facilities. It can be seen that the infrastructure improvement and the economic growth will sustain each other, and both the economy and infrastructure can sustain development when a " good circulating relationship" is achieved.

Fig. 1

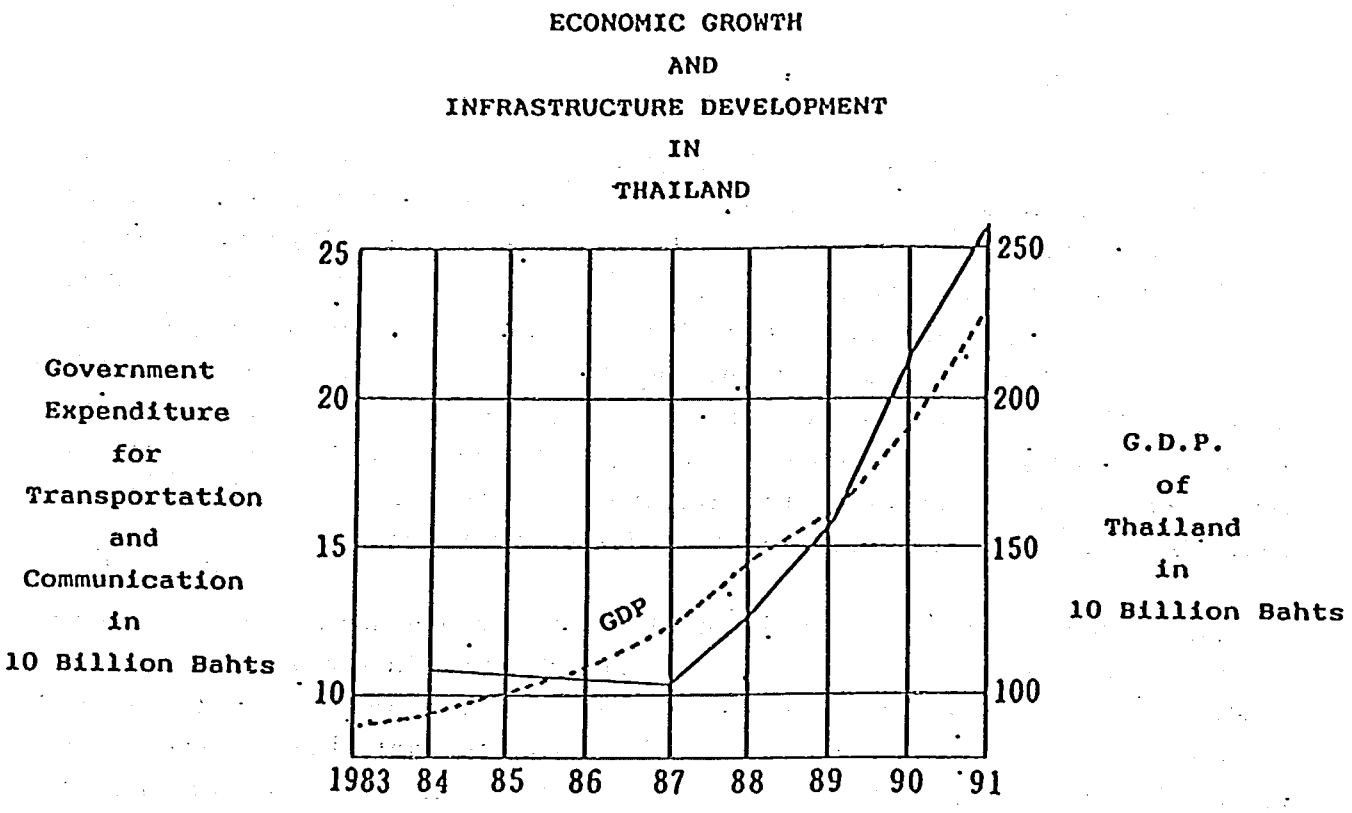
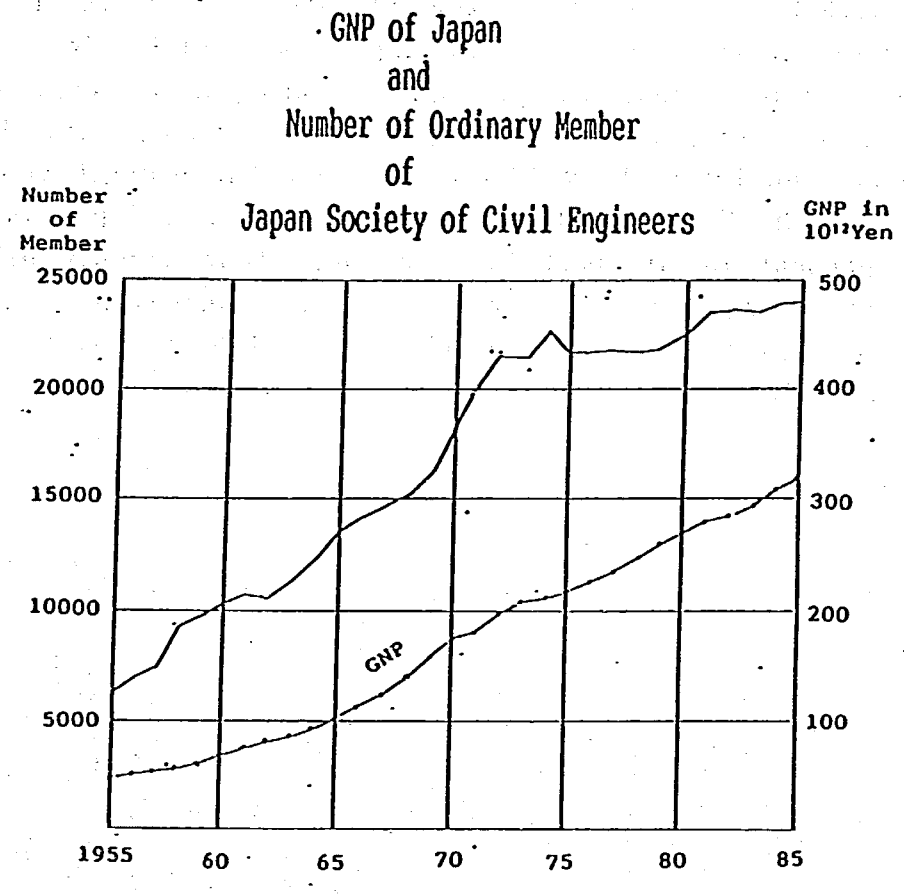

ECONOMIC GROWTH
AND
INFRASTRUCTURE DEVELOPMENT
IN
THAILAND
Government Expenditure for Transportation and Communication in 10 Billion Bahts
G.D.P. of Thailand in 10 Billion Bahts
GDP
25
20
15
10
250
200
150
100
1983
84
85
86
87
88
89
90
91

Fig. 2


GNP of Japan
and
Number of Ordinary Member
of
Japan Society of Civil Engineers
Number of Member
GNP in 10^{12}Yen
GNP
25000
20000
15000
10000
5000
500
400
300
200
100
1955
60
65
70
75
80
85

Experience in Japan

Infrastructure improvement has been carried out also in Japan, as a matter of policy, in ways corresponding to the demands of the times, such as enriching and strengthening military power, unemployment relief, stabilization of the public livelihood and stimulating business. Japan achieved the most rapid and sustainable growth during the period of rapid economic growth which began at the end of the 1950s. During this period, namely in the 1960s, the national income of Japan continued to increase more than 10% every year, and public works expenditures also showed significant increases. Implementation of the works was a great concern of engineers because the budget kept doubling every five or six years.

Figure 2 shows a comparison made between the increase in the gross national product (GNP) and the number of members registered with the Society of Civil Engineers. The number of registered members is not the same as the total number of civil engineers but it can be presumed that these numbers are proportioned. As can be seen in the figure, there is a significant relationship between economic growth and the number of civil engineers, whichever is precedent.

I would like to add the comment that Japan had been furnished with loans in the total amount of 860 million dollars from the World Bank for a period of 14 years, from 1953 to 1966, to improve the infrastructure during that period. The majority of the loans were used for improvement of the infrastructure, including the Tokaido Shinkansen railway, the Tokyo-Nagoya Expressway, the Nagoya-Kobe Expressway, and hydraulic power generation plants. Japan paid back all loans and interest by 1991 and became the highest contributory nation, next to the United States, for the World Bank. Japan is now in a position to present low-interest loans of more than seventy billion U.S. Duller to developing countries under bilateral agreements, mainly for infrastructure improvements to contribute to the economic growth of developing countries.

3. Coping with Environmental Problems

Tragedy of the Aral Sea

There are various factors that can obstruct sustainable development, such as shortage of funds, defective planning and inadequate maintenance, but many development projects are interrupted by environmental impact. One serious example that has recently attracted world attention is the devastation of the Aral Sea and its drainage basin in the former Soviet Union. The Aral Sea was an inland lake having a surface area of approximately 70,000 square kilometers, fed by two major rivers, the Syr Darya and the Amu Darya. This gigantic nature alteration project to convert unproductive areas in the drainage basin to 7.4 million hectares of irrigated farm land, using the river water, was planned immediately after World War II. As the irrigation area increased, the volume of water discharged from the rivers to the Aral Sea decreased. As a result, the area of the lake decreased to 60% of the original area, the water level lowered by 14 meters, and the shoreline receded more than 100 kilometers (see Fig. 3). As the direct impact appeared in the form of a high salt concentration which made the water uninhabitable to fish, the annual fish catch of over 40 thousand tons was lost besides the following environmental impacts were experienced.

(1) All valuable marshland fauna and flora became extinct in areas around the lake.

(2) As cotton was the crop mainly grown, groundwaters and river waters were polluted by agricultural chemicals and defoliants used to enable mechanized harvesting. This caused hepatitis and other diseases in areas downstream from the lake and resulted in an increase in the infant mortality rate to 11%.

(3) Salt crystals, deposited in the dried bottom of the lake and spread in the air by winds, brought damage to farmland and caused eye diseases and other sanitary problems.

What I described above is the damage to areas around the lake, but it is surprising that more than 40% of the farmland newly irrigated under the main project was damaged by salt. This type of phenomenon often occurs in irrigation projects in desert areas. This phenomenon is caused by evaporation and separation of salt components from groundwater with a high

salt concentration, as the water is carried up to the ground surface by capilarity during irrigation. It can be presumed that the damage from excessive salt occurred in this project for the reasons described below.

(1) As the water channels were not lined, a large amount of water leaked out and raised the groundwater level.

(2) Irrigation water was used excessively because wages were paid to managers based on the quantity of the water used.

The farmland damaged by salt was desolated and abandoned, making the development literally unsustainable.

Fig. 3

REDUCTION OF WATER SURFACE AREA
OF
THE ARAL SEA

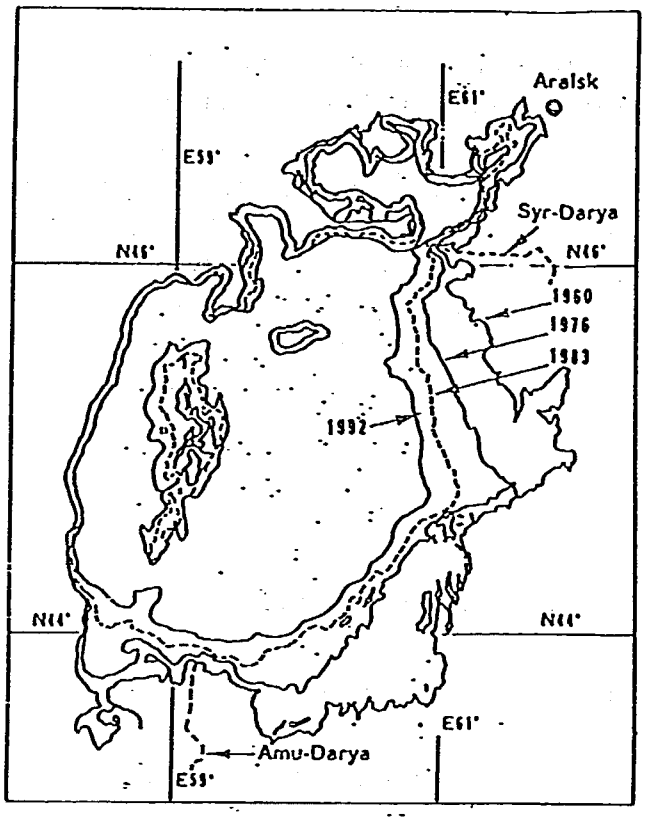
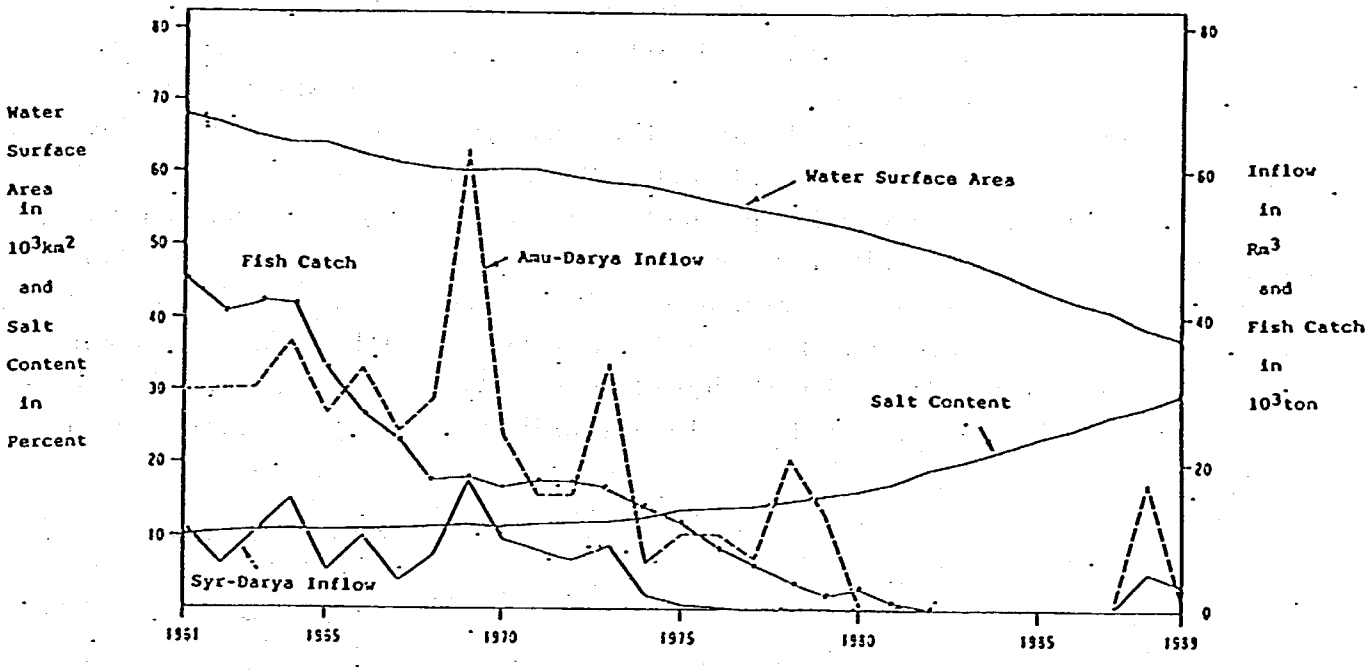


Fig. 4

DIMINISHING PROCESS OF THE ARAL SEA
AND
ENVIRONMENTAL IMPACT



Key to the Solution of the Aral Sea Problems

The impact of the environmental destruction of the Aral Sea affected five republics, inhabited by 37 million people. It is said that approximately 3 million residents in affected areas demanded emergency measures such as the supply of potable water and medicines. Additional mitigation measures are being provided by administrative means, such as reducing the area in cultivation or by the use of water saving cultivation methods to increase the flow of water into the lake, so that the existing conditions will not get any more serious. However, it is presumed that a long-term complete solution can only be obtained by the following drastic measures.

(1) Lining of water channels.

(2) Improvement of the water intake facilities.

(3) Construction of new drainage facilities.

(4) Reconstruction of water reservoir systems.

(5) Improvement of roads and communication networks.

It has to be concluded that this project could be developed on a sustainable basis with proper infrastructure improvement.

Prevention is Better Than Cure

The tragedy of the Aral Sea could have not been really unforeseen. Under the administrative systems of the former Soviet Union, research and investigation expenses were not authorized to those who criticized the policies of the central government. Project execution organizations were forced to devote into the fulfillment of their assigned norma. Briefly to say, checkup systems did not work at all. It is very ironic to see that centralized methods of promoting projects have broken down on such a large project, one that could only be planned by the centralized power. The most critical point here is the importance of advance preparations. There is a proverb in Japan saying that take a stick before you fall down. This means that those who often slip and fall should protect themselves with a stick to prevent the fall, because aged people not only slip and fall easily but a

fall can cause him to die in the worst case. Measures to prevent environmental problems can be effectively and economically taken if advance preparations are made. Some problems cannot be cured after occurrence, depending on the type of problem. There are various examples of advance preparations, but I am introducing here examples with which I was actually concerned.

Figure 5 shows three routes that were examined prior to determining the final route of the Indus Highway crossing the southern part of Pakistan. The first plan shows a route passing through a sanctuary in a national park. As a result of the environmental impact assessment made for this plan it was determined that the environment could be greatly affected. Two alternative plans were presented, one was a plan to widen and modify an existing route (N-55) and the other was for a new route passing by the east side of the national park. The widening and modification plan was finally adopted and the project was pushed forward.

Fig. 5 ENVIRONMENTAL CONSIDERATION IN PLANNING INDUS HIGHWAY PROJECT (PAKISTAN)

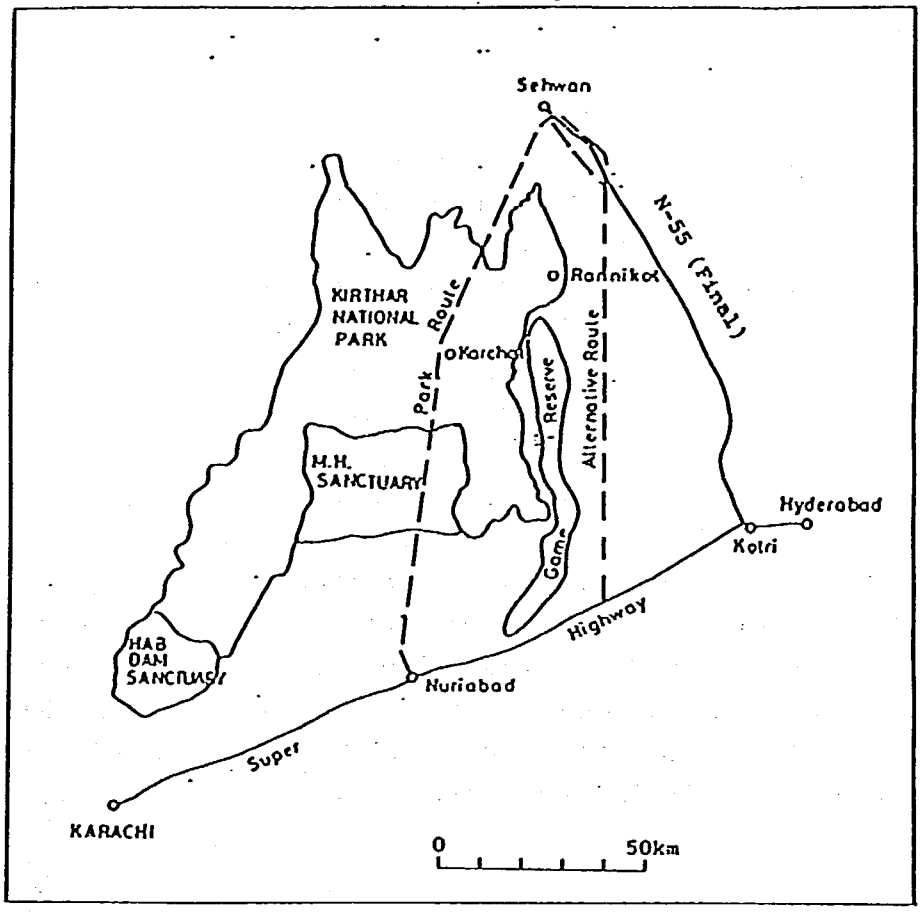


Figure 6 shows the Aceh River Diversion Channel in Sumatra, Indonesia. This diversion channel plan was proposed to protect the city area of Banda Aceh from frequent floods. The plan was made to divert the flow of floods to the ocean at areas 10 km upstream from the city, as shown. A preliminary plan proposed a diversion channel that discharges the flood flow into the lagoon in the northeast part of the city, but the results of the environmental impact assessment indicated that the following impacts might occur.

(1) The lagoon has characteristics making it suitable as a spawning ground for shrimp and milk fish. Local residents drive young fish into fish ponds at high tide to raise them for selling. If the flood flow is led into the lagoon after the diversion channel is completed, the salt concentration will be low and turbidity may increase significantly. These conditions are not favorable for the raising of young fish and it is feared that parent fish may not come back to the lagoon. Even with a diversion made only once every few years, adverse conditions could possibly remain there.

(2) As the bottom elevation of the diversion channel is designed to be lower than the high water level, sea water will come into the diversion channel, resulting in an increased salt concentration in groundwater on both sides of the floodway. This can affect the water used for drinking and irrigation.

In order to avoid the adverse affects described in (1) above, the design was modified so that the diversion channel does not open to the lagoon but extends to the ocean, as shown, with the channel passing through the lagoon protected with banks on both sides to separate it from the water in the lagoon. To avoid the problem described in (2) above, the design was modified to provide a tidal gate at the location indicated. The design was also devised so that the tidal gate can be used as a bridge to mitigate the affect on areas which would be separated by the extended diversion channel.

For complete advance preparations, manuals and guidelines are provided by organizations involved in improvement of the infrastructure throughout the world. During my service with the International Construction Technology Association, I wrote a draft of the Environmental Guidelines for Dam Construction Projects at the request of JICA in 1989 and supervised the work of preparing the JICA Environmental Guidelines for Infrastructure Projects, covering 13 sectors, including: port and harbor, airport, road, railway, river and erosion control, solid waste management, sewerage, groundwater

development, water supply, regional development, tourism development, transportation development, and urban transportation development, for the period from 1991 to 1992. These guidelines were prepared with the intention of providing a practical guidance for non-specialists in environmental problems so that they can screen and scope problems at an initial stage of project. For information purposes, I have included in figure 7 a scoping matrix that is common for all 13 sectors.

These guidelines are now being translated by JICA to be made available to all interested persons in the near future.

Fig. 6

ENVIRONMENTAL CONSIDERATION IN PLANNING ACEH RIVER FLOOD CONTROL PROJECT (INDONESIA)

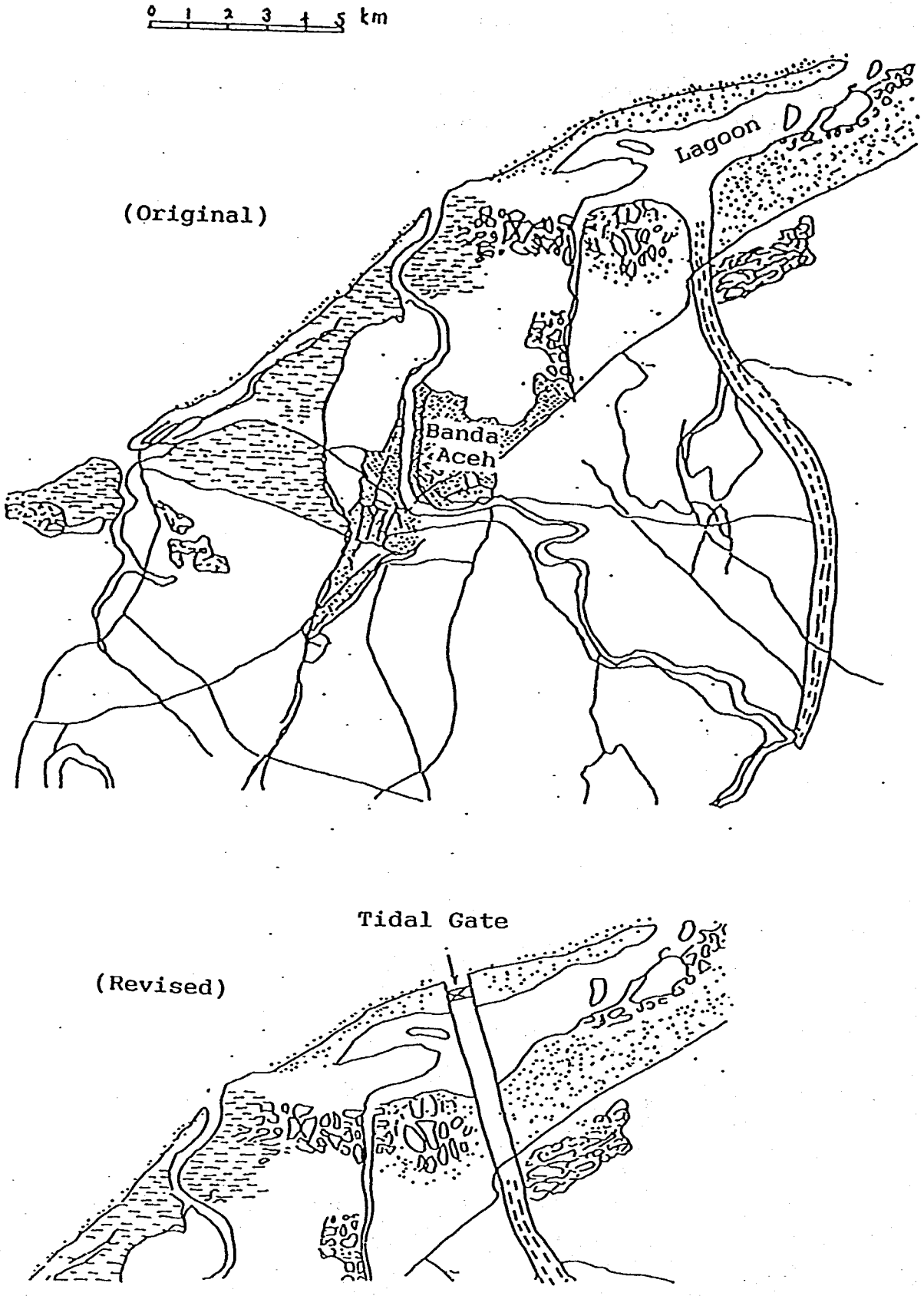


Fig. 7 Comprehensive Matrix for Scoping Guide (JICA Environmental Guidelines for Infrastructure Project)

		Project Type / Sectors / Environment Items	Sectoral Development									Comprehensive Development			
			1. Port and Harbor	2. Airport	3. Road	4. Railway	5. River and Erosion Control	6. Solid Waste Management	7. Sewerage	8. Groundwater Development	9. Water Supply	10. Regional Development	11. Tourism Development	12. Transportation Development	13. Urban Transportation Development
Social Environment	1	Resettlement	◎	◎	◎	◎	◎	○	○		○	○	○	○	○
	2	Economic Activities	○	○	○	○						○	○	○	○
	3	Traffic and Public Facilities	○	○	○	○	○	○				○	○	○	○
	4	Split of Communities		○	○	○	○					○	○	○	○
	5	Cultural Property	○	○	○	○	○					○	○	○	○
	6	Water Rights/Rights of Common	◎	○	○	○	◎			○	○	○	○	○	
	7	Public Health Condition				○		○				○	○	○	
	8	Waste	○	○	○	○	○	○	○			○	○	○	○
	9	Hazards (Risk)	○	○	○	○						○	○	○	○
Natural Environment	10	Topography and Soil Condition	○	○	○	○	○					○	○	○	
	11	Soil Erosion		○	○	○						○	○	○	
	12	Groundwater			○	○		○		◎		○			
	13	Hydrological Situation	○	○	○	○	◎	○			○	○	○	○	○
	14	Coastal Zone	◎	○	○	○	○	○				○	○	○	
	15	Fauna and Flora	◎	◎	◎	◎	◎	○	○		○	○	○	○	○
	16	Meteorology										○		○	
	17	Landscape	○	○	○	○	○	○	○		○	○	○	○	○
Pollution	18	Air Pollution	○	○	◎			◎	○			○		○	○
	19	Water Pollution	○	○	○	○	○	◎	○	○	○	○	○	○	
	20	Soil Contamination	○		○			○						○	○
	21	Noise and Vibration	○	◎	◎	◎	○	○	○	○	○	○	○	○	○
	22	Ground Subsidence								◎					
	23	Offensive Odor	○					◎	○			○		○	

Note: ◎ : The environmental items to which special attention has to be paid, because they might cause serious impacts that may affect the project formulation, depending on the magnitude of the impacts and the possibility of the measures.

○ : The environmental items which may give a significant impact depending upon the scale of project and site conditions.

No mark : The environmental items which require no impact assessment since the anticipated impacts are not significant.

In case of the comprehensive development projects, all the items are classified in ○, because their studies are usually at the master planning stage and extent of impacts are not clear.

4. Challenge to the Next Century

There are only six years remaining in the 20th century. The world is rapidly changing and it is difficult for anyone to predict what may occur in the next century. Even so, it can be presumed that the role of civil engineers will increase more and more towards the 21st century. The following can be important factors.

Increase in World Population

It is said that the world population will increase to 10 billion in the year 2035. Within one half of a century the present population may be doubled. In order for the increasing population to exist new resources may have to be developed and their effective use may have to be considered. If the population is doubled, damage from natural disasters can also be doubled. In order to cope with such conditions, the importance of water resources development and improvement of traffic facilities, disaster prevention facilities and other infrastructure facilities will continue to increase.

Increase in Environmental Problems

Environmental impacts can often be exposed with time. For example, environmental impacts accompanied by development projects exercised during this century, including the rise of sea water level due to the greenhouse effect, will gradually increase and it will become necessary to provide measures to cope with these problems. While the importance of infrastructure improvement increases as the population increases, difficulties for improvement of the infrastructure will more and more increase. To cope with such conditions, more advanced technical abilities covering diversified fields will be required for civil engineers. Particularly important for civil engineers is their mission to find sustainable engineering solutions, not just irresponsible quick-fixes for environmental problems. This is also related to the professional ethic of civil engineers.

Standard textbook solutions to environmental problems often cannot be applied to the diversified and complicated conditions that civil engineers may encounter. If serious floods occur some people would conclude, without making hydrological investigations, that the flooding occurred because trees had been felled in mountains. This can be due to ignorance or negligence as a

professional, or opportunism to a popular saying in the worst case. Either case is contrary to professional ethics. As far as I know, it has not been verified whether or not the effect of timbering is greater than the error in measurement of flood discharge. The cause and effect of environmental problems have not all been established. Common misconceptions are often considered to be based on definite theories without positive backup data. It is necessary to continue research and development with patience, to obtain scientific and quantitative solutions for the cause and effect of environmental problems.

Handmade Civil Engineering Projects

Civil engineering is a field of application of various fundamental theories with diversified features. It is often said that civil engineering's most significant feature is that the civil engineers will never produce the same thing again. The physical environment varies for bridges based on the same specifications if they are constructed at different locations. What is required for civil engineers is not the ability to make the same things, but the ability to meet different environmental conditions. Civil engineering structures may not be able to be manufactured on a mass production line even if the technology is further advanced and automation and energy saving techniques are advanced.

Evolution of International Cooperation

It is believed that the world population will increase mainly because of the population increase in developing countries. There are many countries where the population increase rate continues to exceed the economic growth rate. It is feared that these countries may remain at a level where the funds and technology required for infrastructure improvement cannot be secured without external assistance. Under such conditions, how can increasing demands for infrastructure improvements be dealt with only with assistance from the present developed countries ? It is believed that several Asian countries are now developing at a steady pace above the increase of population. I trust that the countries participating in this conference all belong to this category. These countries will fully achieve economic growth during the 21st century, and will acquire the strength to provide economic and technical support to all other developing countries. Otherwise, people of the world will face gloomy prospects for the 21st century.

International technical cooperation is necessary and effective also among advanced countries. While the world is moving towards borderless, the time is now approaching for civil engineers to take the great challenge joining hands together to support the existence and prosperity of human beings in the 21st century.

II. Socio-Economic Development and Construction Technology Transfer

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2.1 Economic Growth and Construction Technology

(1) *Meiji* Era (1868 through 1910)

To establish modern economic systems and to incubate modern industry, the *Meiji* Government set up currency and financial systems and inaugurated government-controlled projects such as armament and textile industries. These industries accelerated the improvement of transportation and communication systems as necessarily. For this purpose, priority was given to the construction of railways, low-water channel works to secure river transportation, and the spread of cable communication, among various improvements of the infrastructure. Since Japan had no modern construction technology at that time, the government employed foreign engineers from the United of Kingdom, Netherlands, Germany, and the United States, to construct tunnels, bridges, and railways, and to improve or construct rivers and ports for marine transportation. For example, all stages of surveys, design and field supervision were fully commissioned to foreign engineers for railway construction.

During the 10s of *Meiji* era (1878 - 1887), Japanese engineers who had learned from foreign engineers started to plan design and construction by themselves. The Osakayama Tunnel (completed in 1879, total length of 665 m), which was a representative project of this period, is the first tunnel completed by Japanese engineers. It can be determined that this tunnel was constructed by the blending methods of Western and Japanese styles, because excavation by man-power was Japanese traditional method, and using bricks for tunnel floors and the blasting of hard rock was accomplished by methods imported from the Western countries. The Lake Biwako Drainage Channel Works (completed in 1890) was the first large multi-purpose water development project constructed by Japanese with experience gained from foreign engineers using the advanced technology of that time, to accelerate the modernization of the old city of Kyoto. A water channel with a total length of 19.3 km, connecting the lake to the urban areas of Kyoto was constructed. This project provided a water resource capacity of 14 m^3/sec, a hydraulic power generation plant (initial output of 150 kW, improved to 1500 kW in 1989) and a canal for river boat transportation.

Railways were developed in a remarkable manner, as the first transportation system of modern Japan, and began with the opening of the Tokaido line between Tokyo and Kobe, in 1889. Total length of railways reached 8,000 km in 1907. Meanwhile, low-water channel works and canal works, which began in the early *Meiji* era for improvement of river transportation contributed to development of water resources as well as land reclamation, but did not achieve the purpose of flood control. Agricultural products had been seriously affected by repeated floods. In 1894, the River Law was enacted and it was prescribed that flood control plans for 10 major rivers would be made directly by the government. Since the Kanto and Tohoku regions received serious damage from unprecedented floods in 1910, the type of river improvement was switched to high-water channel works for the flood prevention. This change could occur mainly because the dominant transportation shifted to railway from river boat.

In addition, land taxation systems were modified and currency and financial systems were significantly improved in the *Meiji* era, and a capitalistic economy was steadily established. Bureaucracy and equal caste emerged, family registration offices were provided throughout the country, and a compulsory education system was enacted. It can be presumed that these systems became the foundation for the technical growth of Japan.

(2) From *Taisho* through *Showa* to End of World War II (1911 – 1945)

The Sino-Japanese War (1894), the Russo-Japanese War (1904), and World War I (1914–1918) affected greatly the economic structure of Japan. War reparations and emergency procurement demands resulted in the reforming of the industries of Japan from the light industries before the Sino-Japanese War to heavy industries after the Russo-Japanese War. During the period of World War I, heavy and chemical industries rapidly developed in a record war boom. However, the boom was over after the war and Japan faced to specie crisis in reaction to the sharp growth of the economy agitated by foreign bonds.

Traffic and transportation systems had been mainly relying on railways, but the Road Law was enacted in 1920 with the spread of automobiles and because their usefulness was recognized during World War I. Because of the enormous damage from the Kanto Earthquake in 1923 (approximately 140,000 persons missing or dead), which was mainly caused by the poor road networks in Metropolitan Tokyo, and because automobiles were actively used instead of railways which were closed during the period of postearthquake restoration, the importance of road improvement was recognized.

In response to these social situations, the Road Materials Testing Department was established in 1921, under the jurisdiction of the Ministry of Internal Affairs. This was renamed to the Civil Engineering Laboratory in 1922. This is the initiation of the Public Works Research Institute. Neither original standards nor testing methods were available in Japan at that time. Research activities of the Civil Engineering Laboratory started with gathering technical information from overseas countries, understanding, interpreting, and verifying gathered data by tests, and complementing the shortage of data. First studies were made on the effects of road surface conditions and the slope of roads on horse-drawn transportation, and on bituminous materials. After the Kanto Earthquake, the Civil Engineering Laboratory conducted postearthquake investigations placing emphasis on seismic engineering and made researches on the vibration and earthquake resistance of structures such as towers, suspension bridges and beams and girders, and on the earth pressures during earthquakes. Results of these investigations were compiled and published in the book "Earthquake Engineering of Civil Engineering Structures," which is still referenced as the basis of seismic design engineering. Construction of brick structures was prohibited in Japan after the Kanto Earthquake, because they were found extremely weak for earthquake.

However, priority was given to the strengthening of military power until the early years of the *Showa* era and the budget for civil engineering infrastructure projects was often reduced. This resulted in killing the chances for the development of new technology. Only the Kanmon Tunnel, connecting the main island and Kyushu Island by undersea tunnel, was a project of any significance constructed during that period.

The World Financial Panic of 1932 gave a strong blow on the economy of Japan, especially on local areas depending mainly on agricultural industry. The government provided road construction and river improvement projects to relieve jobless laborers in local areas. The first Road Law was enacted, and the second and third flood control plans were made at that time for promoting the improvement of the infrastructure. However, laws and plans were often made without financial backup at that time, most of them tasted the bitters of cancellation or reduction in size.

During World War II (1939 – 1945), the budget was mainly used for military spending and funds for improvement of the infrastructure were not available. Large-scale construction was not provided under the pressure of military spending. Construction works were mainly performed by man-power to secure jobs because of economic stagnation, and projects using large-scale plant and equipment were not accomplished.

Figure 1 shows the history of infrastructure investment for railways, roads, rivers, ports and harbors, and erosion controls during the time before World War II. It can be seen that transportation investment was made mainly on railways during the period from the early years of the *Meiji* era to World War I, but road investment got ahead of railway investment during the early years of the *Showa* era.

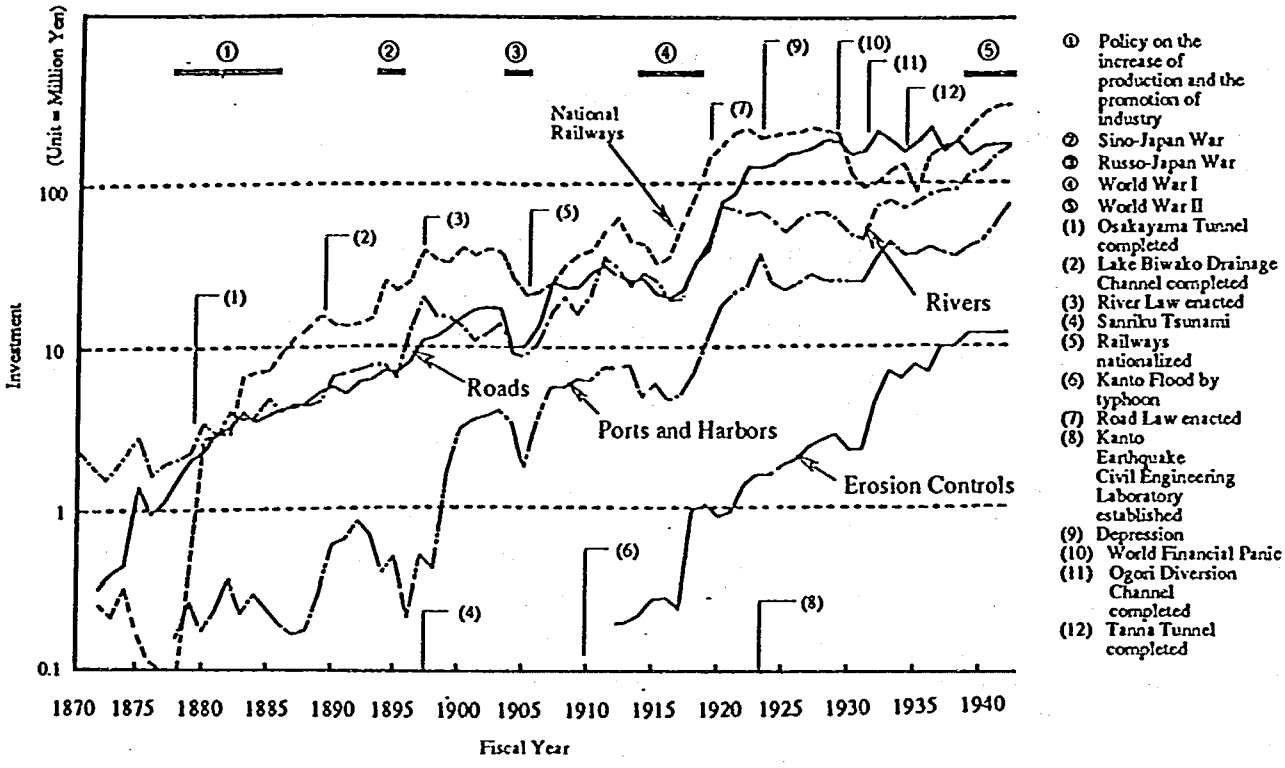


Fig. 1 History of Infrastructure Investment for Different Facilities (Pre-World War II)

(3) Period of Postwar Restoration (1945 – 1955)

Soon after the end of World War II, large typhoons repeatedly hit Japan and caused serious flood damage. The damage could very well have been caused because infrastructure investment was ignored during the war. Therefore, priority was given immediately after the war to flood control measures to respond to the requests for an increase in food production.

The postwar economy of Japan took a favorable turn in about 1950. To correspond to the special procurement demands of the Korean War, equipment and machines of the latest model were imported and heavy industries were rapidly improved. For this reason, the demand for electric power rapidly increased and a number of large-scale dams were constructed, resulting in the generation of road and bridge construction projects. Concurrently, the Multiple Purpose Development of the Land Act enacted in 1950 and the Law for Promotion of Electric Power Development enacted in 1952 accelerated the construction of multi-purpose dams having the functions of flood control, water development, and hydraulic power generation.

Technology imported from overseas countries, and that from the United States in particular, has greatly influenced construction systems in Japan. The machine construction technology from the United States completely changed construction sites of Japan. Using the new technology, the Sakuma Dam with a height of 150 m was completed within only 28 months in 1956. Technology imported from the Western countries during this period has occupied an important position for the development of original technology of Japan in the next generation.

For the construction of the Wakato Bridge, the first long span suspension bridge in Japan, various investigations and tests were made for approximately two and a half years by aggregate power of Japan, including the Public Works Research Institute and universities, to complement the shortage of experience in similar construction and to provide designs resistant to earthquakes and typhoons that are peculiar to Japan. The successful completion of the Wakato Bridge in 1958 has enabled other long-span bridges to be constructed such as the Honshu-Shikoku Bridges that include one of the longest suspension bridges in the world.

(4) Period of Rapid Growth (1955 – 1975)

The postwar economy recovered and in 1954 the GNP regained its pre-World War II level. The economy of Japan entered into a period of rapid growth, represented by the Income-Doubling Program (1960). During this period, both the legal systems and financial systems were improved, and five-year plans were executed in various fields. As a result of various policies and measures that were provided, the growth rate of the annual average GNP reached 10% during the 30s of *Showa* era (1955–64). The rate of vehicle ownership rapidly increased, and road improvement and construction projects were realized and accelerated. The Meishin (Nagoya–Kobe) Expressway and the Tomei (Tokyo–Nagoya) Expressway, constructed along with the Tokaido *Shinkansen* (bullet train) in the latter half of the 30s of *Showa* era (1960 –), were identified as the first step towards the construction of a high-speed transportation network. These became the arterial roads that were absolutely necessary for implementation of the New Industrial Cities Construction Master Plan (presented in 1965) for promoting the development of industries in regional areas throughout the country. In 1964, the new River Law was enacted to develop and control rivers regionaly, and a new flood control project which deals with river systems consistently was started.

During this period, Japanese original technology was created to construct large-scale structures, supported by technical innovation in various industrial fields other than civil engineering, including steel, machinery, and computers. The Honshu-Shikoku Bridges and the Seikan Tunnel are representative examples. In addition, large-scale projects, such as the Kansai International Airport, the Trans-Tokyo Bay Highway, the Tohoku *Shinkansen*, Joetsu *Shinkansen*, the Kan-etsu (Kanto-Echigo) Expressway, and the Tohoku Expressway, were planned during this period, some of which are now being opened in traffic and others being under construction.

However, the strain of the vigorous economic growth started to occur at various places in the 40s of *Showa* (1965 – 1974). *Minamata* disease and *itai-itai* disease, caused by wastewater from industrial factories and mines, river water pollution, photochemical smog, air pollution, and traffic noise, are the environmental pollution effects which represent this period. In response to the demands of the times, the Public Works Research Institute established new divisions, including Urban River Division, Traffic Safety Division, Water Quality Division, Traffic Environment Division, and Advanced Wastewater Treatment Division. They banded together to seek solutions to these problems affecting the society, in addition to their main studies on the development and rationalization of civil engineering technology.

(5) Period of Steady Growth (1975 – Present)

The dollar crisis (1971) and the oil crisis (1973) applied brakes on the rapid economic growth of Japan and forced substantial changes in the economic structure. The economy of Japan moved towards steady growth thereafter. As a result of rapid growth, the national gross income increased and the living standards of the people significantly improved. The infrastructure investment has changed its direction towards the infrastructure for improving people's lite from the infrastructure for industrial development during this period of steady growth. The trend of the public has began to place importance on environmental and urban problems.

In 1980, the Tsukuba Science City was mostly completed as a national project. This plan aimed to provide a new city as base for promoting and developing science and technology, academic research, and high-level education, by moving or constructing national research institutes and educational institutes, for the purpose of mitigating the population overconcentrated in Tokyo. At present, more than 200 private research institutes have moved to Tsukuba, in addition to approximately 50 national research and education institutes, and researchers from the government, academic groups and industries participate in diversified research activities.

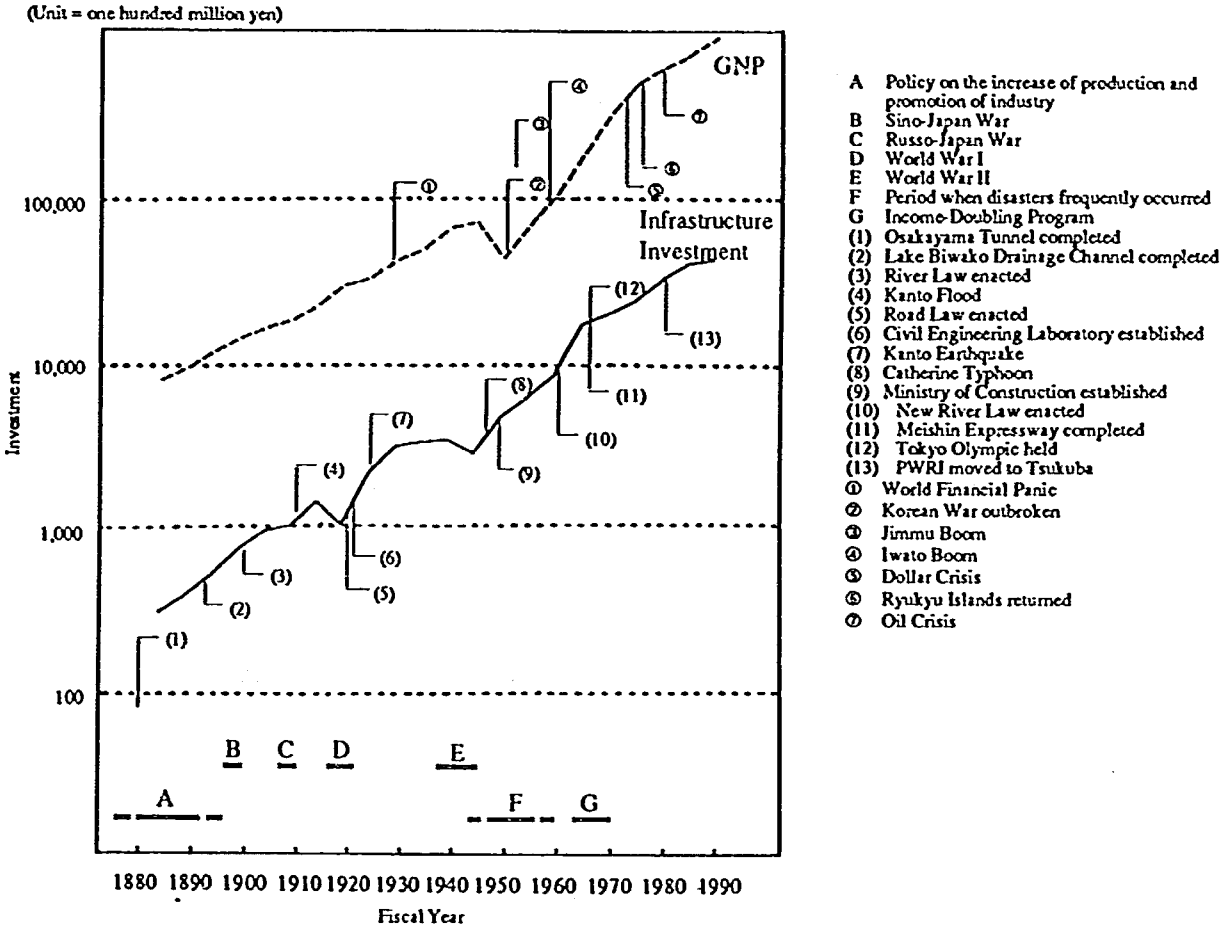
For the seven year period after 1982, the general account budgets for public works were limited to below the level of the previous year under the slogan of financial reconstruction. This is the beginning of the time of the so-called zero-ceiling or minus-ceiling budget. During this period the GNP increased at an average rate of 3.7% but the infrastructure investment increased only 1.4% on an average. It can be concluded that the infrastructure investment fell greatly behind economic and social demands.

In 1990, the 10-year Public Works Investment Program was planned as a result of Japan-U.S. Structural Impediments Initiative (SII) talks. This program was planned to make public works investment in a gross amount of 430 trillion yen, equivalent to 1.6 times the gross investment for the previous decade, during the period from 1991 to 2000. The budget is scheduled to be allocated laying stress on the infrastructures of living-related facilities such as sewer systems, city parks, housing and residential districts, local roads, planting for roads and rivers.

The expansion of infrastructure investment for the improvement of quality of national life is now strongly expected by the people. Problems such as the intensified use of national land by constructing expressways based on newly modified standards and large bridges, the provision of safe living conditions, such as free from dangers of volcanic eruptions and other natural disasters, the harmony with the environment, new construction technology corresponding to changes in the aging and the shortage of man-power of construction industry, development of new materials, and the needs for new technology for maintenance of the infrastructure, are becoming important.

Figure 2 shows the history of the relationship between the GNP and infrastructure investment from the *Meiji* era to the present time. The amount of infrastructure investment is generally proportioned to the increase of GNP. According to socio-economic development, additional demands for the infrastructure have been generated, and construction technology has developed as necessary. Figure 3 shows the history of infrastructure investment made in different fields after World War II. It can be seen that investments for river improvement

increased for the short period after the war, but priority was generally given to the improvement of roads. In can also be seen that the amount of investment rapidly increased for all fields until 1975. The investment for railways decreased after 1980 because the national railway system was turned over to private firms.



A Policy on the increase of production and promotion of industry
B Sino-Japan War
C Russo-Japan War
D World War I
E World War II
F Period when disasters frequently occurred
G Income-Doubling Program
(1) Osakayama Tunnel completed
(2) Lake Biwako Drainage Channel completed
(3) River Law enacted
(4) Kanto Flood
(5) Road Law enacted
(6) Civil Engineering Laboratory established
(7) Kanto Earthquake
(8) Catherine Typhoon
(9) Ministry of Construction established
(10) New River Law enacted
(11) Meishin Expressway completed
(12) Tokyo Olympic held
(13) PWRI moved to Tsukuba

Fig. 2 History of Relationship between GNP and Infrastructure Investment

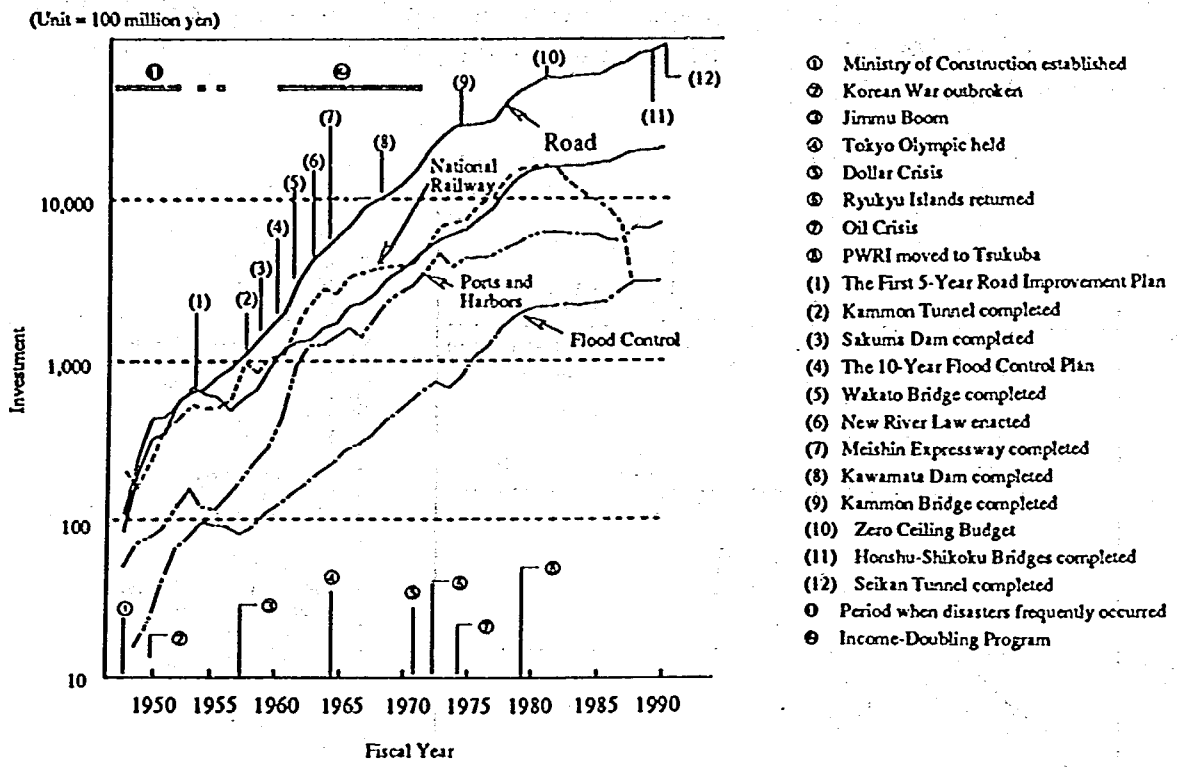


Fig. 3 History of Infrastructure Investment for Different Facilities (Post-World War II)

As an index to show the progress of technology development, it can be pointed out that the size of structures has drastically expanded. Figure 4 shows the increasing length of bridge spans. Major reasons for the increase in size of structures can be explained by the improved welding techniques, development of high strength steel, and improved methods of design and construction of foundations and superstructures. These are typical examples of technology development which started with the introduction of advanced technology from the Western countries and which has reached the level of creating original technology. Advanced construction technology has been obtained also from all industries related to civil engineering, and is used to satisfy the natural, social and economic demands of Japan.

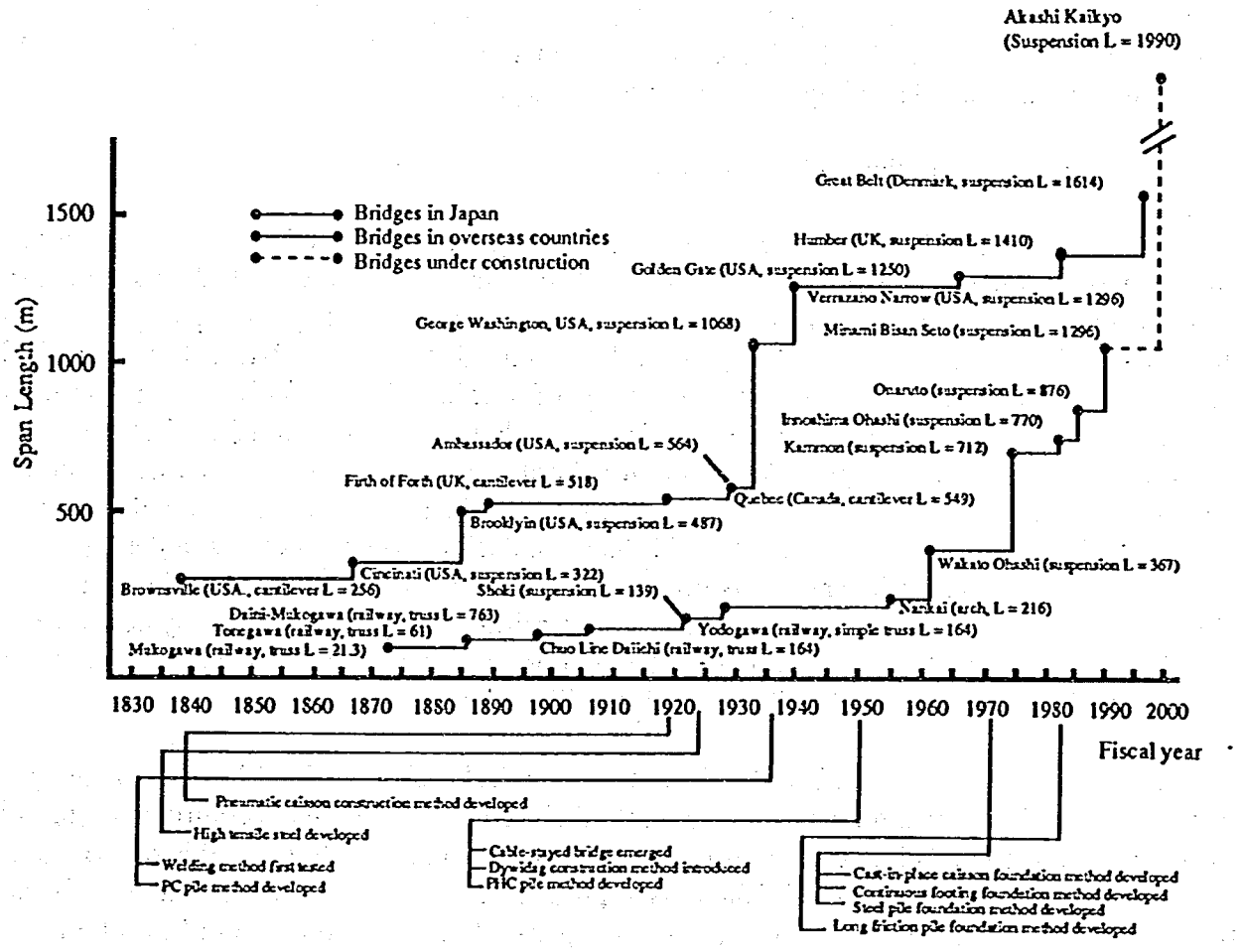


Fig. 4 Increasing Length of Bridge Spans

2.2 Major Factors for Development of Construction Technology in Modern Japan

Following can be pointed out to be major factors that have enabled steady development of construction technology in Japan.

(1) Systems for Technology Transfer as a National Policy

During the early years of the *Meiji* era, Japan made great efforts for construction of a modern capitalistic country and there were systems that positively accept advanced technology and operating systems from advanced capitalistic countries. The government deliberately invited foreign engineers, concurrently sent the elite to study in overseas countries and

vigorously absorbed advanced technology. The government opened schools and improved educational foundations. The knowledge learned from foreign engineers and information obtain in overseas countries were steadily handed over to university graduates and have been transmitted to following generations.

Newly developed knowledge and technology have turned to practical technology through repeated trial and error tests on site, and methods of theoretical analysis and the skills of experimenting, based on reasonable concepts, have greatly improved. Results obtained have been published in various technical standards, manuals and specifications, and have been disseminated widely from individuals and groups to the whole country and became national technical standards. These activities were exercised as a national policy, mainly by national research institutes such as Public Works Research Institute and universities, and have greatly contributed to the spread and improvement of technology.

(2) Improvement of Technical Education Systems

The fact that excellent engineers were steadily being produced by educational facilities is a major reason for the rapid development of civil engineering technology. In 1871, the Ministry of Education was established and a modern concept of achieving equal opportunity of education for all people was presented, taking examples from advanced countries. The first civil engineering education began at the University of Engineering, established in 1873, as recommended by Morel, a British engineer. Thereafter, high class educational institutions, such as Tokyo University and Sapporo Agricultural School, were opened. Instructors were foreign engineers at that time and Japanese students experienced difficulty in understanding the lectures spoken in English. In 1884, the Ministry of Education decided to give lectures in the Japanese language instead of English. This decision was greatly effective for the increase in number of skilled engineers in various fields. Primary and middle class educational systems were established by opening technical schools for the purpose of educating technicians who had been assigned under engineers, and for disseminating skills to lower levels.

After World War II a number of universities, technical high schools and technical colleges were established. Many engineers were sent into the society and they have contributed greatly to the development of civil engineering technology in Japan. Technical high schools and technical colleges, as training establishments to produce human resources to be the foundation for industrial development, were absolutely indispensable for the education of middle class engineers and technicians with advanced scientific knowledge.

(3) Improvement of Research and Development Systems

The Public Works Research Institute has taken the lead for research and development since its establishment in 1922, together with fundamental studies covering various fields of civil engineering, and has responded to the economic and social demands of Japan as a central research institute of civil engineering technology. Results of research by the Public Works Research Institute, including studies on seismic engineering made in the *Taisho* era, the bed load transport formula for rivers developed after World War II, methods of soft ground improvement, and technology of constructing roads and bridges recently developed, were composed the basis of technology for improvement of the infrastructure in Japan. The Public Works Research Institute also played an important role in the education of engineers, both inside and outside the Ministry of Construction.

Before World War II, theoretical and fundamental research and development was made by the Public Works Research Institute mainly and development of applied technology was made at construction sites with projects controlled directly by the Ministry of Internal Affairs. After the war, as the number of public works projects increased, construction works has been carried out in contract basis, in most cases, and research and development has been started by large construction corporations based on government recommendations and encouraging policy for promoting research and development in private sector. In particular, research laboratories of various corporations have been engaged actively in development of applied technology. All phases of planning, research and development, and construction have been executed systematically by the government, academic groups, and industries. All researchers from them have always cooperated in an attempt to solve problems, placing importance on field experience.

As research laboratories of private industries have been developed, the Public Works Research Institute has played an important role in linkage of the government, academic groups and industries as a mediate agent between universities responsible for academic research and industrial laboratories mainly responsible for field applicational studies. In private firms, departments of construction and design having been separated, research laboratories of general contractors and design engineering consultants have been specialized and intensified, respectively. In addition, steel, heavy chemical, and machine industries have been strengthened and they have participated in development of civil engineering technology. Along with the development of the construction industry, development of technology for construction materials and construction methods has been accelerated.

Systematic research projects enhanced by the government, academic groups and industries are one major factor for the rapid development of construction technology.

(4) Improvement of Various Systems

After World War II, the government of Japan pushed forward with five-year plans in various fields and systems and laws for securing funds for improvement of the infrastructure. In addition, the Public Corporation Law was enacted and a number of public corporations were established so that they can run the business by themselves under the toll systems. Financial loans and investment systems (systems that furnish loans to government-related organizations funded by postal savings, postal insurance, and national pensions, for infrastructure projects) contribute to the securing of stable funds for public works projects.

In Japan, the Comprehensive National Development Plan has been carried out since the first phase, started in 1961, to the fourth phase, presently underway, to push forward development projects in consistency with socio-economic changes and the variable demands of the public. This program is designed to assure comprehensive solutions for social problems of the times, for uniform development of national land, and for creating affluent environmental conditions. This concept is now recognized as the basic concept for improvement of the infrastructure.

The government has provided tax advantages for research and development expenses in private industries and has modified laws to open ways of making joint research by the governments and private companies. When large-scale projects are executed, the government takes the lead in helding committees for planning and design works to introduce fundamental knowledge from universities, and directs the promotion of applied construction technologies by

private companies. Through these systems, aggregate technical power of the times was successfully mobilized from various fields.

The modification of laws and systems mentioned above has played a very important role in efficient progress of carrying out systematic development and conservation of national land.

3. Infrastructure Improvement in Various Asian Countries

Asian countries have been developing rapidly for the last 20 to 30 years, but many countries still have difficulties in providing the required infrastructure with their own human resources, technology and funds. Many of those countries depend on economic cooperation and technical assistance furnished by industrialized countries for implementing their infrostructures. Since their infrastructure improvement is way behind their rapid growth, social problems such those in major cities and environmental problems have become significant.

Improvement states and issues of the infrastructure in Asian countries will be analyzed here by the infrastructure cotegories.

3.1 Economic Conditions of Various Asian Countries

There are various countries and territories in the Asian Region, as shown in Table 1; ranging from the lowest income countries with GNPs per capita of only about $200 such as Myanmar, Cambodia, Vietnam, Laos, Nepal and Bangladesh; low income countries such as India ($330 per capita), China ($370 per capita), Pakistan ($400 per capita), and Sri Lanka ($500 per capita); medium income ASEAN countries such as Indonesia ($610 per capita), Philippines ($740 per capita), Thailand ($1,580 per capita), and Malaysia ($2,490 per capita); to countries called "NIES" which have developed rapidly, such as Korea ($6,340 per capita), Taiwan ($8,000 per capita), Singapore ($12,890 per capita), and Hong Kong ($13,200 per capita). As briefly described, the Asian Region consists of countries of various stages of economic developing.

Countries in this region are generally blessed with rich natural resources and have economic structures to acquire foreign currency through the export of primary products, to import capital goods and intermediate goods by the acquired foreign currency, and to reexport products manufactured from imported goods. Among various countries, NIES countries and territories are introducing the economic structure of heavy chemical industry and/or high-tech industry.

The lowest income countries with per capita GNPs of approximately $200, are represented by Myanmar and Cambodia with inconstant political backgrounds, by Vietnam and Laos with planned economies based on socialism that have started to move to market economies, and by Nepal and Bangladesh that often suffer serious damage from natural disasters. The 1991 economic growth rate of these countries was ranging from 2.0 to 5.6% to the previous year, but the inflation rate was extremely high, from 8.2 to 67.6%, because the countries had large trade deficits and an unstable economy.

Table 1 Economic Conditions of Asian Countries (1991)

Country or Territory	Population (10^6)	GNP (US10^6)	GNP/capita (US$1)	GDP (%)	Inflation Rate (%)	Trade Balance (US10^8)
Cambodia	8.7	1,725	200	n.a.	n.a.	n.a.
Sri Lanka	17.2	8,665	500	4.8	12.2	Δ 10.2
Hong Kong	5.9	77,302	13,200	4.2	12.0	Δ 16.8
India	865.0	284,688	330	2.5	13.9	Δ 27.8
Pakistan	115.6	46,725	400	6.5	11.8	Δ 29.1
Thailand	56.7	89,548	1,580	8.2	5.6	Δ 97.1
Nepal	19.1	3,289	180	2.0	8.2	n.a.
Laos	4.3	965	230	n.a.	n.a.	n.a.
Malaysia	18.3	45,787	2,490	8.6	4.4	Δ 23.4
Bangladesh	108.8	23,449	220	3.6	8.9	Δ 18.0
China	1,150.1	424,012	370	7.3	2.9	81.2
Korea	43.2	274,454	6,340	8.4	9.7	Δ 96.6
Singapore	3.0	39,249	12,890	6.7	3.4	Δ 71.3
Philippines	62.7	46,138	740	Δ 0.9	17.7	Δ 32.0
Indonesia	181.4	111,409	610	6.6	9.4	32.7
Vietnam	67.8	5,016	200	3.8	67.6	Δ 4.0
Taiwan	20.2	161,539	8,000	7.2	3.6	133.2
Myanmar	42.5	n.a.	200	5.6	34.0	Δ 5.7
Japan	124.0	3,337,191	26,920	4.0	3.3	1,031
U. S. A	250.9	5,445,825	21,810	Δ 1.2	4.3	Δ 736
U. K.	57.5	923,959	16,080	Δ 2.2	5.9	Δ 180
France	55.5	1,099,750	19,590	1.2	3.1	Δ 101
Germany	77.3	1,411,346	22,360	3.6	4.5	231

(Notes)
- GNP and GNP/capita of Germany show those of the former West Germany only.
- Data of Nepal is based on that of 1990.
- Population, GNP and GNP/capita of Taiwan are based on those of 1990.
- GNP/capita of Myanmar is based on the data of 1986.

For the low income countries with per capita GNPs from $300 to $500 except for Sri Lanka, the gross national product is high, but on a per capita basis is very low because the total population is quite large: for China (1,150 million persons), India (865 million persons), and Pakistan (116 million persons). The 1991 economic growth rate is comparatively high, from 4.8 to 7.3%, except for India with 2.5%. The inflation rate is comparatively high, from 11.8 to 13.9%, except for China with 2.9%. These countries all have a deficit trade balance, except for China. In China, prices are significantly stable, the trade balance is favorable and the economy is rapidly growing. In coastal areas of Kuangtung Province in particular, there are close and active trade and investment relationships with the adjacent countries of Taiwan and Hong Kong. This South China Economic Zone has achieved rapid economic growth.

The medium income ASEAN countries have achieved rapid economic growth with active introduction of foreign currency and export encouragement economies that have contributed greatly to the growth of internal economies and political stabilization. These countries are attracting world attention as areas of rapid economic growth. The 1991 economic growth rate of ASEAN countries is very high, from 6.6 to 8.8%, except a minus 0.9% of Philippines, of which economy is still influenced by political disorder for the previous decade and is emerging from the worst of times. The inflation rate is comparatively stable, within the range from 4.4 to

9.4%; except for the Philippines, which has a rate of 17.7%. Trade balances are deficits, except for Indonesia, which has oil and natural gas resources.

NIES countries and territories have developed significantly throughout the world. The per capita GNP is very high and their 1991 economic growth rates are high, ranging from 4.2 to 8.2%, and the inflation rate is stable, ranging from 3.4 to 12.0%. These countries have deficit trade balances, except for Taiwan.

3.2 Railways

Table 2 shows the population, the per capita GNP, railway density, total length of railways, double-tracking ratio, and electrification ratio of Asian countries.

Table 2 Current Railways in Asian Countries

Country	Population (1988) [10^6]	GNP/capita (1991) (US$)	Railway Network Density (length km/area km^2)	Total Length (km)	Double-tracking Ratio (%)	Electrification ratio (%)
Sri Lanka	16.6	500	0.0221	1,423	7.0	
India	815.6	330	0.0182	61,813	22.0	13.2
Pakistan	106.3	400	0.0110	8,774	11.8	3.2
Thailand	54.5	1,580	0.0073	3,834	2.4	
Malaysia	16.9	2,490	0.0127	1,668	0.5	
Bangladesh	108.9	220	0.0199	2,792	8.2	
China	1,088.4	370	0.0052	52,611	21.3	8.8
Korea	42.0	6,340	0.0325	3,130	25.9	14.9
Philippines	59.9	740	0.0035	771	4.4	
Indonesia	174.8	610	0.0037	6,701	2.5	1.5
Vietnam	64.4	-	0.0079	2,604	1.2	-
Myanmar	35.3	-	0.0047	3,186	12.8	
Japan	122.6	26,920	0.0563	18,984	31.1	50.0
France	55.9	20,600	0.1100	34,563	44.8	34.7
U. K.	57.1	16,750	0.0694	16,937	69.7	25.9

It can be seen that the railway density is higher in countries that had been strongly relationed with the United of Kingdom such as Bangladesh, India, Korea and Sri Lanka. Railway density is very low in China, which has extensive land areas, but the total length, double-tracking ratio and electrification ratio are at the top level of Asian countries. The double-tracking ratio and electrification ratio of India are high, as are those of Korea.

Railways in Asian countries suffer from several problems. The item "operating factor" shown in Table 3 is the expense ratio required for railway fare. It is the factor of expense necessary for earning a railway freight charge of 100 dollars. If the operating factor is less than 100, the business is favorable, but if it exceeds 100 the business is operating at a deficit. Only two countries, India and China, are operating favorable railway businesses in Asia, followed by Malaysia and Korea that are operating slightly below the black ink figure.

Table 3 Operating Factor, Schedule Time Arrival Rate, Number of Accidents and Its Occurrence Rate in 1987

Country	Operating Factor (%)	Schedule Time Arrival Rate (%)		Number of Accidents (derailment + collision)	Rate of Accident Occurrence Accident/K km
		Passenger	Cargo		
Sri Lanka	223	55.0	37.0	57	7.6
India	92	85.0		566	1.0
Pakistan	124	90.7		94	1.8
Thailand	127			86	2.8
Malaysia	100	18.3	19.6	53	6.5
Bangladesh	156	63.2		210	12.0
China	61				
Korea	100	96.0		14	0.2
Philippines	170	13.0		78	65.0
Indonesia	136	15.0	8.0	71	2.2
Vietnam	111				
Myanmar	169	54.2		122	12.4
Japan JRH	159				
JRE	95				
JRC	93			22	0.03
JRW	90				
JRS	142				
JRK	122				
JRF	93				

A deficit balance is caused mainly by the negligent operation of a government-controlled public agency, that often ignores the balance of profit and loss. The other reason is that the railway is way behind other transportation media, including automobiles, because of inefficient operations and delays in technical innovation. These factors can exacerbate a deficit operation. In India and China, the railway system is being operated favorably. The reason for this could be because transportation media other than railway have not developed sufficiently.

Other considerations are the safety and reliability of railways. As shown in Table 3, accidents occurred at the very low rate of 0.03 for every million railway kilometers for the railways of Japan; while in other Asian countries accidents occurred at the rate of 10 to 1,000 times that of Japan. The safety rate in Korea is next to Japan, but the rate of accident occurrence is 0.2, seven times that of Japan. The rate of accident occurrence in Philippines is 65, and this is very unusual. This is approximately 2,000 times that of Japan. Railways with a high rate of accident occurrence are naturally low in reliability. The use of railways decreases accordingly. Schedule time arrival rate ranges from 85 to 96% in Korea, Pakistan and India, but it ranges from 13 to 15% in Indonesia and Philippines. The balance of business is excellent in countries where the schedule time arrival rate is higher. For example, the operating factor of Korean railway is 100 and its schedule time arrival rate is 96%. It can be seen that trains arrive nearly as scheduled there. The schedule time arrival rate in India with favorable operation is 85%. Unless the schedule time arrival rate exceeds 70% a railway cannot assure reliability and can lose users.

Asian railway problems that must be solved in the future includes safe operation, operating with reliable schedules, and stabilized business operations. Safe operation not only improves the reliability, but can stabilize business operations. And for major cities in the metropolitan areas of Singapore, Philippines and Indonesia, urban railways, including subways, can be an effective measure for solving heavy traffic congestion.

3.3 Roads

It can be concluded that road coverage conditions in Asian countries (see Table 4) have a close relationship with the economic conditions of each country. Hong Kong and Singapore have highly improved roads with paved road ratios of over 90%. It can be concluded that these two countries have been highly developed. Conversely, paved road ratios are very low in Myanmar, Laos and Nepal. The ratio is below 10% in Laos.

Table 4 Road Coverage Conditions in Asian Countries

Country	Total Length of Roads (km)	Total Length of Road/Capita (km/capita)	Total Length of Road per 1 km^2 (km/km^2)	Pavement Ratio (%)	Surveyed Year
Sri Lanka	24,752	1.63	377	79.7	1982
Hong Kong	1,244	0.24	1,185	100	1983
India	1,357,784	1.91	413	52.3	1982
Pakistan	94,987	1.09	119	68	1983
Thailand	159,618	3.29	311	18.9	1983
Nepal	5,546	0.36	39	44.8	1983
Laos	7,395	2.27	31	8.4	1974
Malaysia	30,412	2.76	92	79.6	1983
Bangladesh	161,359	1.75	1,121	9.5	1984
China	915,079	0.90	90	77.1	1983
Korea	54,599	1.39	553	39.0	1983
Singapore	2,568	1.04	4,382	92.3	1983
Philippines	155,798	3.07	519	12.8	1983
Indonesia	182,882	1.20	96	63.6	1983
Myanmar	22,471	0.70	33	36.5	1978
Japan	1,123,283	9.46	2,974	53.3	1983

When discussions are held on the road problems of Asian countries, such problems should be classified into three groups, depending on the economic condition of each country. The reason for this is because problems vary, depending on the economic conditions. Lowest income countries such as Laos, Bangladesh and Myanmar, and countries such as India and China which rely on railways for transportation should be classified into the first group. In these countries, motorization has not fully developed, but it is necessary to improve road networks if rapid economic growth is to be expected in the future. Securing necessary funds for road improvement, improvement of arterial highways throughout the country, and especially construction of large structures, including bridges, are the problems.

Thailand, Malaysia, Indonesia, and Philippines should be classified into the second group. Motorization has widely developed in these countries, and it is presumed that it will continue to develop in the future. Traffic congestion is already occurring in these countries. It is necessary to not only maintain the existing roads, but additional roads, including expressways, large scale transportation media in urban areas, and high-standard highways for local areas are required. These countries face to the phase necessary for the secondary road improvement. To secure funds for these objectives is the problem. A part of the cost of road improvements is obtained from toll road systems or private funds, and such measures are being studied, but the following public consensus is strong objections; establishment of road fees for the installation of toll roads, governmental guarantees for incomes of private companies which provided their roads, official guarantees for companies bonds to raise funds.

Finally, NIES countries and territories, such as Singapore, Hong Kong, Taiwan, and Korea, should be classified into the third group. The infrastructure has been fully established in these countries, and high standard roads have been provided. Expressways are also actively being improved, and these countries and territories face traffic congestion and traffic safety problems, in addition to issues of keeping amenity and planting along the roads similar to those experienced by industrialized countries. According their economic growth, the third group can also suffer from traffic noise and air pollution caused by exhaust gases.

3.4 Water Quality Preservation and Sewer Systems

In Japan, water pollution caused by contaminants discharged from mines and factories had developed in a certain trend for the period of approximately 100 years, starting with the initiation of the modernization policy, but mitigating measures were steadily provided for each type of water pollution found. However, developing countries are trying to achieve modernization within 20 to 30 years, compared to the efforts made by Japan for 100 years. As a result, conventional water pollution caused by the mining industry and related industries, and pollution caused by modern industries or high-tech industries are concurrently occurring. Particularly, deterioration of river water quality in urban areas is becoming a hot issue. In Japan and other Asian countries, wastewater has been treated by natural cleaning of river water. However, it cannot be expected that natural river water will continue to provide this cleaning, as industries and population have become densely concentrated in urban areas. Environmental problems, including water pollution in rivers and oceans and the effects on human bodies, are a growing concern.

In various Asian countries, water supply systems have not been widely constructed, even in capitals. Low income people in particular often live under poor living environments and use contaminated river water without purification for drinking. Since the spread of water supply systems has a great effect on the health of people, systems should be actively improved. Water supply systems are way behind traffic networks, including roads. There are some countries where water quality standards have not been achieved because the source water is polluted, even if water supply systems are complete. Wastewater from industrialized chemical plants, feces and urine from stock farms, and contaminated water from refuse disposal plants tend to pollute soil and groundwater.

Current conditions of sewer systems in Asian countries are shown in Table 5. Sewer systems are complete in over 90% of the areas in Singapore and Hong Kong, but many countries have just started to provide sewer systems, beginning in the cities. At present, the area coverage of sewer systems ranges from several percent to 30% in capitals and major cities of Thailand, Malaysia and Taiwan. Efforts are being made in Taipei to improve the area coverage to 42% by 2007, and in Bangkok to 30% by 1997.

Table 5 Current Conditions of Sewer Systems in Asian Countries

Country	Spreading Rate of Sewer Systems		Modification Plan and Current Problems
Hong Kong		90% or more	
Thailand		0.5%	Since sewer systems are not existing in Bangkok at present, efforts are being made to increase the spreading rate to 30% by 1997.
	Urban areas	2.7%	
	Local areas	0.02%	
Malaysia		10.7%	
	Kuala Lumpur	approx 30%	
Bangladesh	Major cities	20%	
	Rural areas	6%	
Singapore		95%	
Indonesia	Lavatories in urban areas	38%	Plans have been made to increase the spreading rate of sewer systems in major cities to 0.6%, the use of simple water-purifier tanks to 50% in major cities and 35% in local areas in 1994.
	Lavatories in local areas	25%	
Taiwan		3%	
	Taipei	17%	
	Target in 2007	42%	
Japan		47%	
	Metropolitan Tokyo	90%	

In Malaysia, master plans of sewer system were made in the 1980s for 16 cities, and public sewage treatment plants have been completed for three cities. Since existing plants have employed a simple method of treatment, they are not suitable for more complicated treatment and cannot discharge clean water as expected. In Indonesia, sewer systems are way behind because the importance of public health has not been widely understood, priority was not given to sewage treatment plants by local governments, and funds were short for construction of sewer systems. Recently, investigations for planning and construction of sewer systems are gradually being implemented in 10 major cities, with grants-in-aid from international organizations and foreign countries. The spreading rate of sewer systems per capita for major cities is intended to reach 0.6% in 1994. The spreading rate per capita of simple treatment by water-purifier tanks is intended to be 50% in major cities and 35% in local areas.

In Asian countries, people have gradually begun to understand that the city life is supported by sewer systems and they play an important role in improvement of public sanitary conditions, and pilot projects are under way in major cities. However, the future serious problems include shortage of engineers and funds for execution of projects, establishment of design and planning methods suitable for cities and areas, and establishment of management methods and water quality regulations.

3.5 Natural Disasters

Natural disasters frequently occur in Asia. It is said that almost 90% of the world's disasters occur in Asia. Bangladesh and China have suffered from numerous disasters because of their geographical configurations. Since many Asian countries are situated in the Circum-Pan-Pacific Volcanic Belt, volcanic eruptions and earthquake disasters are occurring repeatedly. Table 6 shows 65 natural disasters that have killed more than 1,000 persons in the 93 years since 1900. 65 disasters occurred in the world for the period, and killed and missed more than 2.2 millions people. In Asia, about 1.5 millions people were killed and missed by 37 disasters occurred, which is equivalent to 60% of the world. The fatalities and missing in Asia can be halved into typhoon, harrycane and flood disasters, and earthquake and volcanic eruption disasters. About 87,000 lives were lost and missed by 19 former type disasters, and about 78,000 lives were done by 18 latter type disasters. It can be seen that disasters have occurred once every one and a half years, and that 11 disasters occurred in the last decade, and 4 disasters occurred in one year.

There have been 12 earthquake disasters, and the number of deaths has reached 740,000 in Asia. Damage has been concentrated in China and Japan. During earthquakes that occurred in Flores, Indonesia, more than 2,000 persons were killed or lost by tsunami. There have been 19 damaging floods and typhoons, and the number of deaths has reached 870,000. This type damage has been concentrated in Bangladesh and India. In 1991, 140,000 persons were killed or lost in the great cyclone that hit Bangladesh. There have been six damaging volcanic eruptions, and approximately 40,000 were made sacrifices. Volcanic damage was concentrated in the Philippines and Indonesia.

As a result of observing different countries in detail, it can be seen that damage from floods and earthquakes occurred often in China. During floods that occurred in the basin of the Yangtzèchiang and the Hai HeFe in 1991, more than 2,300 persons were killed or lost, and crop fields were extensively submerged, resulting in great economic damage. The Government of China established the China National Committee, with the intention of reducing disaster damage, with this damage as a momentum and is executing various projects for reducing disaster damage. The National Disaster Damage Reduction Management Center was established in 1992 and is carrying out a scientific research project for reducing disaster damage.

Table 6 Major Natural Disasters Occurred During 20th Century

Year	Type of Disaster	Country (Location)	Number of Fatalities and Missing (approx.)
1900	Hurricane	U.S.A. Texas	6,000
1902	Volcanic eruption	Martinique (Montagne Pelée, West Indies)	29,000
1902	Volcanic eruption	Guatemala (Santa Maria Vol.)	6,000
1906	Typhoon and tsunami	Hong Kong	50,000
1906	Earthquake	Taiwan	6,000
1906	Earthquake and fires	U.S.A. (San Francisco)	1,500
1908	Earthquake	Italy (Sicily)	75,000
1911	Volcanic eruption	Philippines (Taul Vol.)	1,300
1915	Earthquake	Italy (central area)	30,000
1916	Landslide	Italy and Australia	10,000
1919	Volcanic eruption	Indonesia (Kuhru Vol.)	5,200
1920	Earthquake and landslide	China (Kansu Province)	200,000
1923	Earthquake and fires	Japan (Kanto District)	143,000
1928	Hurricane and floods	U.S.A (Florida)	2,000
1930	Volcanic eruption	Indonesia (Ganung Merapi)	1,400
1932	Earthquake	China (Kansu Province)	70,000
1933	Tsunami	Japan (Sanriku District)	3,000
1935	Earthquake	India (Baluchistan)	60,000
1939	Earthquake and tsunami	Chile	30,000
1945	Floods and landslide	Japan	1,200
1946	Earthquake and tsunami	Japan (Nankai Islands)	1,400
1948	Earthquake	Turkmenistan (the former Soviet Union)	100,000
1949	Floods	China	57,000
1949	Earthquake and landslide	Tadzhikistan (the former Soviet Union)	20,000
1951	Volcanic eruption	Papua New Guinia (Lamington Vol.)	2,900
1953	Floods	The North Sea	1,800
1954	Floods	China	40,000
1959	Typhoon	Japan (Honshu)	4,600
1960	Earthquake	Morocco (Agadir)	12,000
1962	Landslide	Peru (Huascarán Vol.)	4,000
1962	Earthquake	Iran (northwestern area)	12,000
1963	Cyclone	Bangladesh	22,000
1963	Volcanic eruption	Indonesia (Agung Vol., Bali)	1,200
1963	Earthquake	Italy	2,000
1965	Cyclone	Bangladesh	57,000
1968	Earthquake	Iran (northwestern area)	12,000
1970	Earthquake and landslide	Peru (northern area)	70,000
1970	Cyclone	Bangladesh	500,000
1971	Cyclone	India (Orissa Province)	10,000
1976	Earthquake	China (Tienchin – Tansan)	250,000
1976	Earthquake	Guatemala	24,000
1977	Cyclone	India (Andorra, Pradesh Province)	20,000
1978	Earthquake	Iran (northeastern area)	25,000
1982	Volcanic eruption	Mexico (El Chichèn Vol.)	17,000
1985	Cyclone	Bangladesh	10,000
1985	Earthquake	Mexico (Mexico City)	10,000
1985	Volcanic eruption	Columbia (Nevado Del Louis Vol.)	22,000
1986	Toxic gases	Cameroon (Lake Nios)	1,700
1986	Earthquake	El Salvador (San Salvador)	1,000
1987	Earthquake	Ecuador (northeaster area)	several thousands
1987	Floods	Bangladesh	1,000
1988	Earthquake	India and Nepal	1,000
1988	Earthquake	China (Yûnnan Province)	1,000
1988	Floods	Bangladesh	2,000
1988	Earthquake	Armenia (the former Soviet Union)	25,000
1989	Floods and landslide	China (Szùchuan Province and others)	2,000
1989	Floods	India	1,000
1990	Earthquake	Iran	41,000
1990	Earthquake	Philippines	2,000
1991	Cyclone	Bangladesh	140,000
1991	Floods	China (Chianghsi Province and others)	more than 2,300
1991	Eruption and mudflow	Philippines (Pinatubo Vol.)	900
1991	Typhoon	Philippines	6,000
1992	Floods	Pakistan	1,334
1992	Earthquake and tsunami	Indonesia	2,149

Bangladesh is situated on a delta formed by two great international rivers, the Ganges and the Brahmaputra. Since about a half of the land is located at the area of 8 meters or less above the sea level, damage from floods, blockage of drainage, and high tides often occur during cyclones or monsoons. Six great disasters occurred in the last 30 years, and the dead and missing have reached at least 730,000. The Bangladesh flood action plan (FAP) has been executed since 1989, with members participating from 15 organizations and countries, to make multiple flood controls to relieve Bangladesh, which is categorized as one of the lowest income countries. The future projects are greatly anticipated.

In the Philippines, a number of people were killed by earthquake disasters and volcanic eruptions. It is still fresh in memory that many buildings were crushed by volcanic ash, and a number of people were killed by the subsequent mudflows, during the 1991 eruption of Pinatubo Volcano. It is estimated that the Pinatubo eruptions will greatly affect not only the Philippinés but climate conditions of the globe, i.e. global warming and the problems may develop outside the Asian region. Because of this serious disaster, a long-term disaster prevention plan for arterial highways is being made in the Philippines.

There are about 130 active volcanoes in Indonesia, where approximately 15% of the world's active volcanoes are concentrated. Damage from eruptions is significant. Active volcanoes exist at the two islands of Java and Bali, where the population is densely concentrated. Measures for controlling the large amount of volcanic ejecta from eruptions are a problem. In addition to earthquake damage on Flores island, described earlier, it is pointed out that flood damage has been increasing recently due to deforestation by unplanned timbering and cultivation, and due to disordered land development and unplanned river improvements.

In Japan, a serious disaster with over 1,000 deaths has not occurred recently because of prevention measures for natural disasters provided since the end of World War II, but serious damage was experienced by the Nihonkai Chubu (Japan Sea Central Offshore) Earthquake (1985), pyroclastic flows of Mt. Unzen-Fugendake (1991), and the Hokkaido Nansei-oki (Hokkaido Southwest Offshore) Earthquake (1993). During these disasters, more than 100 persons were killed. Damage was minimized with the existing prevention measures. With natural disasters damage restoration works, several emergency projects and grants-in-aid works related the natural disasters were quickly resorted and secondary damage was prevented.

In major cities such as Manila, Bangkok, and Jakarta in Southeast Asia, where serious damage has not occurred, inner water inundation are frequently occurring due to local thunder storms or sustained rainfall during the rainy season, and sanitary problems and traffic obstructions are being caused. All of these cities are very important politically and economically, and these damages affect seriously social and economic activities of the countries.

In Asian countries it will be necessary to determine the occurrence possibility and to develop methods of prediction, and to provide projects for structural reinforcement, namely establishment of design method for resisting earthquake, construction of dams for flood control, river banks and erosion facilities for disaster prevention, and to establish systems for restoration planning, for repeated earthquakes, volcanic eruptions, typhoons and cyclones, and floods.

4. Current Status of Technology Transfer in ASEAN Countries

It is important to understand the current status of construction technology transfer, but there are few cases of research on the subject. The current status of technology transfer in ASEAN countries, based on investigations made by the Ministry of Construction will be introduced here.

The Ministry of Construction conducted investigations on the construction technology transfer in the ASEAN countries of Malaysia, Singapore, Indonesia and Thailand for the period from 1985 to 1989. The investigation work was commissioned to the Overseas Construction Association of Japan by the Ministry of Construction, and an task team was dispatched for field investigations by the association. Investigations were conducted to identify the present level of construction technology, and determine the current status and problems with technology transfer. This was accomplished through discussions with the related institutions and organizations (government agencies, private corporations, various associations, and universities) and Japanese engineers employed by Japanese firms stationed in the related countries. There is no definite theory for identifying the technical level and the status of technology transfer, and investigations were made mainly depending on the ability and evaluations of the investigators. Data was gathered mainly through Japanese engineers and the content is generally relative based on the subjective view of individual engineers, but it is considered that these data will fully serve for understanding the general situation.

4.1 Evaluation of Construction Technology Level

(1) Individual Technology Level

As a result of evaluations made on the individual technology level of the four countries, it was found that technical ability is insufficient in the following fields.

① Civil engineers (university or higher level graduates): • feasibility studies, • design of sewer systems, dams, river improvement, ports and harbors, railways and erosion controls, • cost estimates of preparation works, • general construction management including construction planning, schedule control, quality control and safety management, • mechanical construction, manufacture of steel piles, deep foundation works, pneumatic caisson works, manufacture, installation and construction of bridges.

② Civil engineering technicians (technical high school or professional school graduate foremen or workers with less education): • drainage system structures, poor subsoil improvement, and open and pneumatic caisson works.

③ Architectural engineers: • design of medical, welfare, communication, and broadcasting facilities, and steel structures, • cost estimates of temporary works, • general construction management, • temporary works, manufacture of steel piles, and construction of medium-size or larger steel structures and inspection of steels, and water proofing works, • installation of communication systems, fire protection and smoke prevention systems, and electrical and mechanical systems for waste disposal plants, and • various management techniques.

④ Architectural technicians • working drawings, • soil improvement, drainage systems, welding works, iron works, steel erection, and waterproofing works by sheeting and coating, and • general installation works.

⑤ It was commonly pointed that the technical capability is generally insufficient in the field of engineering, construction management, temporary works, and installation works in the fields not seen nor required in these countries. The results of the evaluation show that the knowledge of engineers has reached satisfactory standards, but their construction and management abilities are still low. The evaluation shows that technicians are at a satisfactory level, except for management capability, and that skilled workers are also at a satisfactory level, although the level is still low. When a comparison is made of the different countries, Singapore rises significantly above the average and Indonesia is below the average.

(2) Technical Level of Countries

① Malaysia
For technology that has never been experienced (such as tunnels, subways, dams, and ports and harbors) and technology that has not been required because of climate and geographical conditions (such as waterproofing and steel structural works), technical capability is naturally insufficient, but the various construction techniques that have been required for the country have steadily been brought up. However, it can be seen that the way of utilization of human resources and organizations are way behind the required standards to actively use these techniques. When a comparison is made on the balancing between element technologies required for actual construction and management technology, it can be determined that management technology is evaluated insufficient.

② Singapore
It can be seen that the technology that has never been experienced in the past (such as tunneling, shielding, construction of subways and dams) is naturally short, but demands for the construction technology transfer are comparatively low. There is little room for importing construction technology from Japan. It can be determined that general construction technology, except for management technology, is little required for Singapore because the technology has reached very high level and the infrastructure has been almost completed. Training systems for skilled workers are also complete.

③ Indonesia
Since permanent or continuous employment systems have not been established in Indonesia, the abilities of construction tradesmen and skilled workers is not being raised in this country, and subcontractors are not technically reliable. Prime contractors who are forced to directly hire such tradesmen and skilled workers must exert extra effort all the time as necessary. As most plasterers, painters and masonries of the tradesman class have not reached satisfactory skill levels, constant supervision by direct-hired middle-class engineers is required to assure satisfactory quality control and schedule management. Therefore, a number of middle-class engineers are required and the work to be done by subcontractors is often borne by prime contractors or government agencies.

These problems are considered senously and a solution has been sought by the Construction Industry Promotion Bureau, Ministry of Public Works but nothing has been done for improvement. It is said that the establishment of permanent jobs for tradesmen and skilled workers is the only way of strengthening of construction industry in Indonesia. It is presumed that a special project should be executed to provide training centers and employment systems of construction industry should be imminently improved. It is understood that what is most urgently required is the improvement of skills of tradesmen and workers in at the downstream levels, before the technology of management and control or other more advanced technology are transferred to engineers and technicians.

Famous successful example of technical transfer between Japan and Indonesia is the construction projects for dams at Karangkates, Kalikonto, and Wonogiri. These projects were executed and successfully completed by Indonesian engineers, using materials and technology furnished by Japan. Reason for the success is because the project was executed by the Ministry of Public Works and the required technology for the entire project was systematically transferred to young government engineers who graduated from universities and professional schools.

④ Thailand

It can be found that construction technology has been smoothly and orderly transferred to the construction industry in Thailand, without delay in the development of the infrastructure. Permanent employment of skilled workers has not been established because of social conditions—the country is founded on agriculture and modern occupation employment systems have not been set up. As with other ASEAN countries, it cannot be concluded that the country will always be stable, but Thailand is in comparatively good condition. During the time of the construction boom in the middle east countries in the latter half of the 1970s, Thai technicians and workers polished their skills in world markets and have reached a level that can be internationally acknowledged.

Theoretical construction technology and methods that are taught in the top educational institution is not far behind that taught in industrialized countries. There is an institute called the "Asian Institute of Technology" (AIT) in the suburbs of Bangkok that is available for Asian students who study to obtain a master's degree. Thailand is blessed with an excellent environment in this field.

There are still a number of technologies that have not been transferred in the field of advanced construction and special technologies, but these are not always necessary for the present economic foundation and may be subjects to be considered in the future.

A recent example of successful technology transfer between Japan and Thailand is the bridge manufacturing and welding techniques for the construction of the Rama IX Bridge (cable-stayed bridge). A Japanese prime contractor completely manufactured bridge members on the site and transferred the technology through training courses held in Japan, person-to-person training, and on-the-job training. The factory used for the manufacture of bridge members is still in operation and subsequently serves for constructing other bridges.

4.2 Evaluation of Technical Transfer Potentialities

Comparison has been made here on the four countries to determine potentialities for the subject of construction technology transfer, using data obtained through the investigations

conducted in these countries. To clearly distinguish the differences between countries, demands for the construction technology transfer and the potentialities for accepting such technology have been used as technical background factors in Table 7 below.

Table 7 Potentialities for Construction Technology Transfer in ASEAN Countries Determined Based on the Technical Background Factors

Technical Environmental Factor		Malaysia	Singapore	Indonesia	Thailand
Demand factor	Requirements for infrastructure improvement	high	low	high	high
	Requirements for construction works	low	low	low	high
	Public investment policy	medium	low	medium	high
	Requirements for improvement of technical standard	medium	low	high	medium
Potential factor	Attitude towards the operations of Japanese construction industry	low	low	high	medium
	Dependence on foreign funds	high	low	high	high
	Preparedness for receiving the technology transfer	medium	high	low	low
	Acceptance for receiving Japanese technology	medium	low	high	medium

The potentialities of the four countries for the construction technology transfer is shown in figure 5.

As seen in figure 5, demands for the construction technology transfer are comparatively low in Singapore and there is little room for accepting new technology. The reason for this is because the technical level has been significantly developed, the infrastructure implementation is almost complete, and general construction technology is not required in this country. However, the country shows interest in the advanced technology of Japan, including urban civil engineering and advanced building construction. It is necessary to promote the transfer of selected technology that will be welcome there.

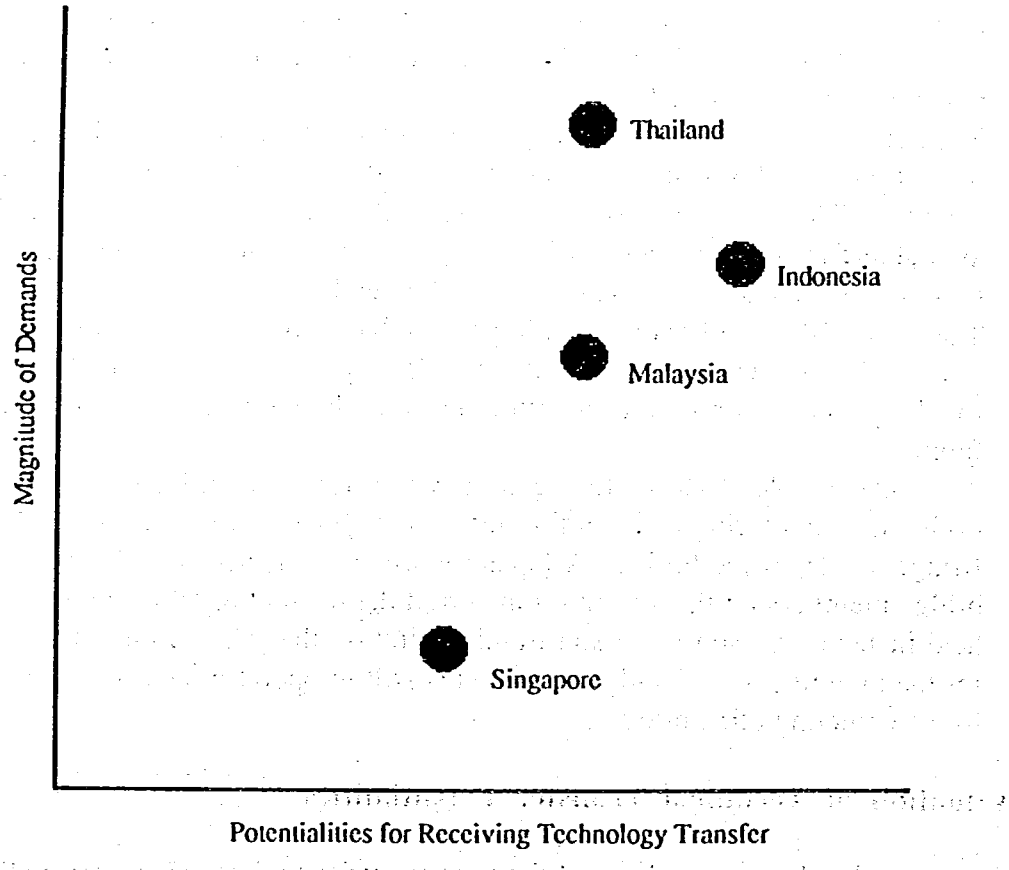


Fig. 5 Potentialities of ASEAN Countries for Construction Technology Transfer

Conversely, demands for general construction technology are high in the three other countries, although there are slight differences between the different countries. For Malaysia it will be necessary to examine methods of transfer in considering the roles of government and private sector, to select construction technology that can be transferred, and to determine topics that can be jointly developed, with careful consideration being given to the country's "Look East" policy, as what-is-called the "overpresence by Japan" has caused troubles there in the past.

It is also important to promote economic aid that can contribute to the expansion of their domestic demand. For Thailand it is most important to settle the feeling of the overpresence by Japan, which has started to agitate displeasure among local enterprises, and to select the optimum technology that meets local demands. For Indonesia, it is necessary to consider multiple means of transferring technology to improve the entire infrastructure of Indonesia.

4.3 Problems on Promoting Construction Technology Transfer

Problems on promoting construction technology transfer found through the investigation for four courtries will be described below.

(1) Most engineers employed by government agencies are highly educated and have theoretical knowledge on the project planning, design, and construction and its management, but they have little practical experience and knowledge. In a few examples in the 1960s, it was identified that government employees were directly involved in public works projects from the planning stage to construction. In recent years, major construction projects were often executed by grants-in-aid from foreign countries, and government employees tended to be kept away from the practical works because the most of them was done by foreign consultants and construction contractors. This tendency is not desirable for government employees because they will lose the chance of acquiring important knowledge and experience required for planning projects that are foundations of national development program.

(2) Engineers of private corporations tend to rely on their own technique other than their organizations and to reject the sharing of new technology with others. They tend to change their occupation very easily if better conditions are offered. Architects and engineers are deemed to have a high social status and they tend to seek executive positions from the beginning, instead of seeking positions providing construction and management services.

Technicians (high school graduated, foreman class) are required to do most field work, from the purchase of materials to job completion, including supervision of skilled workers and preparation of working drawings. Since qualification and examination systems have not been established for this class, their efforts and abilities are not properly evaluated.

For skilled workers (tradesman class), batter board markers, formwork carpenters, rebar erectors, and plumbers are able to finish their work as required but most of them are unskilled or latent jobless from rural areas. Labor forces are not reliably able to meet demands both in quality and in quantity.

(3) Structural problems exist since there are no agencies having direct jurisdiction over the construction industry. Construction registration services are provided by the Ministry of Commerce, construction contracts and management for publics works are dealt with by the Ministry of Public Works, and personnel management of engineers is dealt with by the Ministry of Labor. Not only are the protection and promotion of construction industry ignored, but also increased cost of public works due to inflation is rarely reconsidered under the current situation.

Proper systems have been established to qualify architects and engineers who are university graduates, but qualification procedures for technicians (high school graduate level) or skilled workers have not been properly established. Qualification and training procedures for technicians are almost complete in Singapore.

Most private corporations are established by private investments that strongly seek profit but do not respect engineering background. There are few private corporations having sufficient time and money to spend for technology development and for the education of engineers and technicians.

The number of university graduates as a source of high level engineers is very limited. Most graduates tend to seek jobs in government agencies or in the educational field. In Thailand, the professional activities and high employment standards of private corporations has recently tended to attract university graduates. It can be expected that private corporations in Thailand will see a lot of future growth.

5. Forwarding to Promote Construction Technology Transfer

To further promote the construction technology transfer as discussed above, various conditions that should be examined and considered both by the donor countries and recipient countries will be summarized below.

(1) Requirements for Technology Transfer Meeting Conditions of Recipient Country

Construction technology requiring transfer varies depending on various conditions, such as natural conditions including geographical configurations, and geological and climate conditions, socio-econmic growth level, institutional systems, customs and infrastructure improvement level of recipient country. As it can be seen in the technology transfer achieved in Japan, the required types of construction technology changed towards more advanced technology with the progress of modernization. Now Japan is able to create its own original technology. The infrastructure improvement in various Asian countries has also varied depending on the growth of their economy and society. As it can be seen in the example of ASEAN countries, the types of technology required by individual countries are diversified.

To achieve an individual technology transfer, it is necessary for both the donor country and the recipient country to discuss the various conditions in the recipient country.

(2) Requirements for Technology Transfer Meeting Various Phases of Project and Organizations

The term "technology transfer" covers a wide area. It is important to properly identify the specific technology requiring transfer. Figure 6 shows various phases of civil engineering and building construction projects and the major organizations involved.

Preliminary planning of civil engineering construction projects and their maintenance and management (if toll is involved) after completion are carried out by government agencies, such as the Ministry of Public Works. Detailed planning, investigations and design are undertaken by consultants. Materials procurement and construction works are provided by construction contractors. Preliminary plans for building construction projects are made by owners, design and construction management by architects and engineers firms, materials procurement and building and structural construction by construction contractors, utilities and related facilities by installation firms, and maintenance services by the owner.

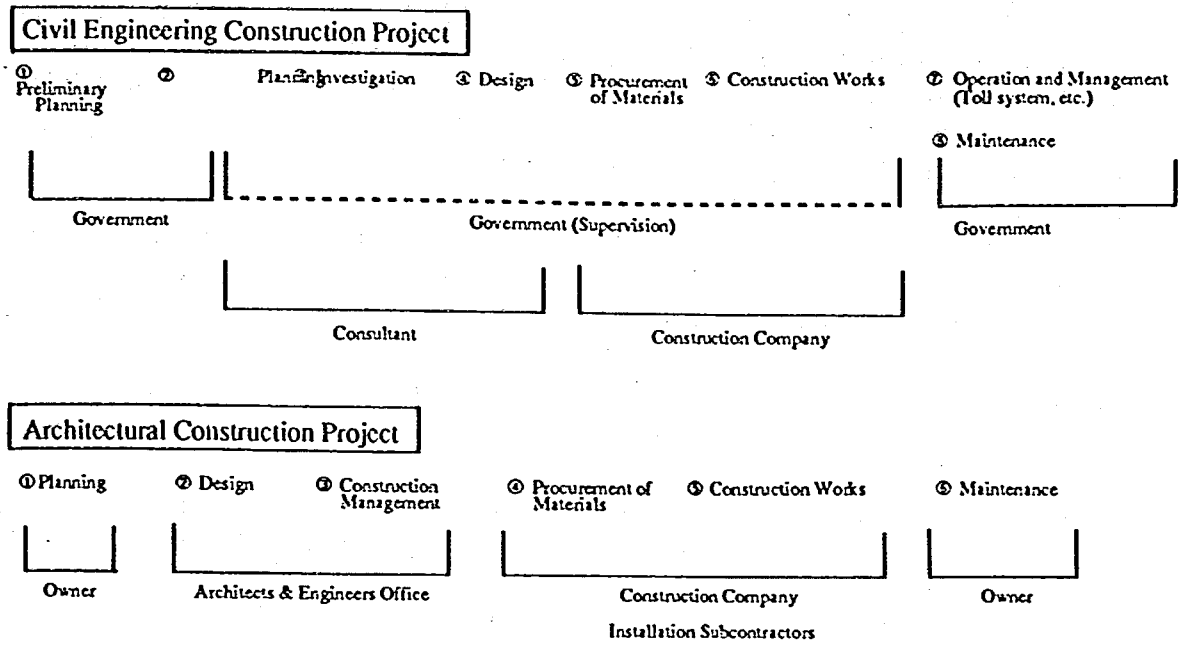


Fig. 6 Flow of Construction Project and Its Stages of Progress and Organizations Involved

The construction technology transfer has often been limited to the topics of design and techniques required for the stage of construction. Construction technology is composed of individual technical elements and management technology, including material procurement, arrangement, labor force allocation and quality control. Needs are increasing recently for the management technology transfer. Job classification required for the technology transfer varies depending on the different stages of construction and the required technical elements. For example, technology is transferred mainly to technicians and skilled workers in the field of construction and to engineers and technicians in the field of material procurement, quality control and construction management.

Demands are also increasing for the technology transfer to execute the entire project, namely project management technology. This technology should be transferred to government officials or engineers who are responsible for improvement of the infrastructure, such as the Ministry of Public Works. For the transfer of project management technology, subjects such as preliminary planning, or financial procurement, or study of cost-benefit analysis during early stages of planning will become important.

Prior to starting concrete planning on the technology transfer, it is important to clearly identify the phase of construction, the technical elements, to properly designate organization, and job classification.

(3) Requirements for Determination of Optimum Transfer Method

There are various methods used for the technology transfer. There is a close relationship between the technology requiring transfer and the transfer method. For project management technology which is mainly transferred to engineers of the Ministry of Public Works, project-type technical cooperation agreed upon between the two governments, is most suitable. This is a method that transfers the technology of project management for the entire process of at least three to five years from the planning to completion of the project. Construction of buildings and facilities, supply of materials, experts and job training services are totally furnished by donor countries. This method was applied to the construction of the three dams in Indonesia, a machinery road construction project in Thailand, and the bridge construction center in

Myanmar. With project-type technical cooperation, as described above, extensive effects can be expected because practical techniques, from general management to concrete construction management and operations, are individually transferred. As another method of technology transfer for government engineers, experts are dispatched from donor countries and trainees are invited to donor countries (normally for one to six months).

One way of transferring technology between private firms is to have prime firms make a joint venture agreement with local firms, or to make local firms hire as subcontractors. In case of construction project of financial aid from donor countries and government-controlled projects in developing countries, the prime contractor is forced to give job training to technicians and skilled workers of local contractors, to transfer technology, and sometimes to pay with necessary expenditures. However, it is said that prime contractors cannot afford to transfer technology, as expected recently, under a strict construction contract agreed to for a very limited price in a highly competitive circumstances.

There is an example of a foreign aid grant from Japan that provided a training center of construction technology for skilled workers. This training center, called the "ASEAN Manpower Center," was constructed in Philippines for the 10-year period from 1982 to 1991, in which construction technical courses were given to trainees from various ASEAN countries for the trades of maintenance of construction equipment, welding, electrical wiring, plumbing, rebar erection, steel structural work and concrete masonry work. This center was established for the purpose of educating skilled workers who will be the leaders for development of rural areas.

For the method of technology transfer, it is said that practical training along with theoretical schooling, particuraly the on-the-job training system that provides trainees with experience and repeating trials and errors on the site of project is best way. The technology transfer can be more effectively achieved if there is a system that properly evaluates the results of training.

(4) Strengthening of Sovereignty by Recipient Countries

It is important that the recipient country strengthens its own sovereignty for promoting the technology transfer more smoothly. As can be seen from the examples of ASEAN countries described in Chapter 4, there are labor systems and customs that interrupt the smooth technology transfer in some recipient countries. It is also said that some private corporations are lacking a long-term vision and ignore engineering principals. If the executives in the recipient country desire to import technology to improve their competitive strength in world markets, it is important for them to make continued efforts for improvement of various institutional systems, and to modify and emphasize their legal systems for further development of the construction industry.

As the socio-economic development of a recipient country continues, it can be presumed that demands of people for government administrative services and for infrastructure improvement will rapidly increase. As the number of grants or loan projects increases, main portions of those projects may tend to be commissioned to foreign consultants or construction contractors, chances of the government officials of recipient country participating in project management may be reduced, and private investment projects called "B.O.T." may increase. These tendency is considered not to be desirable in the viewpoint of sovereign execution. An improvement of the infrastructure that remains as a national asset in the future should be planned and executed under the responsibility of the government and relevant risks should all be borne by the country.

(5) Requirements for Transfer of Advanced Technology – Research and Development Technology

In order to forward the technology transfer more smoothly, each country should modify imported technology to suite local conditions, spread the modified technology widely to improve its own technology and create its own original technology, as described in the previous chapter on Japan.

It is presumed that technology to be transferred should change in the order of: ① operational techniques currently used for construction, ② technology modified as required to meet characteristics of each field, and ③ technology for research and development to meet the needs of the customer. Request of technology transfer for research and development, including fundamental and applied research is increasing.

This means that we need machine producing machine in the field of machine engineering. It is necessary to consider what should be done for the technology transfer that can create new technology. The ultimate goal of the construction technology transfer is to be able to create the technology having high productivity and producing high quality products with enough competitiveness in the world market. For the future aspect of construction technology, there are topics of development of new technology that corresponds to projects rapidly increasing in size, that enables construction which cannot be performed by hand under severe conditions, that is supported by automation and computers, and that utilizes the advanced technology of other than civil engineering. It is presumed that the transfer of such advanced construction technology will be a major objective in the future and could become a hot topic.

6. Postscript

As the socio-economic development of Asian countries continue, it is necessary to improve further infrastructure that is the fundamental element vital to the development of the economy and is the major factor supporting the healthy; comfortable and safe national life. For Asian countries, the development of their construction industry is very important to be able to support the implementation of their infrastructure. The construction industry is a comprehensive industry covering a bload area, and is related to various fields. It has the strength to absorb excess labor forces mainly from rural areas, to make practical use of natural resources, and to develop middle and small size businesses as the supply sources of materials and parts.

It is necessary to promote the transfer of more advanced construction technology to realize improvement of the infrastructure and to promote the development of the construction industry. The construction industry comprises diversified engineering groups from various widespread fields. It is important to make a multiple and strategic transfer program.

Construction technology is developing rapidly in industrialized countries as well. It is presumed that the transfer of advanced construction technology employing the results of research and development in other fields, and innovative engineering concepts, will become major subjects in the future.

It will be the author's unexpected pleasure if this paper contributes to some extent to the promotion of construction technology in various Asian countries. I would like to express my deepest appreciation for the assistance and great cooperation extended by the Planning and Research Administration Department of the Public Works Research Institute to prepare this paper.

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Appendix. International Cooperation by the MOC and the PWRI

A.1 International Cooperation by the Ministry of Construction

(1) General Description

As a new international framework is being constructed subsequent to the breakdown of the Soviet Union and the peace negotiations taking place in the Middle East and in Cambodia, the international role of Japan is rapidly becoming important. Infrastructure improvement is the foundation for development of the economy and it is becoming an important subject for the international contribution of Japan. Therefore, active efforts are being made by the Ministry of Construction to facilitate technical cooperation for developing countries and international exchange with international organizations and various countries.

Technical cooperation activities to provide aid to developing countries and international exchange to promote bilateral or multilateral relationship will be discussed in the following sections.

(2) Technical Cooperation

Technical cooperation by the Ministry of Construction is provided either through the Japan International Cooperation Agency or directly by the Ministry. The technical cooperation through the Japan International Cooperation Agency is provided in the form of inviting foreign trainees, dispatching experts and investigation teams, and providing a project-type cooperation.

The trainee invitation program is executed based on the request of developing countries to provide training in various fields of engineering and administration. Table 8 shows the past record of the trainee invitation program. During 1992, 21 group training courses were given to 237 trainees, and 128 individual courses were given for 357 trainees, 594 trainees in total.

Table 8 Number of Trainees Invited or Accepted by the Ministry of Construction

Category \ Year	1988	1989	1990	1991	1992
Group training course	18 courses 216	19 courses 244	20 courses 268	24 courses 268	21 courses 237
Individual course	140 courses 336	129 courses 292	84 courses 215	122 courses 436	128 courses 357
Total	552	536	483	704	594

Experts in the field of rivers, roads, housing, city planning, and land survey were dispatched to various Asian countries, the Middle and Near East countries, the Middle and South American countries, and to Africa, to give helping hands to the preliminary planning and execution of various development projects of such developing countries. Table 9 shows the record of dispatching experts. During 1992, 95 experts were dispatched to 22 countries on a long-term basis, and 205 to 26 countries on a short-term basis, for a total of 300 experts. The International Emergency Relief Team was dispatched to Indonesia and Egypt to provide relief aid for earthquake damage during 1992.

Table 9 Number of Experts Dispatched by the Ministry of Construction

Category \ Year	1988	1989	1990	1991	1992
Long-term (one year or more)	20 nations 95	26 nations 104	26 nations 94	24 nations 84	22 nations 95
Short-term (one year or less)	24 nations 161	27 nations 248	25 nations 180	23 nations 149	26 nations 205
Total	256	352	274	233	300

Investigation teams were dispatched from the Japan International Cooperation Agency to provide research and development investigation services or grants-in-aid preliminary design investigation services, and also dispatched to examine loans from the Overseas Economic Cooperation Fund. The teams conduct field investigations, including discussions with the government agencies of developing countries, and prepare and submit reports to countries requesting grants-in-aid to contribute to promotion of development projects. Table 10 shows the record of the dispatching of investigation teams.

Table 10 Investigation Teams Dispatched by the Ministry of Construction

Category / Year	1988	1989	1990	1991	1992
Number of Project	99	99	83	83	105
Number of Investigation Team	134	140	109	102	137
Number of Staff Dispatched	282	283	208	180	243

Technical cooperation financed by the Ministry of Construction is provided in the following forms:

① VIP Invitation Program

This program invites influential high-ranking officials from developing countries and introduces Japanese construction administration system and construction technology in order to promote better understanding of the development assistance by Japan.

② Construction Technology Development Program in Developing Countries

This program aims at developing appropriate and suitable construction technologies which meet natural, economic and social conditions and technology level of developing countries (4 projects during 1992)

③ Survey Program for Infrastructure Condition in Developing Countries

This program identifies and makes guidelines on the priority field of economic and technical cooperation through dispatching survey missions to gather overall information about current level of infrastructure development and medium and long-term national development plan.

④ Construction Project Promotion Program in Developing Countries

This program includes various activities such as finding high quality construction project in developing countries (15 projects during 1992), follow-up service of already surveyed project, after care service for constructing project and evaluation service for completed projects (4 projects during 1992), and survey of new construction technology for global super project, etc.

⑤ Technical Assistance Program

This program makes guidelines on economic and technical cooperation for urban development projects in developing countries, and makes proposals and guidelines on standard methods of public infrastructure maintenance in developing countries, and studies effective measures to rehabilitate disaster damages, etc..

⑥ Financial Assistance Program to Non-Government Organization (NGO)

This program gives subsidy for dispatching experts and training services to NGO activities in the fields of restoration from disaster damage, disaster prevention and improvement of living environment (15 experts were dispatched to Philippines and other countries in 1992)

(3) International Exchange

Major international exchange activities currently being executed by the Ministry of Construction are described below.

① Relationship with the United Nations
Active support is provided by dispatching experts to or participating in conferences held by the Economic and Social Commission for Asia and the Pacific (ESCAP).

② Relationship with Organization for Economic Cooperation and Development (OECD)
The Ministry dispatches experts to conferences related to the Road Transportation Research (RTR).

③ Various Multilateral Cooperations
Experts are dispatched to various conferences held by the Asian Development Bank (ADB), the Asian Institute of Technology (AIT), the Permanent International Association of Road Congress (PIARC), and the International Commission on Large Dams (ICOLD).

④ Bilateral Cooperation
Bilateral scientific and technical cooperation are being provided based on government-level bilateral agreements made with major advanced countries.

⑤ Cooperation for Global Super Projects
International cooperation are being provided to promote global super projects, including the alternative Panama Canal construction project.

⑥ Promotion of International Disaster Prevention Decade
International cooperation activities are being provided and seminars are held in Japan to promote the International Decade for National Disaster Reduction of the United Nations which began in 1990.

A.2 International Cooperation by the Public Works Research Institute

(1) General Description

The Public Works Research Institute actively promotes the program of research exchange to improve and disseminate the construction technology of Japan through channels of international exchange to match the increasing demand throughout the world. International joint research is actively underway, using the technology and various facilities of the institute to acquire immediate solutions to international problems such as natural disaster prevention and global environmental problems, and to develop construction technology for improvement of the infrastructure, including road traffic technology.

As a part of international contribution program of Japan, the Public Works Research Institute is active in providing technical cooperation, dispatching experts to provide technical consultation services, and receiving trainees from overseas countries to promote the technology transfer.

(2) International Research Cooperation

As a part of the multilateral research cooperation activities, the Public Works Research Institute participates in the six international committees shown in Table 11 and deals with approximately 20 research cooperation projects. As a part of the bilateral research cooperation efforts, 39 projects are being dealt with under the framework of scientific and technical cooperation agreements made with 10 countries of the North American Continent, Europe and Asia in the style of conference participation, information exchange through documents and others, personal exchange and cooperative research.

Under the above framework, joint research is being forwarded in the fields of global environment, coastlines, rivers, roads, dams and earthquakes, including Japan–U.S. cooperative research program on hybrid control of seismic response of bridge structures, Japan–U.S. cooperative research on test pavement under the Strategic Highway Research Program, Japan–Indonesia joint research on technology for preventing sediment disaster on alluvial fans, and Japan–Germany joint research on the Production of Construction Materials from Sewage Sludge and Recycling.

Table 11 International Cooperation by the Public Works Research Institute

(a) Multilateral Cooperation

Organization	Cooperative Committee
OECD	International Road Transportation Research Program Steering Committee
	International Road Transportation Research Program Expert Committee
	International Road Research Documentation (IRRD)
PIARC	International Road Conference
ESCAP	Committee on Shipping and Transport and Communications
RILEM	International Union of Testing and Research Laboratories for Materials

(b) Bilateral Cooperation

Country (Number of themes)	
Australia (4)	Norway (2)
Canada (4)	Sweden (2)
China (6)	U.K. (1)
Germany (1)	U.S.A. (8)
Italy (1)	
Korea (1)	

The Public Works Research Institute (PWRI) holds international conferences and exchanges researchers to promote international research cooperation projects. Major conferences are tabulated in Table 12. The Japan–U.S. Joint Panel Meeting on the Advanced Technology in Highway Engineering will be introduced here.

The meeting was established in November of 1992 under arrangement of the PWRI and the Federal Highway Administration (FHWA), the Department of Transportataion of U.S. to cooperate researches on the whole highway engineering field. The first meeting was held in the PWRI from the end of November to beginning of December of 1992 and the second meeting was held in the FHWA in October of 1993. The 8 task group meeting (Pavement, Highway Bridge Design and Wind Engineering, Highway Bridge Maintenance, Tunnel Safety, Earthquake Engineering and Geotechnical Engineering, Intelligent Vehicle Highway Systems

(IVHS), Road Traffic Safety and Road Environment) were established in the first meeting. It was agreed in the second meeting that Traffic Demand Management task group meeting would be newly established . Cooperative efforts are being made on the subjects of feasibility of long life pavement, comparative design for structures using U.S. and Japan criteria and seismic evaluation and strengthening methods for existing structures, repairment of bridge substructures and geotechnical improvement methods, and man-machine interface of IVHS. In addition, it was proposed that further efforts would be continued through periodical meeting and personal exchange for the development of highway engineering in both countries.

Table 12 Major International Conferences Sponsored by the Public Works Research Institute

Title of Conference [Time of Commencement and Counterpart Organization]	General Description
Conference on Public Works Research and Development in Asia ['92 – : Public works departments and research institutes in Asian Region]	Aimed to construct a permanent network for exchanging technical research information among related government agencies to serve for promotion of proper infrastructure improvement and development of technology in Asian countries including Japan. The conference started in February 1993.
U.S.-Japan Conference on Development and Utilization of Natural Resources (UJNR) - Panel on Wind and Seismic Effects - ['69 – : National Institute of Standards and Technology (NIST) and others]	Aimed to serve for the development of wind resisting and earthquake resisting designs for civil and architectural structures. The conference has a long history over a quarter of century.
Japan - U.S. Committee on Hydrology, Water Resources and Global Climatic Changes ['91 – : U. S. Geological Survey Institute (USGS) and others]	Aimed to gather data through investigations made for the effects of changing global environment on the hydrology and water resources in river basins, to develop evaluation methods, and to exchange research information. The conference started in February 1992.
Japan - U.S. Joint Panel Meeting on Advanced Technology in Highway Engineering ['92 – : Federal Highway Administration (FHWA)]	Aimed to exchange technology research information to promote research and development of technology in all fields of road. The conference started in November 1992.
Japan - U.S. Conference on Sewage Treatment Technology ['71 – : Environmental Protection Agency and others]	Aimed to solve problems in prevention of water pollution, advanced sewage treatment, and modification of combined systems of sewage.
Japan - Germany Workshop on Environmental Protection Panel - Workshop for Drainage Systems and Sludge Treatment - ['82 – : Karlsruhe Nuclear Research Center and others]	Workshops are held every other year alternatively sponsored by Japan and Germany for the purpose of exchanging technology research information on drainage systems and sludge treatment.
Japan - Canada Workshop on Paving in Cold Area ['82 – : Ontario Department of Transportation and others]	Aimed to exchange technology research information on maintenance of paved roads in cold areas, new materials and construction methods.

For the technical cooperation, an average of 100 researchers have been dispatched annually to participate in conferences and workshops held under the auspices of multilateral and bilateral cooperation agreements or through the Japan International Cooperation Agency and others, as shown in Figure 7 and Table 13. It can be seen that the Southeast Asian countries stand out from other countries, followed by the United States and European countries in order. An average of 50 researchers were dispatched through the Japan International Cooperation Agency.

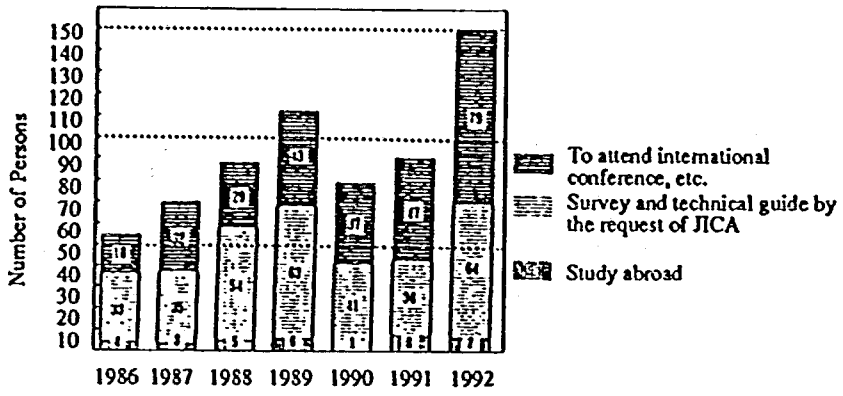


Fig. 7 Foreign Business Trip by PWRI's Staff

Table 13 Business Trips by PWRI's Staff, Classified by Destination

Year	United States	Europe	Southeast Asia	Others
1984	9	5	34	8
1985	12	3	22	9
1986	11	4	35	9
1987	10	11	36	18
1988	11	15	38	30
1989	18	21	35	43
1990	13	13	47	11
1991	17	21	23	10
1992	43	28	47	40

The Public Works Research Institute also invites foreign researchers as a part of the personal exchange program, as shown in Figure 8. About 10 researchers have been invited every year from the United States, China, Thailand and Britain to study at the Public Works Research Institute.

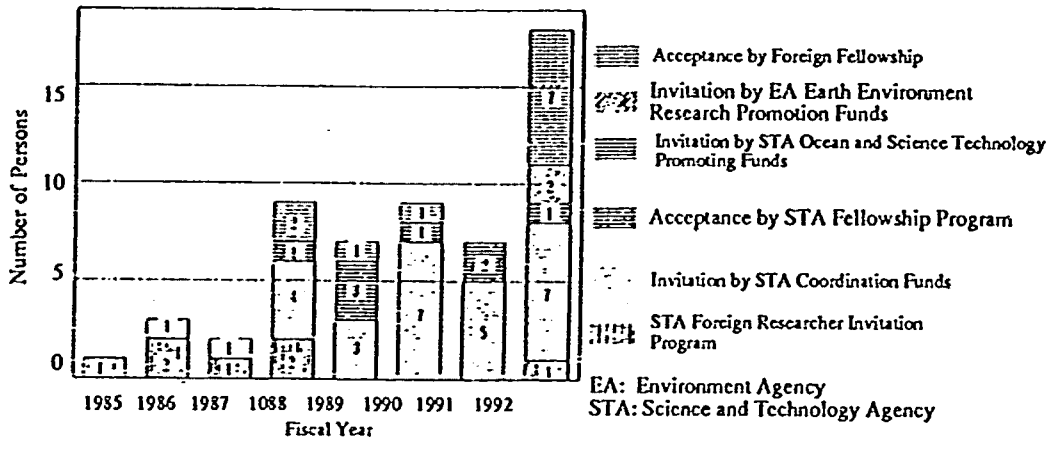


Fig. 8 Invitaion or Acceptance of Foreign Specialists

In addition, a number of foreign researchers and engineers have visited the institute. The annual average number of visitors has reached 200, as shown in Figure 9. The number of foreign trainees invited at the request of the Japan International Cooperation Agency and others has reached an annual average of 250, as shown in Figure 10.

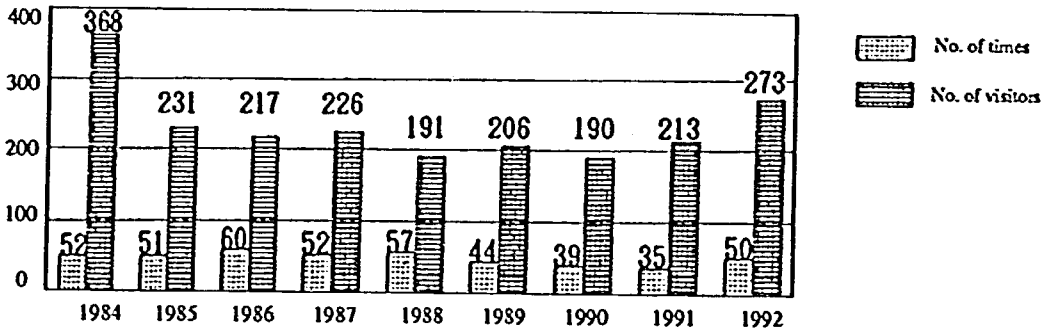


Fig. 9 Visitors from Overseas Countries

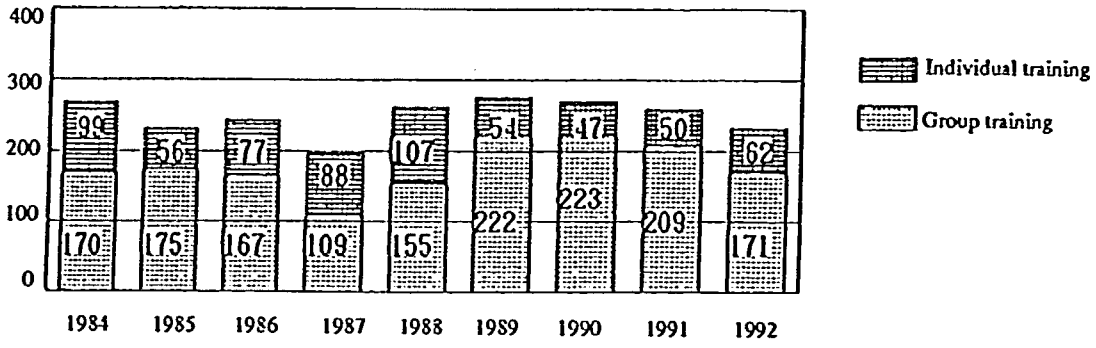


Fig. 10 Invitation or Acceptance of Trainees from Overseas Countries

III. Research in Japan

– Focusing Civil Engineering –

Prof. Hiroyoshi Shi-igai
Institute of Engineering Mechanics,
University of Tsukuba

Research in Japan
Focusing Civil Engineering

Hiroyoshi Shi-igai, D. ENG.
Professor of Engineering Mechanics
University of Tsukuba

1 Characteristics of Science and Technology of Japan

It has frequently been referred to among western observers, and some Asian observers as well, that Japanese science and technology are focused to applications, and not to fundamental science. Since this comment is appealing, and is partly true regarding with the period after the Second World War, the observation mentioned above has been well accepted in the world. To find out a theory that will develop to destroy the whole world may be fundamental in one way, but I do not take it as fundamental to human being, at least.

As a matter of fact, western sense of "fundamental" is somewhat different from Asian sense of "fundamental". It is ironical that so to speak "developed countries" suddenly realized the danger of environmental world crises in these twenty years, which means that many developed countries misunderstood the meaning of basic human needs for long time in the past, and perhaps in the future as well.

After Meiji Restoration(1868) in which Shogun returned his governorship to Emperor, Japanese Government spent much effort to modernize Japan. At that time, the population of Japan was about thirty million living on four major islands and a number of small ones of which area is approximately 377 thousand square kilometers. Therefore, population density at that time was 80 capita/km2. This figure is almost equivalent to that of Cuba, for instance.*

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* If the world population reaches ten billion (US billion), population density of the world will be about 75capita/km2 just for curiosity.

At that time Japan was self-supporting country in food and other goods, supplying a lot of copper to the world. A British diplomat, Satoh, realized that the public order of safe was very good in Japan, and that many young women were travailing alone from Tokyo to Kyoto without any troubles.

The new Meiji Government made much effort to modernization of Japan. The slogan of Meiji Government was "Rich country with strong military force". Civil engineering was one of important technologies, together with Agriculture to make Japan rich. In modernized new universities, Physics, Chemistry and Medicine were the major fields of science. To be scientist became one of the dreams of Japanese youngsters, together with general and admiral. Note that the first civil engineering department belonged to the Faculty of Science in the University of Tokyo. Faculty of Engineering started somewhat later.

Japan experiences many types of natural disasters; they are earthquakes, tsunamis, floods, draughts, typhoons, foens, heavy snow, storm surges, volcanic action and landslides. Before the formation of the modern government, the development of Japan was seriously hindered by these natural disasters. Among those disasters, flood was one of the most serious disasters, since it attacks Japan very often, in spring , as the result of melting snow, in June, during and after a month of rainy season and in September and October due to typhoons. Although Japan was self-sufficient with 30 million population at that time, repeating floods prevented her further growth, both in population and economy. Note that 70 % of Japanese islands is mountainous areas, and her population and property are accumulated on the rest 30% flat areas. It was a wise decision that Meiji Government started to flood control at this stage.

In that sense, flood control was "fundamental" to the society of Japan at that time, and it is so even today. The flood control technology is not fundamental from physical point of views, but very fundamental from socio-economical point of views. Natural disaster management is also fundamental technology in Japan as well. The western world considered the nuclear physics as fundamental science

for long period, for example, and did not consider environmental management as fundamental. Of course it should be noted that two "fundamentals" are greatly different in their meanings from each other, and that many Asian countries had achieved some kind of "sustainable development" already in 19th century.

It is also worthwhile to note that the education policy at that time was put on the education of natural sciences, and not engineering in general. Until the end of World War II, Faculty of Sciences in universities of Japan were quite strong, while Engineering Faculties were relatively small. It is after the World War II that Japan realized the importance of laboratory work in research and that engineering balanced with science was quite important for the further development of Japan.

2 The Role of Public Research Institute

After Meiji Restoration, the new government of Japan at that time invited many consultants from a number of foreign countries. Dutch engineers, invited by Japanese Government for relatively short period, contributed a lot to river management. The development of Japan in late 19th century greatly owes to them. At the same time, some students were sent to Ecole de Polytechnique in France to learn river management. Dutch engineers considered the navigation system, utilizing major rivers, would be beneficial to the future of Japan, while Japanese engineers who, having spent many years learning in France, came back to Japan thought flood control was more important than navigation. As Dutch engineers went back to their country when their contracts were over, this difference of opinions disappeared. Rightly or wrongly, flood control has been main aim of river engineering since then.

Civil engineers used to belong to Ministry of Interior until the end of WW II, under the control of lawyers and others. In 1929, Ministry of Interior realized that the engineering judgment was so important for flood control and water resources development, and any other civil engineering work. Around that period, Public Works Research Laboratories was established. The second Director of this

laboratory was Dr. Mononobe, professor of University of Tokyo and Director of the laboratory at the same time. He published in 1933 the first comprehensive text book of hydraulics of which revised edition is still read occasionally among hydraulic engineers in Japan. At that time, there were only three textbooks published in the world, namely, of Forchheimer(Germany), of Flamant(France) and of Schocklitsh(Austria). He also showed that tall buildings must be flexible for anti-seismological points of views. His theory of flexible design for tall buildings was well recognized and all tall buildings in Japan are designed based upon his theory. Professor Mononobe was awarded Prize of Japan Academy of Science (not Engineering) in 1929.

This text book, written by the director of Public Works Research Institute, influenced in many areas. The book was used as standard for design work. The back water theory by Mononobe was also published in ASCE Journal, and later, Ven Te Chow improved this theory, which gradually guides to "Open Channel Hydraulics" by Chow, which is still read widely through Dover Edition.

After WWII, Ministry of Interior was dissolved and most of civil engineering work was transferred to a new ministry, Ministry of Construction. Public Works Research Institute played an important role not only for the development of civil engineering, but also for its academic works, supplying many famous professors to universities in Japan.

3 What is Research?

I was very fortunate enough to spend almost six years in Thailand, teaching at Asian Institute of Technology.

Six years of stay in Thailand gave a lot of experience, and many friends in South East Asia as well.

AIT is consisting of students from many countries, 40 to 50, and of faculty members from more than 15 countries always. Therefore, discussions at AIT were always vivid, exciting and fruitful. I found occasionally that some students take anything titled "theoretical" as not practical. For example, when I had a lecture titled "

Theoretical Hydrodynamics", some students, not all, thought the hydrodynamical phenomena described by theories would never take place in the real world, and practical design, for example, might be something else. On the other hand, some students thought that theory was everything.

From the above experience, I made it a rule to explain that there are three "m"s important for civil engineers. They are, mathematics, measurements and maintenance.

Mathematics stands for "theory", which is a very strong tool for engineers if they can make use of it.

Measurement is important for design work. Without analyzing field data, it is almost impossible to design river an coastal structures.

Finally, maintenance of structures is very important to make fully use of expensive structures.

And I strongly believe that to ensure these three "m"s is the principal role of laboratories, particularly those of government.

4 Conclusion

If I evaluate the present situation of technology and engineering of Japan, they are strongly backed up by science. As a matter of fact, Japanese leaders up to WW II thought that science was a key to strong military. It was after the war that many Japanese realized that engineering and technology were important for the further development of Japan. It was relatively easy to encourage engineering, since Japanese education system already established a reasonable education system for scientists.

As for civil engineering, disaster prevention technology became strong, which contributed a lot for economical development. Public Works Research Institute contributed a lot by technology innovation and by supplying strong professors to universities.

I strongly believe that to have strong scientists is the key for further development of engineering and technology in a long run.

(D) COUNTRY REPORT

I. People's Republic of China

Mr. Wu Jishan, Director,
Institute of Mountain Hazards and Environment,
Chinese Academy of Sciences

1. AN OUTLINE OF CHINA

1. 1. Description of the land

China, located in the east of Asia, has a vast territory of 9. 6 million km^2. Its major topographical features are plateaus, mountains and hills which account for about 66% of the country's land and its surface outline descends from west to east in a three-step staircase. At present, the area of land utilized is about 564 million ha. , which account for 72. 2% of the country's utilizable area and 58. 8% of the total area.

1. 2. Climate

In China, some districts are warm all the year round, while others have long winters and short summers. The annual precipitation decreases gradually from the southeast coast (the average 1, 000 to 2, 000 mm) to the northwest interior (100 to 200 mm). However, monsoonal climate is one of major characteristics. Because of the monsoons' impact, there are a dry, cold northwest wind from hinterland towards the sea in winter and a hot, moist southeast wind from the sea in summer. Most of the land lies in the temperate zone with four distinct seasons.

1. 3. Demographics

In 1990 the total population of China was 1. 13 billion, with an annual growth rate of 1. 48%. The average density of population is approximately 118 per km^2. However, the distribution of population is extraordinarily uneven. Districts where population is extremely dense concentrate on the southeast coast . For example, Jiangsu Province with the highest density of population has born a great population pressure of 67 million on only 100, 000 km^2. Shandong Province, where the total area is 150, 000 km^2, has a population of 84 million. Conversely, the population in Northwest China is sparse. Tibet Autonomous Region holding a vast land area of 1, 200, 000 km^2 has only a population of 2. 2 million. Of the total population of China 26. 23% live in urban area and 73. 77% in rural area.

1. 4. Economy and society

The national economy developed rapidly. In 1992 the gross national product (GNP) was almost 2, 400 billion yuan ($ 414 billion), with GNP growth rate of 12. 8% over the previous years. The total value of industrial output rose at an average rate of 15% and that of agricultural output at an average rate of 4. 9%. The main output of industrial products was raw coal with 1. 1 billion T, steel with 80 million T, installed power capacity with 165 million kw, and petroleum with 142 million T. Also in 1992 the total import and export value reached $ 165. 6 billion, and 2600 billion yuan ($ 448. 5 billion) had been invested in social fixed assets since 1987.

2. A DESCRIPTION OF THE PUBLIC WORKS SYSTEM IN CHINA

2. 1. Master plan of national land development

Laws relating to national land development in China comprise key laws such as National Land Management Law (1986) and its amendment (1988), National Grassland Law (1985), National Forest Law (1984), National Water Law (1993), Law of National Land for Construction (1982). The other related laws include Water and Soil Conservation Law (1991), and Environment Protection Law (1979), etc..

2. 2. Budget for investment in construction

By 1995 the annual growth rate of investment in construction will reach 5. 7%, resulting in the total value of 2600 billion yuan, including 1700 billion yuan for state-owned enterprises with an annual growth rate of 5. 5% and the rest 840 billion yuan for capital construction with an annual growth rate of 2. 1%.

2. 3. Organizations concerned with public works

- Ministry of Water Conservancy: Responsible for construction of water conservancy projects and small-sized water power stations.
- Ministry of Energy: Responsible for construction of hydroelectric, themal and nuclear power plants.
- Ministry of Communications: Responsible for construction of water courses, harbours and highways.
- Ministry of construction: Responsible for construction and infrastructures of cities.

2. 4. History, progress and problems of major infrastructures

Erosion control is chosen as an illustration.

According to the statistics of 1950s, water and soil erosion covered 1. 5 million km^2, 1/6 of the total land in China, mainly scattered on the Loess Plateau, hilly areas in the south of the Yangtze, earth-rock hilly regions in the north and black soil regions in the northeast.

With 40 years' efforts, an area of 500, 000 km^2 has been harnessed; 260, 000 km^2 of forest for water and soil conservation planted; 77, 000 km^2 of terraced fields constructed; 15, 000 km^2 of land reclaimed by warping and dyke building.

2. 5. Major project in progress

The Three Gorges Project is taken as a typical example. The general construction period for the principal part of the project will last 15 years. In the ninth year after construction begins, the first power generating unit begin generating electricity. Calculated in terms of 1990' price, the total investment could reach 57 billion yuan.

3. AN OUTLINE OF IMHE

3. 1. The Institute of Mountain Hazards and Environment (IMHE), the Chinese Academy of Sciences (CAS) and the Ministry of Water Conservancy (MWC) is a comprehensive institute of mountain sciences. Its research topics are mountain hazards (debris flow, landslide, etc), mountain ecology and environment, development of mountain areas, utilization of mountain resources, mountain remote sensing and computer mapping.

3. 2. Founded on Jan 26, 1965, the Institute was originally named Southwest Branch of Geographical Institute, CAS, and it was renamed Sichuan Institute of Geography in 1971. It was returned to CAS and called Chengdu Institute of Geography, CAS in 1978. In 1987, it was renamed Institute of Mountain Hazards and Environment, CAS. It was under the dual leadership of CAS and MWC in 1989 and given the present name.

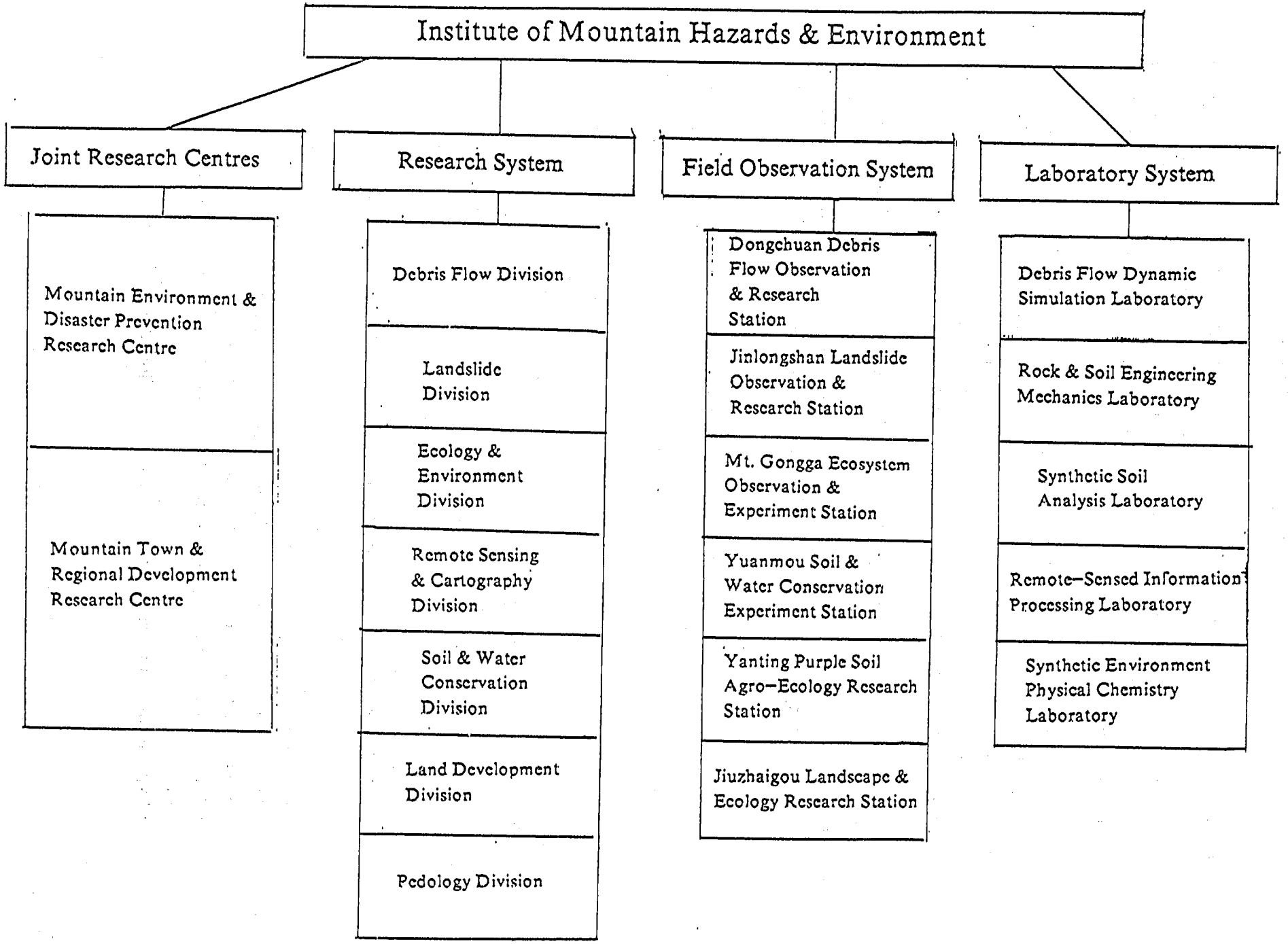
3. 3. It has a current staff of 382, among them 80 are senior research fellows, 119 middle and 88 junior researchers and engineers. There are 7 research divisions, 2 debris flow and landslide simulation laboratories and one synthetic technical and specialized laboratory. The Institute with new approaches and qualified professionals has become a major organization for mountain sciences.

3. 4. To meet the needs of sustainable mountain development, the Institute focuses its research activities on: the distribution, formation and control of hazards (debris flow, landslide, and soil erosion, etc.) in the mountain areas; the formation, evolution, and protection of and human impacts on mountain environment; the development and utilization of mountain resources, especially soil resources and the allocation of productive force in the mountain areas; and the application of remote sensing and computer mapping. Since its founding, the Institute has completed 410 research subjects or productive tasks, of which 128 obtained significant achivements with 81 prizes.

3. 5. The annual budget of the institute is 4. 5 million Yuan.

3. 6. Recent Main achievements

- Debris flow occurrence, development and movement laws and integrated control in Dongchuan, Yunnan;
- Research and assessment of the conditions of ecological environment and socio — economy in the upper Yangtze River;
- An atlas of ecology and environment in the Three Gorges of Yangtze River;
- A series of monographs of agricultural geography in China;
- A research on the land capacity in the reservoir area of the Three Gorges of yangtze River
- Experiment and research engineering of debris flow dynamic simulation;


Institute of Mountain Hazards & Environment
Joint Research Centres
Mountain Environment & Disaster Prevention Research Centre
Mountain Town & Regional Development Research Centre
Research System
Debris Flow Division
Landslide Division
Ecology & Environment Division
Remote Sensing & Cartography Division
Soil & Water Conservation Division
Land Development Division
Pedology Division
Field Observation System
Dongchuan Debris Flow Observation & Research Station
Jinlongshan Landslide Observation & Research Station
Mt. Gongga Ecosystem Observation & Experiment Station
Yuanmou Soil & Water Conservation Experiment Station
Yanting Purple Soil Agro-Ecology Research Station
Jiuzhaigou Landscape & Ecology Research Station
Laboratory System
Debris Flow Dynamic Simulation Laboratory
Rock & Soil Engineering Mechanics Laboratory
Synthetic Soil Analysis Laboratory
Remote-Sensed Information Processing Laboratory
Synthetic Environment Physical Chemistry Laboratory

4. MAJOR RESEARCH AND DEVELOPMENT PROJECTS IN IMHE

4. 1. The major research and development projects

Since the establishment of IMHE, more than 410 research and production assignments have been completed. Now about 200 projects are being carried out.

4. 1. 1. Debris flow research;

- Distribution, classification and regional characteristics of debris flow;
- Formation, movement and deposition laws of debris flow;
- Basic properties and mechanical features of debris flow;
- Observation and simulation experiment of debris flow;
- Regional planning and comprehensive control of debris flow;
- Forecast and warning system of debris flow.

4. 1. 2. Landslide research;

- Distribution, classification and regional characteristics of landslide;
- Formation mechanism and motion laws of landslide;
- Landslide simulation test and mechanical characteristics of rock and earth mass slides;
- Monitoring and forecast of landslide;
- Landslide hazard mitigation.

4. 1. 3. Mountain erosion and protection research;

- Mountain erosion mechanism, classification and distribution;
- Observation of soil erosion and its simulation experiment;
- Measurements of soil erosion rates with radioactive techniques (^{137}Cs, ^{232}Th);
- Protection measures against soil erosion in mountain areas.

4. 1. 4. Ecology and environment research;

- Integrated assessment of regional ecology and environment and development strategies;
- Integrated assessment of impacts of large projects on environment;
- Research on regional ecologic economics and urban ecology and environment;
- Utilization and conservation of natural resources.

4. 1. 5. Regional development research;

- Integrated evaluation of regional development conditions and environment impact assessment;
- Research on strategies and patterns of integrated mountain development;
- Mountain population, urban and rural development;
- Economic regionalization, regional planning and allocation of production.

4. 1. 6. Pedological research;

- Mountain soil resources and fertility theories;
- Mountain agro—ecologic system.

4. 1. 7. Remote sensing and cartography research;

- Application of remote sensing to monitoring mountain hazards and environment and to

development and protection of resources;

- Computer mapping for mountain hazards and environment;
- Theory and method of thematic mapping, serial mapping and atlas;
- Application of remote sensing to construction of city and town in mountain areas.

4. 2. One typical example of research and development in progress

4. 2. 1. Project name and research contents

The project name is "The development laws, movement process and disaster reduction theory of debris flows and landslides", which includes four research topics: Inventory, data bank and regional laws of debris flows and landslides in China; Mechanical properties of debris flows; Landsliding process and movement process and its simulation; and Disaster reduction theory of landslides and debris flows.

4. 2. 2. Background and purposes

China is one of the countries in the world subject to the heaviest damage made by debris flows and landslides. Widely distributed in 29 provinces and municipalities of China, these hazards endanger 200 cities above the county level, 10 million ha. of cultivated land, and 10,000 km of railways with an average economic loss of about 1 billion Yuan and a death toll of 500—1,000 each year. Based on the summarization of the past achievements, this project is aimed at establishing the data bank, theoretical system and control system of debris flows and landslides in China.

4. 2. 3. Organization and administration

This project is one of the basic studies specially supported by Chinese Academy of Sciences. It is hosted by IMHE and joined by othe four institutes of CAS under the guidance of an expert commission.

4. 2. 4. Period and results

Staring from June, 1993, this project will last three years. Main results include: inventory and data bank of debris flows in China; Inventory and data bank of landslides in China; and monographs of regional debris flows in China, regional landslides in China, debris flow mechanics, landslide mechanics, debris flow control and landslide contorl.

4. 3. Problems in promoting research and development

Insufficient funds and outdated technical conditions are the common problems.

5. INTERNATIONAL RESEARCH EXCHANGE PROGRAMMES IN IMHE

In 1987-1992, 294 scientists and scholars from 27 countries and regions in the world visited our institute for international meetings, scientific investigation, joint research, lecturing and training. Since 1979, 43 scientists have been sent abroad as visiting scholars or postgraduate students for advanced study.

IMHE has established a publication exchange relationship with more than 60 organizations and institutes of about 20 countries.

5. 1. Present situation

The international research exchange programmes in progress or in planning stage are as follows.

5. 1. 1. China-Germany scientific expedition on climatic changes and mountain hazards on the eastern Qinghai-Tibet Plateau. The cooperative partner is the Instiute of Geography of Gottingen University and the Botanic Institute of Hohenheim University. Beginning from 1989, this project has been conducted for 4 years.

5. 1. 2. A study on the off-farm population employment in mountain area. Given by the International Center for Integrated Mountain Development, this project started in September, 1990, and has been going for 2 years.

5. 1. 3. An experiment on methane from paddy fields. This project is the 4th subject "Observation on Trace Gases in the Atmosphere" of a joint research programm between the Chinese Academy of Sciences and the US Energy Ministry from 1988 to 1993.

5. 1. 4. China-Japan Joint Research on the Prevention from Debris Flow Hazards. The cooperative partner is the Disaster Prvention Research Institute of Kyoto University and the Agricultural Department of Kyoto University. This project is from 1991 to 1994.

5. 1. 5. Integrated environmental protection programme for the Upper Minjiang River Basin. The cooperative partner is the Royal Tropical Institute of the Netherlands.

5. 2. Problems in promotion

To further promote international research exchanges, international assistance is necessary in terms of bringing foreign experts to China and sending Chinese counterparts abroad for learning advanced technical know-how, improving our outdated research facilities and initiating new, interesting joint projects in a broader area.

5. 3. Necessity for Inter-Asian research exchange and problems

IMHE has 28 years of know-how and experiences in mountain disaster prevention and control. We need to let more countries and organizations in Asia know us and our work. At the same time, international financial assistance is necessary for personnel exchange, training, meetings and initiating cooperative projects with other Asian countries.

6. ACTIVITIES CONCERNING"DISASTER AND DISASTER PREVENTION"

6. 1. Summary

China is a country subject to frequent natural disasters, mainly floods, droughts, typhoons, hails and frosts, earthquakes, debris flows and landslides. The average annual disaster-induced loss to economy was 8 billion yuan RMB during the 1950s, 41 billion yuan during the 1980s. In 1989, disasters caused a loss of 52. 5 billion yuan. In 1990 the direct disaster-induced economic loss amounted to 61. 6 billion yuan in the whole country. Every year, about 300 counties, 200 to 300 million pecple and 46. 7 million ha. of farmland are affected to various degrees by disasters. In 1991, floods and drought were the most serious than those in a normal year, the total direct economic loss reached up to 77. 9 billion yuan. In 1992, the farmland affected by natural disasters was 51. 3 million ha. , of which the damaged area was 25. 3 million ha. , the total destroyed area was 4. 3 million ha. , and 240 million people were affected with 5000 casualties, the total direct ecnomic loss amounted to 85. 4 billion yuan.

6. 2. Present situation and problems in China

In order to reduce the loss caused by disasters, the government has adopted many measures. In 1990 the government established the China National Committee of International Decade of Natural Disasters Reduction. Under the unified arrangement of government, the related deparments of the State Council and local governments have implemented a batch of disaster reduction and study projects, such as water disaster reduction projects, earthquake, desertization projects, debris flow prevention projects, large-scale protective forests, desertizatiion prevention projects, etc. .

In the scientific aspect of disaster reduction, since 1991 the government has sponsored a large number of disaster reduction study projects involving in dozens of thousands experts. For instance , a scientific study project of dozens of million yuan investment is being carried out for reducing marine disasters, earthquake disasters, forest fire, disease and insect disasters and monitoring the disasters comprehensivelyfor applying remote sensing techniques.

However, because of the geographic conditions which favour the intense rainstorms caused by monsoon in the major industrially and agriculturally developed areas on the plains along the lower river reaches, China is under the serious threatening of floods, as well as debris flows, landslides in mountain area. In addition, because the precipitation mainly comes from the irregular monsoon, severe droughts occur occasionally. Severe natural disasters are big problems in China. Economic loss caused by disasters accounts for about 1/6 of GNP every year, and becomes more and more serious in the recent years.

Compared with the developed countries, science and technology in China are relatively backward. Especially the technique of disaster prevention and mitigation need to be improved and highlighted. Thus it is necessary to strengthen the international cooperation and exchanges

on hazard reduction.

China is still a developing country, whose economic force is comparatively weak. Financial shortage is another problem. The percentage of money used to control natural disaster is very low. In addition, the lack of master plan of national disaster mitigation, and the lack of the long-term plan to control disasters also hinder the efficiency of disaster reduction.

6. 3. Activities in the IMHE

In the recent more than 20 years, IMHE has undertaken a lot of works concerning mountain disasters with the main items as follows.

6. 3. 1. Debris flow research

- Debris flow and its comprehensive control in Heishan River in Xichuan Prefecture of Sichuan Province;
- Debris flow and its comprehensive control in eastern Xidei Ravine in Lianshan Prefecture of Sichuan Province;
- The inter-influences of debris flow and landslide on the Three Groges in Yangtze River and their countermeasures;
- The formation, development and movement of debris flows and their comprehensive control in Dangchuan City of Yunnan Province. Awarded the 1st prize of the advance of Science and technology by Chinese Academy of Science in 1991;
- Simulating experiment project of debris flow dynamics;
- Debris flows and their comprehensive control principle in Northern Section of Chengdu-Kunming Railway;
- Distribution map of debirs flows and landslides in China on 1 : 6 million scale.

6. 3. 2. Landslide reasearch

- Landslides and their prediction in reservoir of LongYang Gorge Hydro-power Station;
- Stability assessment of reservoir slopes of hydro-power project in Etan;
- Observation on the landslide stability in Jinlongshan;
- Investigation and analysis on the rainstorm-induced landslides in Sichuan Province;
- The influence of landslides and debris flows on the productivities in Panxi District in Sichuan Province.

6. 3. 3. Water and soil conservation

- The basic laws of water and soil conservation and the construction of shelter forests on the upper reaches of Yangtze River;
- The assessment of soil erosion rates on the Loess Plateau using Caesium-137 technique;
- Evaluation on the environment background for builiding up water resource forests in the upper Yangtze River Basin and investigation of the regional distribution characteristics of soil erosion in Southwest China;
- Soil erosion mechanism and soil conservation strategies and techniques in tha Jinshe River dry and warm valley, the surrounding mountain area around Sichuan Basin and the

limestone mountain area in Southwest China.

6. 3. 4. Mountain environment research

- A series of researches of remote sensing investigation method on the land resources in Sichuan Province;
- Research and evaluation on the ecology environment and society-economy conditions on the upper reaches of Yangtze River;
- Comprehensive assessment of the influence of Three Gorges on ecology and environment;
- Research on the soil environment background in Tibet;
- Natural disasters and their countermeasures in Southwestrn China.

6. 3. 5. Remote sensing and cartography research

- Remote sensing application in mountain resource and disaster research;
- Atlas of ecology and environment in the Three Gorges Area of the Yangtze River;
- Atlas of resources and dovelopment strategy in Southwestern China;
- A series of maps of resources and economic development in the Three Gorges Area.

6. 4. Comprehensive countermeasure against floods

6. 4. 1. The disaster of floods in China

China is a country with serious flood disasters. According to the statistical data from 1950 to 1980, the serious floods average are 50 times per year. Land affected by floods was hundreds of thousand km^2 each year, of which arable land was up to 10 million ha.. Crop loss was about 10 million T, and economic loss is about 15 billion yuan each year. Meanwhile, the flood disaster is becoming more and more serious. For example, the affected people in 1960s were 52 million and in 1970s were 1514 million; in 1980s, in spite of the improvement of flood prediction, the people affected by floods still increased; affected land was also increasing year by year. For instance, in Guangxi Autonomous Region, if the affected land was represented as 1 in 1950s, then in 1960s, 1970s and 1980s it should be 2, 3 and 4 respectively.

6. 4. 2. Comprehensive countermeasures against floods

China has a long flood control history. Especially since 1949, the comprehensive flood countermeasures in large rivers have made a great achivement. For example, the big water conservancy project on the upper reaches of Yellow River, large areas of water and soil conservation on the middle reaches and reinforced dikes make it not burst in 40 years. Because flood disasters are the result of various factors, flood countermeasures mainly consist of five systems.

(1)System of water and soil conservation

The system, through afforestation and terraced check dams, is to conserve water and soil, reduce water and sediments into rivers, and decrease the flood discharge and frequency. In 1982, the State Council approved to establish 8 key areas of water and soil consevation in the basins of Yellow River, Yangtze River, Haihe River and Liaohe River. It was adopted to combine water and soil erosion control with poverty alleviation and to combine the benefits of

both ecology and economy together, thus good results have been achived.

(2)System of flood storage

In order to reduce peak discharge of floods, unnumbered reservoirs have been built up on the upper reaches of rivers for flood storage and several emergency flood storage areas in the lower reaches of big rivers, such as Yellow River and Yangtze Rver, have been set up for temporal storage of floods. The completed or planning key water conservancy works of rivers in China, such as the Longang Gorge and Liujia Gorge multi-purpose projects of Yellow River, and the Tiansherqiao No. 1, Longtan, Dateng Gorge and Feilai Gorge multi-purpose projects of Zhujiang River, all have considerable capacites for flood storage. Particularly, the planning Three Gorge Project of Yangtze River has a storage capacity of 39. 3 billion m^3, of which 22. 1 billiion m^3 is for flood storage purpose, at the water level of 175 m above sea.

(3)System of river channel regulation

In order to increase flood delivery capacities of river channels, channel dredging, widening of narrow channels, regulating of meandering channels and river embankments have been widely undertaken in China. Unnumbered embankments have been built up in the areas prone to flood disasters in China for last 40 years. But the standards are quite low for most of the embankments. The total length of the embankments for city flood protection, which can protect the cities from the floods of return periods of 20-50 yeras, is 6500 km.

(4)Warning system

Through rainstorm and flood prediction and alarming, the system reports the floods, particularly large floods, situation, and provide data for disaster relief, property and resident protection. In all river networks of China, there are hydrological and water level stations, which comprise a relatively integrated warning system. Especially in the recent 10 years, the high quality instruments and their automation and hydrological station expansion greatly improve the precise prediction and warning against floods.

(5)Emergency system

When a flood is dangerous, the system will provide a planned and prepared relief, property diversion, people evacuation, and minimize the loss, especially casualties. In the rivers subject to floods frequently, particularly those close to cities and towns, feasible emergency systems are very important.

6. 4. 3. Comprehensive countermeasures against debris flow

(1) Debris flow disaster with wide distribution, strong activity and severe damage in China. According to preliminary statistics, debris flows are distributed in 28 provinces, autonomous regions and municipalities throughout China. There are about 8500 catastrophic debris flow ravines in China. The economic loss made by debris flows is up to 300-500 million yuan and 300-500 casualties. In many regions the active debris flow ravines have doubled. Since 1960s, the highway and railway department has carried out debris flows control programmes but mainly through diversion. In the early 1970s, comprehensive countermeasures were adopted. In Sichuan and Yunnan Provinces, there are more than 40 comprehensively controlled debris flow ravines, of which 23 have been ameliorated, and all took good effects. The ratio of finance input to the protected property value is 1 : 25 to 1 :

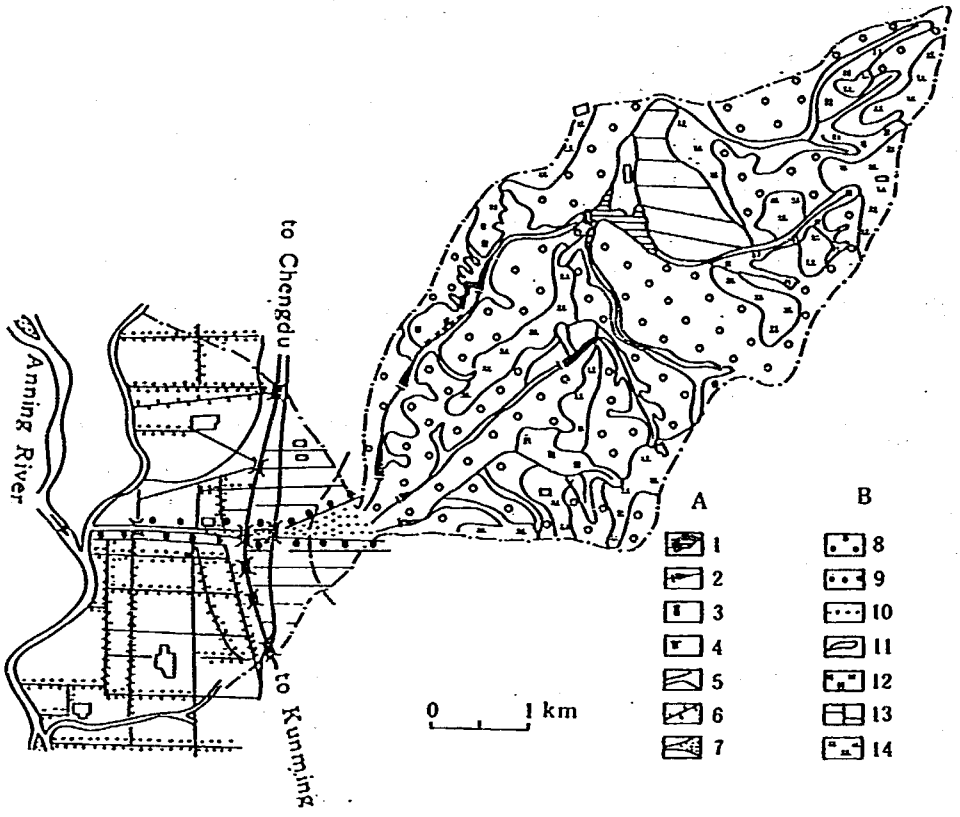


Fig. Map showing comprehensive control of debris flow in the watershed of the Heisha River

A —— Engineering measures 1 —— Reservoir of regulating flood, 2 —— Silt trap dam, 3 —— Check dam, 4 —— Bank revetment, 5 —— Diversion dyke, 6 —— Escape canal, 7 ——Silting area;
B —— Biological measures: 8 —— Forest for preventing soilerosion, 9 —— Shelter belt of diversion dyke, 10 —— Windbreak belt, 11 —— Shrub forest, 12 —— Grassland, 13—— Striped field, 14—— Cultivated land

(2)Countermeasures and a typical control project

Heisha River in Xichang City of Sichuan Province is taken as an example.

Heisha River has an area of 22. 7 km^2. Forest coverage is 2. 7%. There are 180 landslides, slumps and rockfalls, and more than 26 million m^3 of loose materials. A powerful debris flow could burst out whenever a heavy rain falls. The depositional fan is 3 km in width. The Chengdu-Kunming Railway and the Sichuan-Yunnan Highway, factories, 12 villages were often subjected to the devris flow damage.

Comprehensive countermeasures in the catchment include; a flood control reservoir with a 22-m-high dam and 540, 000 m^3 capacity, and 800 ha. conservation forest to regulate the floods and reduce their peaks on the upper reaches; 7 silt-trap dams, 5 check dams, 7 revetments and longitudinal dykes and 400 ha. of water and soil conservation forests to arrest sediment, stabilize slope and control erosion on the middle reaches; a 5. 8-km. long diversion dike, a drain ditch and 39 shetler belts to consolidate beds, release flood water or debris flow in the lower region. All the countermeasures were completed by 1978, the total investment was 1. 75 million yuan.

The projcet has obvious benefits. Since 1978, the debris flow has not occurred in the main course of the river. The amount of sediments transported out of the catchment after the treatment has been less than a quarter of what was transported out before under similar rainstorm conditions. The peak discharge induced by a rainstorm of 10 years recurrence has been 1/5 of that before the treatment on the lower reaches; in the main course of the river, the peak discharge induced by the same rainstorm has been only 1/20 of that before the treatment. 133 ha. of farmland have been recovered. The irrigation area has increased to 67 ha. , and forest coverage has increased to 59. 3% in the catchment. On the debris flow fan, a mulberry orchard base has been established. The annual output value reached 10 milion yuan in 1992 in the mulberry orchard base, with a net profits of 2 nillion yuan, equivalent to the total investment of the debris flow control project.

6. 5 Control Countermeasures to Slope Failures along Highway in China

6. 5. 1 The harm situation of slope Failures along highway

The slope Failures along highway in China are mainly landslide and debris flow disasters. 85% of the total duration for traffic interruption of the mountainous highway in rainy season resulted from landslide, debris flow (including higher sediment laden flood). The direct economic losses in a year are more than 100 M yuan; the indirect losses due to traffic interruption are more than 100 M yuan and even to 1000 M yuan. In the mountainous area of China, particularly, in southwestern or northwestern China, the debris flow and landslide activities often result in traffic interruption for several days or several months, even over a half year in rainy season. For example, there are 3428 different slope Failures along Sichuan-Xizang Highway, among them debris flow has 1036 and landslide 1525. These slope failures are mostly at Yaan-Lingzhi section. The cumulative duration of traffic interruption may be for two months in a year, even about a half year. Most disasters are of large scale and

suddenly occur. For example, layue collapse of Dongjiu in 1973, the total volume of solid materials was $4\times10^7m^3$, traffic interruptinn was for six months and the casualties were about 20; A large debris flow at Peilong Gully nearby Tongmian in 1986, resulted that all materials carried by more than 80 cars were buried and traffic interrupting was for six months. The slope failures along highway in Yunnan Province are constantly increasing with the stretch of highway. In 1949, highway in Yunnan Province was only 2783 km, but it had been to 46230 km in 1990, Most highways in mountainous area were harmed from debris flow and landslide, and on some low-grade highways, traffic was held up during rainy season. The cost for rush-repairs was 165 M yuan from 1952-1987, even up to 14 M yuan in 1986. In other mountainous Provinces, extreme harms often occur. For example, Qikouzhen Landslide of Huaying, Sichuan on July 9, 1989, with volume 1 M m^3, buried the highways and transport corps as well as residential houses, the casualties were 221 and the direct economic losses were several M yuan; The Xintan Landslide of Zigui County, Hubei, on June 12, 1985, destroyed the old highway and Xintan Town, but didn't cause casualties due to a prompt forecast; in March, 1983, Shaleshan Landslide of Dongxiang County, Gansu Province, with volume of 31 M m^3, buried 3 highways and destroyed 3 vellages, the casualties were 260; At the Heisha River of Xichang, Sichuan, the west line of Sichuan-Yunnan Highway Passed through here before 1970, Debris flow deposit fan was 3 km, the debris flow would destroyed the highway and traffic would not pass through when it was rainy.

6. 5. 2 The control conditions for debris flow and landslide along highway

The communications and transportation in the mountainons area of China mainly rely on the highway. In order to ensure the transportaion going, to control debris flow and landslide is one of important tasts in construction of the mountainous area, on the west line of Sichuan-Yunnan, Gansu-Sichuan, Xian-Lanzhou and Sichuan-Shannxi etc. Highways, the prevention and control of debris flow and landslide have been carried out early or late, and have achieved a marked effect. The harms from debris flow and landslide have been clearly reduced. After reformation and opening, the communications and transportation were put in the first place in basic construction of our country. The investments used for control projects of debris flow and landslide disasters along highway had a distinct increase. For example, Sichuan. provincial government invested 500 million yuan to transform and improve the Chengdu-Jiuzhaigou Highway, where the control of debris flow and landslide was a key. And then, the Ministry of Communications of China has examined the programm for controlling the road-bed harms along Sichuan-Xizang Highway. In 1993, The state council approved "the Regional Programme of Westnorth China" and "the Regional Programme of some Areas in Westsouth china and South China" early or late. In these programme, the construction of highway and railway was put in the important place. The National and provincial governments will allocate funds to construct and improve the highways in the mountianous area and to control the slope failures of these highways.

6. 5. 3 Control Countermeasures to debris flow and landslide disasters along highway

A series of control conntermeasures suitable to the national conditions of China have been found out through practice to control debris flow and landslide disasters along highway for 40 years. Because China is a developing country, the funds used for debris flow and landslide control are not enough. Therefore, it should persist in "effcient, reasonable, economic and reliable control" principle, and select the programm and engrneering measures which would put less funds and achieve high effects.

(1) Selection of control planning

Whether the programm would be reasonable will be directly related to engineering effects and costs. Therefore, in the areas of debris flow and landslide activities, the reasonable passing and controlling programm should be selected from route selection to running in many years.

1. Passing programm

It is possible to take a programm to detour debris flow gullies and landslides with strong activity and large scale (including the serious and lattent harms). If it could be detoured or the detoured programm would need many money, it is necessary to take the programm which will cause the least harm. The programms of high bridge and single opening (such as Jamaqimei Gully of Sichuan-Xizang Highway), tunnel or open-out tunnel may be taken in debris flow gullies; and the programms of fill (stricty forbid to excavat the base slope), building viaduct or open-out tunnel may be used to landslide.

2. Selection of individual control programm

The debris flow gullies and landslide along the highways which have been constructed should take prevention measures. If the scale of the debris flow and landslide are small, as well as there are no important buildings or a wide rang of farm land, the individual control programm will be selected. At the debris flow gullies, the drainage works, including drainage canal, drainage ditch and aqueduct etc. may be taken, but the retaining wall or dredging may be used to landslide.

3. Integrated control programm

The integrated control programm should be used to debris flow gully or landslide which the scale is large, genesis is complicated, and where the important buildings or a wide range of land should be protected. According to the formation mechanism of debris flow and local conditions, the various intergrated control programms should be selected: i. e. 1, overall intergrated control programm: to carry out the prevention and control in whole basin in order to control debris flow occurrence and prevent the harm. For example, at the Heisha River on Sichuan-Yunnan Highway in Xichang, a reservoir with a dam height of 22 m and capacity of 5400 m^3 was built, as well as the shelter forest of 800 ha was built at the upper reaches; At the middle reaches, there are 7 sediment control dams, 5 check dams, 7 longitudinal dikes or retaining walls and conservancy forest of 400 km; At the lower reaches, the drainage canal of 5. 8 km, a drainage ditch and 39 protect forest belts were built. 2, the intergrated control

programm for controlling the sediments; for example, Yanjin Gully on Ganluo-Lugu Highway in Mianing County, at the middle reaches, the key works —— retaining walls were built, and then diversion dike of 400 m and 2 sediment control dams were built in order to control the debris and spoil that caused debris flow. 3, the intergrated control programm for controlling flood; for example, Guojia Gully on Gansu-Sichuan Highway in Wudu County, at the upper reaches a diversion flood dike was built for diverting the flood that could cause debris flow. 4, the intergrated control programm for draining and diverting; for example, Xidedong Gully on Ganlu-Lugu Highway in Xide Couhty, a straight diversion ditch with a width of 20 m was built at the lower reaches. 5, the integrated control programm of building conservancy forest; for example, Xigou of Xichang on west line of Sichuan-Yunnan Highway, at upper and middle reaches, the cover rate of the conservancy forest is up to 70%. The above-mentioned programms not only protect the highway, but also protect railway, city and town, factory and farmland.

(2) Determination of Control Works

There are many control works to debris flow and landslide. Here, 4 types works which are easy to construct, nead less money and may achieve high effects will be presented;

1. Multi-functional gravity-dam

In debris flow control of China, sediment control dam is mostly adopted (including check), occupying about 50% in whole control works, in which the gravity-type grouted rubble dam is main, occupying over 70% of all sediment control dams. This dam type characterizes by simple structure, better stability, convenient materials and lower costs. In order to make the most of this dam, a sediment control dam with bigaperture drischarge orijices has be designed in recent years. For example, 3# Dam at Yanjin Gully, crack dam (the left sediment control dam at Jiuzhigou), comb dam etc. these dams can regulat the flood, dam the stone and stabilize the gully-bed.

Because the deposit bed of debris flow gully is thick, the dam foundation will be on the loose deposit layer. When debris flow passed through, the foundation of dam presented deep pits under heavy scouring, thus the foundation would loosen stability to result in damage of dam. In China, gravity dams of 60% were destructed due to these factors. Therefore, a series of measures to stabilize the dam foundation have been tried to find out; 1, concreting; to consolidate loose deposits under the dam (3# Dam of Yanjingou); 2, pile foundation; to drive the reinforced concrete piles or cast the big-aperture piles on the dam foundation; (Hunshui Gully, Yunnan); 3, arched foundation; to cast arched foundation under the dam. It may be single arch (Babuli Gully, Heisha River, Sichuan), and may be double arches (Hieisha River, Sichuan); 4, beam foundation; to cast a reinforced concrete beam at the side of lower reaches (Heisha River); 5, plate foundation; the dam foundation is a reinforced conerete plate (Heisha River). The characterestics of these foundation are; all have stable foundation of dam. The dam could not be damaged even if the dam foundation was undercut or scoured out deep pits.

2. V-type drainage trough

The angle and width of V will be determined by discharge of debris flow, the sizes of stone and gradient of the trough. Usually, when the discharge is small, the stone will be bigger, the angle of V will be smaller, and the gradient will reduce and the width should lessen. Most trapezoidal troughs were silted up in the past. After V-type troughs were employed, the deposit almost would not arise.

3. drainage ditch with ribbed sills

Generally, the sides of drainage ditch are called as embankment, and the bed of it is the loose deposits layer formed by the debris flow and flood. Nevertheless, the serious scouring led to the embankment-foundation emergence and the embankment damage. The ribbed sills i. e. to build some small transverse sills sport in definite distance to control scouring. Their distance and burial depth will be determined by the gradient of the gully-bed i. e. the top of next sill will be higher than the above one. The ribbed sill may be built through out the transverse section (Daqiao River, Dongshuan); and may be built at the side to be serious scoured (Donggou, Xide County).

4. Pre-stressed skid-resisting pilles with anchor-cable

Pre-stressed skid-resisting pilles with ancher-able is a new structure to control landslide. That is to set up anchor-cable with definite angle to level and strong pre-stress on the top of the skidresisting pilles to change the pill sate, reduce the force bearing, cross-cut area and buried depth of pill body, save the raw materials and reduce project costs. At present, it has good effects and has been applied in wide range in china.

7. ACTIVITIES CONCERNING "HARMONY BETWEEN THE ENVIRONMENT AND IMPROVEMENT OF INFRASTRUCTURE"

7. 1. Summary

China is a developing country with vast terriotory of 9. 6 milllion km^2 and huge popullation of 1. 1 billion people. Since founding of New China in 1949, China has made remarkable achievements in country's economy development and people' s livinghood improvement. However, the environment pollution and ecological environment degradation problems became severe during 1959-1980 in China because of ignorance of harmony between the environment and ment of infrastructure. The government has realized the problems and emphasized that economy development must be in harnomy with environment improvement, and protection of environment has been determined to be the basic policy of the state, since 1980. Based on the conditions in China , "putting environment prevention first", "who, causing pollution, must control the pollution", and "strengthening environment management" have been put into practice as the three important national principles against environment pollution. Therefore, the sustainable development of economy in last decade did not result in severe environment pollution as usual in China. Meantime, large scale of territory renovation has been carried out in China. Protection forests have been established in coast, river bank, and desert edge areas. Birth control policy has largely relieved the pressure of population explosion on environment. The gross national product has doubled, but the environment quality hasn't been degraded and the environmert quality in some areas has been improved since 1978. The achievements of last decade indicated that the strategies of economy and environment developments with Chinese characteristics suited to the Chinese conditions and were successful. However, China is still a developing country, implementation of economy development and environment improvement is an arduous task of long term for country because the economical power of the state is limited as other developing countries.

7. 2. Present situation and problems in China

7. 2. 1. The present environmental quality in China is not optimistic although great achievements have been made to improve environment. Both environment pollution and ecological environment degradation are considerably severe. The daily mean value of suspension dust concentration in cities varies from 80 ug/m^3 to 1433ug/m^3, The average level of the concentration is 429ug/m^3 in the cities of North China and 225ug/m^3 in the cities of South China, much higher than the allowable level of 90ug/m^3 by the standard of the World Health Organization. The daily mean value of sulfur dioxide in air in cities varies from 4 ug/m^3 to 351ug/m^3. The average level of the concentration is 92ug/m^3 in the cities of North China, and 88ug/m^3 in the cities of South China. The acid rain is localized around a few cities

suth as Changsa, Chongping, Henyang, etc. The water qualities of big rivers are not too bad, but water pollution is quite severe in the river segments near cities. In seven biggest river catchments, the river length of monitoring water quality is 43562km. The water quality is of the first or second grade by "the environmental quality standard of ground surface water" in 45% of the monitoring river segments; of the third grade, 11%; of the fourth or fifth grade, 44%. The main pollution materials in rivers and reservoirs are the oxygen exhausting organisms, the volatile phenol and ammonia nitrogen. The nitric and phosphate pollution is quite common in lakes. In most of lakes near cutues, the annual nean values of total nitrogen and total phosphorus concentration of lake water exceed the toleable level. The water qualities of big reservoirs are fairly good. Of the 16 biggest reservoirs, the water qualities of 14 reservoirs reach the first or second grade by "the environmental quality standard of ground surface water". The quality of groundwater is fairly good in most of cities. The water qualities are excellent in most of sea areas, but quite poor in some of harbor and river mouth areas. The main pollution materials of sea water are ammonia nitrogen, nitrate nitrogen and various oil.

7. 2. 2. The ecological environment in China is also not optimistic. The forests only occupy 12% of the territory in the country, the area of severe soil erosion is 1. 32 million km^2, 13. 8% of the total territory of the country, the desertification area is about 0. 16 million km^2. Unwise policies and population explosion in the rural area during the period of 1958-1978 were the main reasons resulting in worse soil erosion and desertification and in the reduction of forests. The increase in use of chemial fertilizers and pesticides results in the pollution and degradation of cultivation soils. The soil erosion causes not only land degradation in upstream areas and sedimentation in downstream areas, but also water pullution in rivers and reservoirs. The total sediment discharge is 3. 5 billion T per year in China.

The government has recently made great efforts to prevent the environment pollution and degradation. Several important laws and regulations for environment protection have been promulgated, such as "the land management law", "the soil conservation law", "the water law ", "the water pollution prevention law", and "environment protection law". Mr Li peng, the primary minister of the state attended the United Nation's symposium on environment and development in 1992 and Chinese government signed the five documents of the symposium. China is keen to develop international cooperation for solving the environment and development problems in the world.

7. 2. 3. The government has put the industry pollution into the first order to be prevented because most of pollution materials come from industry. Factories have been encouraged to revise their backward production techniques or set up waste material treatment facilities to reduce waste materials. New factories must have relative pollution control systems. Delivery of waste materials over standard is punished by charge of fine fees. The industry pollution has not increased and has been controlled to a certain level for the whole China, the pollution has decreased in some regions since 1980's.

The government has also realized the improtance of protection of ecological environment and revised the policies in rural areas to encourage sustainable development of agricuture. Several forestation projects have been carried out in coast areas, desert fringe areas and the upper Yangtze catchment. The forest area has increased since 1985. The government has up two national key soil conservation areas. One is the Loess plateau, the other is the upper Yangtze River catchment. About 50 thousand km^2 of severe erosion area are recently controlled each year. To protect nature environment and bio-diversity, 468 natural preservation regions have been established with a total area of 220 thousand km^2.

7. 3. Activties in IMHE

Protection and improvement of mountain environment is one of the major objectives of IMDE. The main activities carried out by IMHE in the field of harmony between the environment and improvement of infrastrucures in mountain regions can be divded into five categories:

7. 3. 1. Investigation of mountain environment such as:

- Land usage investigation by using remote sensing method, editing a land usage atlas of Sichuan Province(scale 1 : 10000000);
- Integrated environment investigation in the Three Gorge Region of Yangtze River, editing an environment atlas of the Three Gorge Region of Yangze River;
- Investigation of chemical element background levels in Tibet;
- Investigation of soil erosion rates and sediment sources by using casium-137 method;
- Investigation of water qualities of Jialing River, Sichuan.

7. 3. 2. Monitoring environment changes in mountain regions such as:

- Monitoring the impacts of climate changes on alpine environment such as glacier advance or retreat and ecology of subalpine coniferous forests by Gongashan Alpine ecology observation stastion;
- Monitoring the impacts of human activites on the land quality and living standard in the densely populated hilly area by the Yanting Agrcultural Ecology Station;
- Monitoring the land degradation processes in the dry and hot valley area by the Yuanmou Soil Conservation and Ecology Ststion

7. 3. 3. Assesment of human impacts on mountain environment such as:

- Impacts assessment of the coming Three Gorge Hydro-power Station on Yangtze River on the ecological environment of both upstream and downstream regions;
- Comprehensive assessment of the environmental benefits of the plan of water resources forests and agricultural protection forests in the upper catchment of Yangtze River;
- Impacts assessment of tourism development on mountain environment in West Sichuan.

7. 3. 4. Pre-implementation studies of the harmony between the environment and economy development in mountain regions such as:

• Pre-implementation studies of economy development and environment improvement in the Xijiang Catchment, the biggest tributary of Zhujing River;

• Pre-implementaion studies of regional development and environment protection in the border area between Sichuan, Yunnan and Guizhou.

7. 3. 5. Strategies and measures for harmony between the environment and improvement of infrastructures in mountain regions such as:

• Strategy and policy studies of sustainable development of rural area in mountain regions of West Sichuan;

• Revegetation on bad land and reasonable utilization of degraded land in the dry and hot valley area;

• Developing and improving cultivation techniques for soil fertilization and conservation in the hilly area of East Sichuan.

7. 4. Activities for infrastructure development taking account of the global environment and the living environment.

7. 4. 1. Water in rivers and reservoirs is polluted by both point and nonpoint sources. Urban area and factories are of the point pollution sources. Rural area is of the nonpoint pollution sources. In China, industry is the main source for water pollution. According to state statistics, the gross amount of wastewater is 33. 6 billion T per year in China, of which 23. 6 billion T are produced by industry. Also, 3. 4 million T of soild waste materials, produced by industry, are dumped into rivers and reservoirs per year in China.

7. 4. 2. To control the water pollution of point source type, the following measures have been undertaken in China:

(1)Factories that may cause severe water pollution are restrictively prohibited from being located within the upper catchment of reservoirs and on the river segments for city water supply.

(2)The wastewater, produced by factories, must be treated before dumped into rivers, and 63. 5% of industry wastewater has been treated in China.

(3)Backward techniques and facilities have been revised or changed to reduce wastewster and wastewater treatment facilities have been set up for wastewater treatment. Reuse of water in factories has been encouraged by the government.

(4)Wastewater treatment factories have been built up to treat the wastewater of cities .

(5) Waste solid is restrictly prohibited from being dumped into rivers and reservoirs. Dumping waste water and wastesolid into river and reservoirs will be punished by fine.

7. 4. 3. To control the water pollution of nonpoint type, the following measures have been taken in China:

(1)Ecological agriculture has been encouraged for comprehensive utilization of bio-waste materials in rural area.

(2) Administration policies in rural areas have been revised to encourage farmers

protection their land from erosion, and soil conservation on a large scale have been carried out to reduce delivering sediment into rivers and reservoirs in China.

(3) Some pesticides such as hexachlo-rocyclohexane, chloropheny, tricloroethane, etc, causing severe water pollution, have prohibited to manufacture and use.

8. PROPOSALS FOR FURTHER DISCUSSION

8. 1. The relationship between ecologic environmental deterioration and natural disasters

The irrational economic activities of mankind, such as destroying the forest, reclaiming and cultivation on the steep slope and reclaiming land from the floodland of the river and lake, all of these lead to deterioration of ecologic environment, aggravate soil erosion, landslide and debris flow disasters, increase the occurrence, frequency and intensity of drought and flood disasters, impair the sustainable development of agriculture, as well as bring out great economic losses. For example, in some areas of Southwestern China, the landslide and debris flow disasters have increased two times in the last 40 years. The occurrence frequency and damaged area of the drought and flood disasters have almost multiplied by three and four times respectively, these are mainly caused not by climatic change, but by environment deterioration. There are similar phenomena in some developing countries in Asia. Therefore, a discussion on the following problems is very important;

- the relationship between the ecologic environment deterioration and the occurrence and development of landslide and debris flow;
- the inner link of the ecologic environment deterioration and the occurrence of flood and drought disasters;
- the coordinated development of resource exploitation and environmental protection;
- the prevention countermesaures against the natural disasters caused by environment deterioration.

8. 2. Damages caused by landslide, debris flow and flood to communications and water conservancy.

In the mountainous areas of China, railways, highways and navigation channels are often held up in the rainy season. 85% of them are caused by debris flow, landslide and floods. In China, aome large hydroelectric and water conservancy projects under construction suffer to various degrees from landslide, debris flow and floods. Most countries in Asia have similar conditions. Thus, it is necessary to discuss following problems;

- the formation process and laws of landslide, debris flow and floods;
- the reactivation mechamism of old landslides and debris flows;
- the effects of reservoirs to slope stability;
- the monitoring forecast and integrated prevention and control of landslides, debris flow and floods.

Appendix

Control Countermeasures to Slope Failures along Highway in China

1. The harm situation of slope Failures along highway

The slope Failures along highway in China are mainly landslide and debris flow disasters. 85% of the total duration for traffic interruption of the mountainous highway in rainy season resulted from landslide, debris flow (including higher sediment laden flood). The direct economic loss in a year is more than 100 M yuan; the indirect losses due to traffic interruption are more than 1000 M yuan and even to 100 M yuan. In the mountainous area of China, particularly, in southwestern or northwestern China, the debris flow and landslide activities often result in traffic interuption for several hours or several months, even over a half year in rainy season. For example, there are 3428 different slope Failures along Sichuan-Xizang Highway, among them debris flow has 1036 and landslide 1525. These slope fialures are mosthy at Yaan-Lingzhi section. The cumulative duration of traffic interruption may be for two months in a year, even about a half year. Most disasters are of large scale and suddenly occure. For example, layue collapse of Dongjiu in 1973, the total volume of solid materials was $4\times10^7 m^3$, traffic interruptinn was for six months and the casualties were about 20; A large debris flow at Peilong Gully nearby Tongmian in 1986, resulted that all matrials carried by more than 80 cars were buried and traffic interrupting was for 6 months. The slope failures along highway in Yunnan Province are constantly increasing with the incrense of highway. In 1949, highway in Yunnan Province was only 2783 km, but it had been to 46230 km in 1990, Most highways in mountainous area were harmed from debris flow and landslide, and on some low-grade highways, traffic was held up during rainy season. The cost for rush-repairs was 165 M yuan from 1952-1987, even was up to 14 M yuan in 1986. In orther mountainous Provinces, extreme harms often occur. For example, Qikouzhen Landslide of Huaying, Sichuan on 9 July, 1989 the total volume 1 M m^3 and the highways, a transport corps and residential houses were huried. The casualties were 221 and the direct economic loss was sevéral M yuan. The Xintan Landslide of Zigui County, Hubei, on 12 June, 1985, destroyed the old highway and Xintan Town, but didn't cause casualties due to a prompt forecast; on March, 1983, Shaleshan Landslide of Dongxiang County, Gansu Province, having volume of 31 M m^3, buried 3 highways and destroyed 3 vellages. The casualties were 260. At the Heisha River of Xichang, Sichuan, the west line of Sichuan-Yunnan Highway Passed through here before 1970. Debris flow deposit fan was 3 km. The debris flow would destroyed the highway and traffic would not pass through when it was rainy.

2. The control conditions for debris flow and landslide along highway

The communications and transportation in the mountainons area of China mainly rely on the highway. In order to ensure the transportaion going, to control debris flow and landslide is the one of the important tasts in construction of the mountainous area, on the west line of Sichuan-Yunnan, Gansu-Sichuan, Xian-Lanzhou and Sichuan-Shannxi etc. Highways, the prevention and control of debris flow and landslide have carried out early or late, and have achieve a marked offect. The harms from debris flow and landslide have clearly reduced. Since reformation and opening, the communications and transportation have been put in the first place in basic construction of our country. The investments used for control projects of debris flow and landslide disasters along highway have had a distinct increase. For example, Sichuan provineal government invested 500 million yuan to transform and improve the Chengdu-Jiuzhaigou Highway, where the control of debris flow and landslide is a key. And then, the Ministry of Communications of China has examined the programm for controling the road-bed harms along Sichuan-Xizang Highway. In 1993, The state council approved "the Regional Programme of Westnorth China" and "the Regional Programme of some Areas in Westsouth china and South China" early or late. In these programme, the construction of highway and railway put in the important place. The National and provinal governments will allocate funds to construct and improve the highways in the mountianous area and to control the slope faitures of these highways.

3. Control Countermeasures to debris flow and landslide disasters along highway

A series of control conntermeasures suitable to the national conditions of China have been found out through practice to control debris flow and landslide disasters along highway for 40 years. Because China is a developing country, the funds used in debris flow and landslide control are not enough. Therefore, it should persist in "effcient, reasonable, economic and reliable control principle, and select the programm and engrneering measures which would put less funds and achieve high effects.

3.1 Selection of control planning

Whether the programm would be reasonable will be directly related to engineering effects and costs. Therefore, in the areas of debris flow and landslide activities, the reasonable passing and controlling programm should be selected from route selection to running in many years.

3.1.1 Passing programm

It is possile to take a programm to detour debris flow gullies and landslides with strong activity and large scale (including the serious and lattent harms). If it could be detoured or the detoured programm would need many money, it is necessary to take the programm which will cause the least harm. The programms of high bridge and single

opening (such as Jamaqimei Gully of Sichuan-Xizang Highway), tunnel or open-out tunnel may be taken in debris flow gullies; and the programms of fill (stricty forbid to excavat the base slope), building viaduct or open-out tunnel may be used to landslide.

3. 1. 2 Selection of individual control programm

The debris flow gullies and landslide along the highways which have constructed should take prevention measures. If the scale of the debris flow and landslide are small, as well as there are no importemt buildings or a wide rang of farm land, the individual control programm way be selected. At the debris flow gullies, the drainage works, ineluding drainage canal, drainage ditch and aqueduct etc. may be take, but the retaining wall or dredging may be used to landslide.

3. 1. 3 Integrated control programm

The integrated control programm should be used to debris flow gully or landslide which the scale is large, genesis is complicated, and where the important buildings or a wide range of land should be protected. According to the formation mechanism of debris flow and local conditions, the various intergrated control programms should be selected; i. e. 1, overall intergrated control programm; to carry out the prevention and control in whole basin in order to control dehris flow occurrence and prevent the harm. For example, at the Heisha River on Sichuan-Yunnan Highway in Xichang, a reservoir with a dam height of 22 m and capacity of 5400 m^3 was built, as well as the shelter forest of 800 ha was built at the upper reaches; At the middle reaches, there are 7 sediment control dams, 5 check dams, 7 longitudinal dikes or retaining walls and conservancy forest of 400 km; At the lower reaches, the drainage canal of 5. 8 km, a drainage ditch and 39 protect forest belts were built. 2, the intergrated control programm for controlling the sediments; for example, Yanjin Gully on Ganluo-Lugu Highway in Mianing County, at the middle reaches, the key works —— retaining walls were built, and then diversion dike of 400 m and 2 sediment control dams were built in order to control the debris and spoil that caued debris flow. 3, the intergrated control programm for controlling flood; for example, Guojia Gully on Gansu-Sichuan Highway in Wudu County, at the upper reaches a diversion flood dike was build for divering the flood that could couse debris flow. 4, the intergrated control programm for drainaging and divering; for example, Xidedong Gully on Ganlu-Lugu Highway in Xide Couhty, a straight diversion ditch with a width of 20 m was build at the lower reaches. 5, the intergrated control programm of building conservancy forest; for example, Xigou of Xichang on west line of Sichuan-Yunnan Highway, at upper and middle reaches, the cover rate of the conservancy forest is up to 70%. The above-mentioned programms not only protect the highway, but also protect railway, city and town, factory and farmland.

3. 2 Determination of Control Works

There are many control works to debris flow and landslide. Here, 4 types works which are easy to construct, neads less money and may achieve high effects will be presented;

3. 2. 1 Multi-functional gravity-dam

In debris flow control of China, sediment control dam is mostly adopted (including check), accupying about 50% in whole control works, in which the gravity-type grouted rubble dam is main, occupying over 70% of all sediment control dams. This dam type characterizes by simple structure, better stability, convenient materials and lower costs. In order to make the most of this dam, a sediment control dam with bigaperture drischarge orijices has be designed in recent years. For example 3# Dam at Yanjin Gully, crack dam (the left sediment control dam at Jiuzhigou), comb dam etc. these dams can regulat the flood, dam the stone and stabilize the gully-bed.

Because the deposit bed of debris flow gully is thick, the dam foundation will be on the loose deposit layer. When debris flow passed through, the foundation of dam presented deep pits under heavy scouring, thus the foundation would loose stability to result in damage of dam. In China, gravity dams of 60% were destructed due to these factors. Therefore, a series of measures to stabilize the dam foundation have been tried to find out; 1, concreting: to consolidate loose deposits under the dam (3# Dam of Yanjingou); 2, pile foundation: to drive the reinforced concrete piles or cast the big-aperture piles on the dam foundation: (Hunshui Gully, Yunnan); 3, arched foundation: to cast arched foundation under the dam. It may be single arch (Babuli Gully, Heisha River, Sichuan), and may be double arches (Hieisha River, Sichuan); 4, beam foundation: to cast a reinforced concrete beam at the side of lower reaches (Heisha River); 5, plate foundation: the dam foundation is a reinforced conerete plate (Heisha River). The characterestics of these foundation are: all have stable foumdation of dam. The dam could not damage even if the dam foundation was undercut or scoured out deep pits.

3. 2. 2 V-type drainage trough

The angle and width of V will be determined by discharge of debris flow, the sizes of stone and gradient of the trough. Usually, when the discharge is small, the stone will be bigger, the angle of V will be smaller, and the gradient will reduce and the width should lessen. Most trapezoidal troughs were silted up in the past. After V-type troughs were employed, the deposit almost would not arise.

3. 2. 3 drainage ditch with ribbed sills

Generally, the sides of drainage ditch are called as embankment, and the bed of it is the loose deposits lager formed by the debris flow and flood. Nevertheless, the serious

scouring led to the embankment-foundation emergence and the embankment damage. The ribbed sills i. e. to build some small transversal sills sport in definite distance to control scouring. Their distance and burial depth will be determined by the gradcint of the gully-bed i. e. the top of next sill will be higher than the above one. The ribbed sill may be built through out the transverse section (Daqiao River, Dongshuan); and may be build at the side to be serious scoured (Donggou, Xide County).

3. 2. 4 Pre-stressed skid-resisting pilles with anchor-cable

Pre-stressed skid-resisting pilles with ancher-able is a new structure to control landslide. That is to set up anchor-cable with definite angle to level and strong pre-stress on the top of the skidresisting pilles to change the pill sate, reduse the force bearing, cross-cut area and buried depth of pill body, save the raw materials and reduce project costs. At present, it has good effects and has been applied in wide range in china.

II. Republic of Indonesia

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1. INDONESIAN OVERVIEW

1.1. Description of the land

Indonesia is a country comprising a vast archipelago of over 13,500 islands spread between 95 and 141 Meridian and between 6 and 11 North Latitude. Amongst those islands, Kalimantan, Sumatera, Irian Jaya, Sulawesi, and Java are considered to be big islands with the area of more than 1,000 square kilometers each. The total area of the country is over 5,000,000 square kilometers where nearly 2,000,000 square kilometers consists of land and the remaining consists of sea.
(The Territorial Map of Indonesia is shown on Appendix 1)

The archipelago is endowed with extensive mineral wealth, particularly in Sumatera and Java islands, and they are also very fertile. Active volcanoes are to be found in most of the islands.
The country is administratively classified into 27 provinces.

1.2. Climate

The climate and weather of Indonesia are characterised by two tropical seasons, that is, rainy and dry seasons. The rainy season is normally from October to March whilst the dry season is from April to September. Annual rainfall is in the range of 1,500 mm and 2,500 mm. The average air temperatures vary from 27 centigrade in the lowlands to 22 centigrade in the highlands. Indonesia being in tropical zone has relative humidity varying between 75% and 85% with its minimum of 50% and its maximum of 100%.

1.3. Demographics

The population of Indonesia in 1993 is estimated to be more than 188 millions people. It is the fourth most populous country in the world after China, India and the USA. Indonesia has actually shown impressive declining of population growth during the last decades, namely from 3.6% in 1970 to 2.08% in 1990.
The population is unevenly distributed throughout the archipelago where about 50% live in Java and Bali although the area is less than 7% of the total area. On the other hand, only 2% of the population lives in Irian Jaya and Maluku where the area is about 25% of the country.

It was reported that urban population has been almost doubled in the last two decades. Between 1980 and 1990 the annual rate of population growth in urban areas was estimated to be 5.1% percent whereas the annual rate of the whole population was about 1.8%.

1.4. Economy and society

Indonesia is officially categorised by the World Bank as a middle-income country. Over half of the labour force, more than 40 millions people, is employed in agriculture which generates just over one-fifth of the GDP. Although less than one-tenth of the labour force, about 7 million people is employed in manufacturing, the relatively high productivity in this sector ensure that it is responsible for 14% of the GDP.
At the beginning of the first Five Year Development Plan (FYDP1) the Indonesian Gross National Income per capita was about US$ 50, but it is now estimated to be more than US$ 600.

2. PUBLIC WORKS SYSTEM

2.1. Master plan of national land development

For the last two decades the Java island has produced more than 60% of the national crop commodities, for example, rice, sugar, corn, cassava. This percentage tended to decrease lately due to the conversion of the land function into non-agricultural area mainly for housing and industry. On the other hand, agricultural area in other islands was developed, so the provision of food for the national demand was being maintained in parallel with the development of the industry. At the same time development of the public works infrastructures has been also done throughout the country to stimulate the achievement of the overall objective aiming to eliminate poverty and ignorance, and to reduce economic and social imbalance amongst the regions.

2.2. Budget for investment in construction

A huge amount of funds is required to develop the public works infrastructure. This infrastructure development has so far been funded both by the national budget as well as foreign aids which are complementary in nature. The foreign aids were mostly given through the International Bank for Reconstruction and Development (IBRD), the Asian Development Bank (ADB) being the multilateral source of fund and the Overseas Economic Cooperation and Fund (OECF) of Japan, KFW of Germany, British ODA etc., being the bilateral one.

2.3. Organization concerned with public works

The development of the public works infra structures is nationally coordinated by the Ministry of Public Works. Operationally there are three directorate generals under

the ministry, namely, the Directorate General of Highways, the Directorate General of Human Settlement, and the Directorate General of Water Resources Development. In addition, there is the Agency for Research and Development of Public Works whose function is to coordinate the research and development in road engineering, human settlement, and water resources development.
(Organization of the Ministry of Public Works as shown on Appendix 2).

2.4. History, progress and problems of major infrastructures

Land transportation within the islands is highly dependent upon the road infrastructure. The total length of the road network is now estimated more than 250,000 kilometers where about 10,000 kilometers have been built since the beginning of the seventies. About 50 percent of the network consists of unpaved road by which intensive maintenance or improvement is highly demanded to provide a good transport facility. Landslides and floodings were experienced to be a natural causes which harm the road infrastructure.

2.5. Major project in progress or in planning

The focus of the road project is mainly on maintenance and improvement of the existing roads. However there are road projects to undertake new construction, for example, Cikampek-Padalarang Toll Road Project. The route is located in West Java traversing a mountainous area where cuts and fills are to be done or tunnel is to be built to provide a high standard road.
The project is so vital but it requires a large investment of more than US$ 150 million. When this toll road is finished, it will be the longest toll road in the country in that moment linking Jakarta to Bandung for 140 km.

3. AGENCY FOR RESEARCH AND DEVELOPMENT

3.1. Name of organization

It was mentioned previously that the institution which is responsible for research and development of public works is called the Agency for Reasearch and Development of Public Works. This Agency has a similar level with the three directorate generals under the Ministry of Public Works. The Institute of Road Engineering, the Institute of Human Settlement, and the Institute of Water Resources Development are institutions under the Agency of Research and Development of Public Works which undertakes research and development in road engineering, human settlement, and water resources development engineering respectively.

3.2. History

The activity of research and development of public works in Indonesia has been started before the Second World War, that is since the Dienst van Verkeer en Waterstaat was established in Bandung, West Java. The institution was composed of three laboratories for soils, construction material, and hydraulics.

When directorate generals under the Ministry of Public Works and Energy were established in 1958 the three laboratories were operationally assigned under the Directorate Generals of Hihgways, the Directorate General of Human Settlements, and the Directorate General of Water Resources Development respectively.

The Agency for Research and Development of Public Works was established in 1984 aiming to coordinate and responsible for

the research and development of public works. Since then the three laboratories were attached to the agency and their names were changed into the Research Institute for Roads, the Research Institute for Human Settlements, and the Research Institute for Water Resources Development (See Appendix 3 for the Organization Structure).

3.3. Function of the Agency

The executing agency of the Agency for Reseach and Development of Public Works has the following functions:

a. to process and coordinate the formulation of research and development policies within the ministry;
b. to guide and coordinate the development of research and development programmes and their implementation;
c. to conduct research and development of public works in order to support the ministry in carrying out its tasks;
d. to examine the equipment, materials, and construction;
e. to disseminate and publish the results of the research and development;
f. to prepare technical standards and guidelines.

3.4. Number of staff member and budget

In 1990 the Agency for Research and Development of Public Works employed more than 1700 persons. Amongst those personnels, about 370 persons undertook research work.
Just over 16 trillion rupiahs, or about 0.71% of the Ministry's budget, was allocated to the agency for 1992/93 fiscal year. The Research Institute for Roads, the Research Institute for Human Settlements, and the Research Institute for Water Resources Development received 0.26%, 0.66%, and 1.28% of the corresponding directorate general's budget respectively.

4. MAJOR RESEARCH AND DEVELOPMENT PEOJECT.

4.1. Name of the major research and development projects

Major research and development projects under the agency may be shown by the following examples:

a. Road engineering:

(1) The use of non-standard local materials for pavement and bridge construction.
(2) The use of old materials for pavement construction such as Recycling.

b. Human settlement:

(1) Housing and buildings for low income people.
(2) Human settlement to improve housing quality in densely populated areas.

c. Water resources development:

(1) Sediment control.
(2) Hydraulic structure construction.
(3) Water Pollution Control.

4.2. Research and development in progress.

Title

The development of a prototype of an ideal village for Indonesia.

Background and administrative

Most of the Indonesian people lives in rural areas where public works facilities have not been provided properly. The government tries to encourage the villagers to be a self-supported society in fulfilling their needs for the facilities. A proper technology should of course be demonstrated and be transferred to the villagers in order to make them understand how to build and maintain the facilities by themselves. The agency has selected a village in West Java in which creation of an ideal village is being implemented. This is being done by facilitating the village with public works infrastructures using locally available materials and under a simple technology.

Time period

The project was started in 1992/93 fiscal year and was scheduled to be finished within three years.

Methology

As mentioned above the methology selected in this research is by a direct application of the technology which may be brokendown into the following steps:

- Identification of the available facilities
- Investigation of the local condition, e.g. soils
- Implementation
- Monitoring.

The research is carried out jointly by the three institutes under the coordination of the Agency.

Possible results

A prototype of an ideal village for Indonesia.

Problems

During the implementation of the research few problems were experienced, for examples, lack of information on materials, field equipment, and the limited availability of funds.

5. International research programmes

5.1. Present situation

International cooperation has been performed between Indonesia and both international agencies and foreign countries, for examples:

a. International agencies under the United Nations:

UNDP/WMO : Real Time Data Collection for Operational Hydrology.
UNDP/ESCAP : Development of Rural Road Infrastructure
Both projects have been completed recently.

b. International financial agencies:

IBRD : Institutional Development and Training Project (Improvement of Quality Control of Construction Sub Project/Component 12).
ADB : Water Pollution Control Project.
Both are on-going projects.

c. Foreign countries:

The United Kingdom:
Program for Strengthening and Development of the Institute of Road Engineering (IRE-TRRL Cooperation).

Japan : - Project Type Technical Cooperation for the Development of Appropriate Technology for Multi-Storey Residential Building and its Environmental Infrastructure for Low-income People.
- Assistance for Irrigation and River Improvement.

Canada : Establishment of National Water Quality Data Bank.

Italy : Joint Research Cooperation in the field of Road Engineering.

The above five, are on-going projects.

Denmark : Study of Improved Bearing Capacity Evaluation and Strengthening Design of Roads

The above project have been completed recently.

The current situation is not much different with the above cooperations.

5.2. Problems in promotion

So far there has been no significant problem encountered in conducting joint research programmes.

5.3. Necessity for, and problems involved in inter-Asian research exchange

Necessity

Some urgent necessities may be described as follows:

- Creation of a regular communication
- Sharing findings
- Sharing problems
- Sharing information
- Sharing experience
- Improvement of man power capabilities
- Improvement of facilities for research, for example, equipment for both laboratory and field testings and investigations
- Temporary exchange among the researchers in the region
- Creation of a collaborative research
- Assignment of coordinator or secretariat for inter-Asian research exchange.

Problems

Examples of problems which may be identified are as follows:

- Lack of communication
- Lack of coordination

6. ACTIVITIES CONCERNING "DISASTER AND DISASTER PREVENTION"

6.1. Summary

Natural disaster may happen at anytime and anywhere in Indonesia. They may vary from small to large in scale. They are caused mainly by floods, earthquakes, landslides and water erosion of both seas and rivers. Most of the islands exhibit active volcanoes as Indonesia lies on a high potentially seismic disastrous region. A seismic belt passes some islands such as Irian Jaya, Maluku islands, Nusa Tenggara islands, Java and Sumatera (Map of earthquake zones of Indonesia as shown on Appendix 4).

In addition, Indonesia lies on the equator with its tropical climate. The year consists of two seasons, that is, the wet and dry seasons. During wet seasons high intensity of rain often occurs for long period of time. This causes floods at some areas and landslides at others. Waves and streams sometimes erode shores and cliffs that endanger public works facilities close at hand.
These catastrophes cases, loss of home, cut off transportation routes and telecommunication means, other structural constructions and even lives. Long period of dry season can also create a problem with road pavements, especially with roads which were constructed over expansive soils. This problem leads to cracking of pavements due to a shrinkage of soils underneath the pavements.

6.2. Present situation and problems

Some catastrophic occurrances can be shown by the following illustration:

In South Kalimantan

Sliding and deformation of road section between Martapura and Bantau. The disaster was caused by flood.

In Irian Jaya

Road section between Jayapura and Sentani slided and the Harapan Bridge cut off.

In Central Sulawesi

Road section between Poso and Tambarana and the Masani Bridge settled. The settlement was due to the scouring of the river.

In Flores

The disaster was considered to be a national problem because of such a huge loss of live and materials. This was caused by an earthquake and tsunami. The tidal wave swept the available infrastructures as well as human and lifestock.

6.3. Activities

When the disaster deals with the public works facilities, experts from the agency were asked to visit the site and then the problems were identified and investigated. Technicians were also sent when necessary. The report containing the findings and recommendation was sent to the relevant institutions. In supervision of the works the agency is usually involved.

6.4. Comprehensive countermeasure against floods or highway slope failure

As a reseach institution, the agency usually involves in the provision of recommendation to deal with the problem. For a complex case, the problem is usually handled by the three institutes and relevant institutions in order to gain an optimum results.

6.4.1. Landslide near Mount Semeru caused by rain.

Mount Semeru is located in the East of Java. It is the highest still active volcano (about 3676 meters above sea level) in Java. It has hills with steep slopes. The gradient is so steep that its slope stability is susceptible to water especially during the rainy seasons. By constrast,

the mountain is surrounded by fertile plantations and farms which can support vegetable needs of the province.
On May 14, 1981, there was a heavy rain for three days in succession. The rain intensity reached about 164 mm. The rain caused the forest on the hilly side at the east side of the Mount Semeru to slide. The saturated soil at a volume of approximately 250,000 cu meters and debris slided by its gravitational weight. The soil and debris came down and eroded small rivers and carried with them about 4 million of mud filling the rivers and covered the region. The soil, rocks and debris moved fast filling the irrigation ditches, covering roads and damaging contructions and houses.

Action undertaken :

The action undertaken by the local public works and Government offices were composed of three stages :

1. **The emergency action one.**

   a. Roads toward remote areas which were cut should be maintained for traffic to get through within 3 days.

   b. The irrigation ditches should be restored within 10 days. Water should be able to pass to the farms and plantations.

   c. Emergency embankments should be built so water can be controlled.

   d. Telecommunication system should be repaired.

2. **The emergency action two.**

   a. Means of communication system which were defected should be normalized.

b. Defected houses should be repaired and established.
c. Openings to the irrigation ditches should be constructed.

3. **The permanent action.**

a. The irrigation system should be improved for the future similar event.

b. Roads and bridges should be reconstructed.

c. Resettlement of the inhabitants to a stable land area.

d. To normalise ditch according to the master plan.

The danger of current event caused by landslide will probably occur at other locations which have similar geological, topographical and meteorological conditions.
Not all of the mud carried by the flood (14 May 1981) was totally being removed, but millions of it settled as sediment along the way which is now turned dry. Thousands of it which is located at the higher places are critical for the low land at heavy rain. For further actions such as the construction of control ditches, Sabo Consolidation Dam, retaining walls and cribs for controlling river stream should be constructed. In addition to removing the earth at the slopes, other actions include to construct surface and underground drainages, to control the ground water, to provide safety constructions (such as anchorages, retaining walls), replantation of trees and also to improve the communication means.

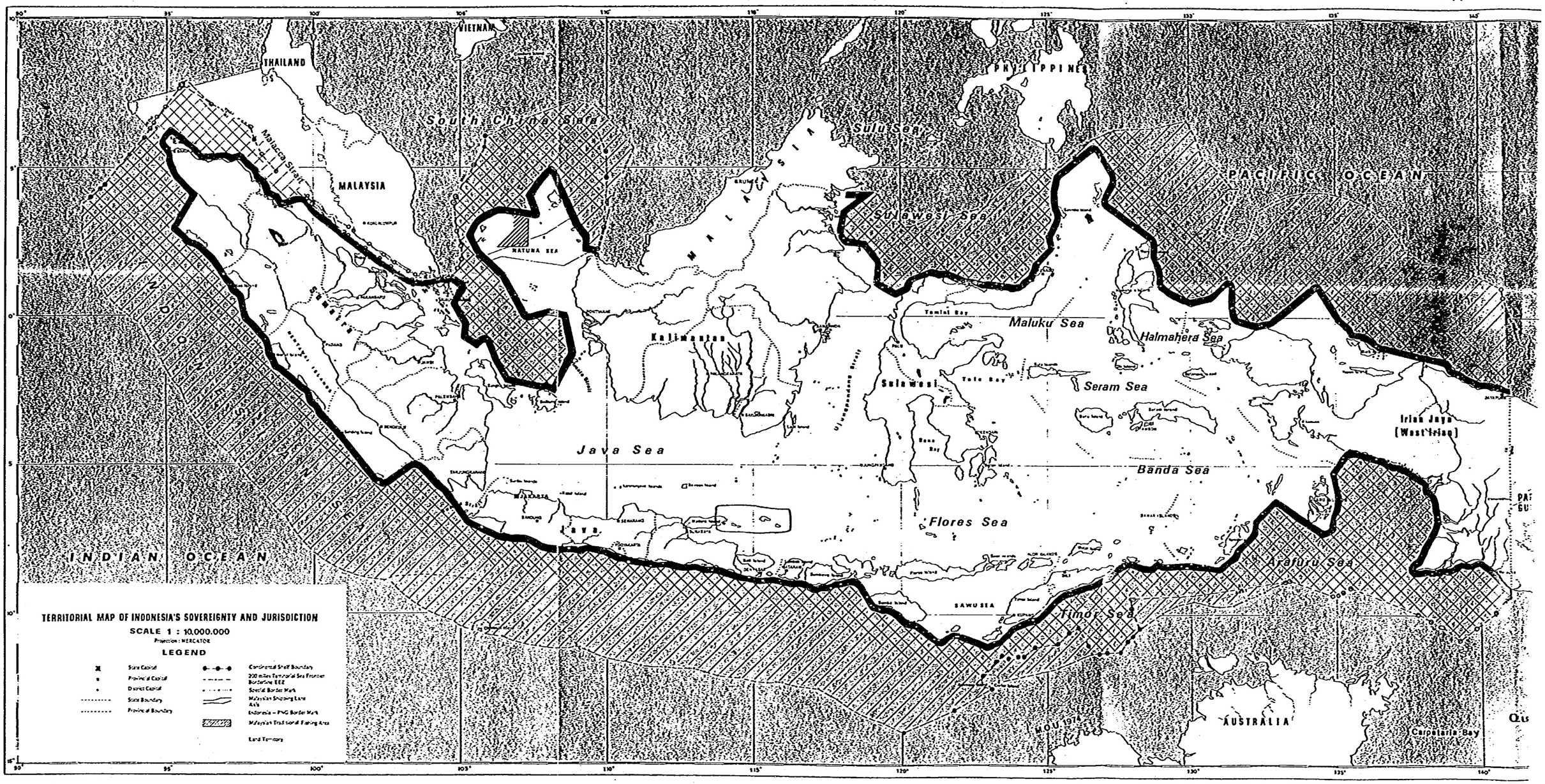
6.4.2. Landslide at Wangon (Central Java Province).

Road section between the border of West Java province and Wangon (Central Java) is a very important road,

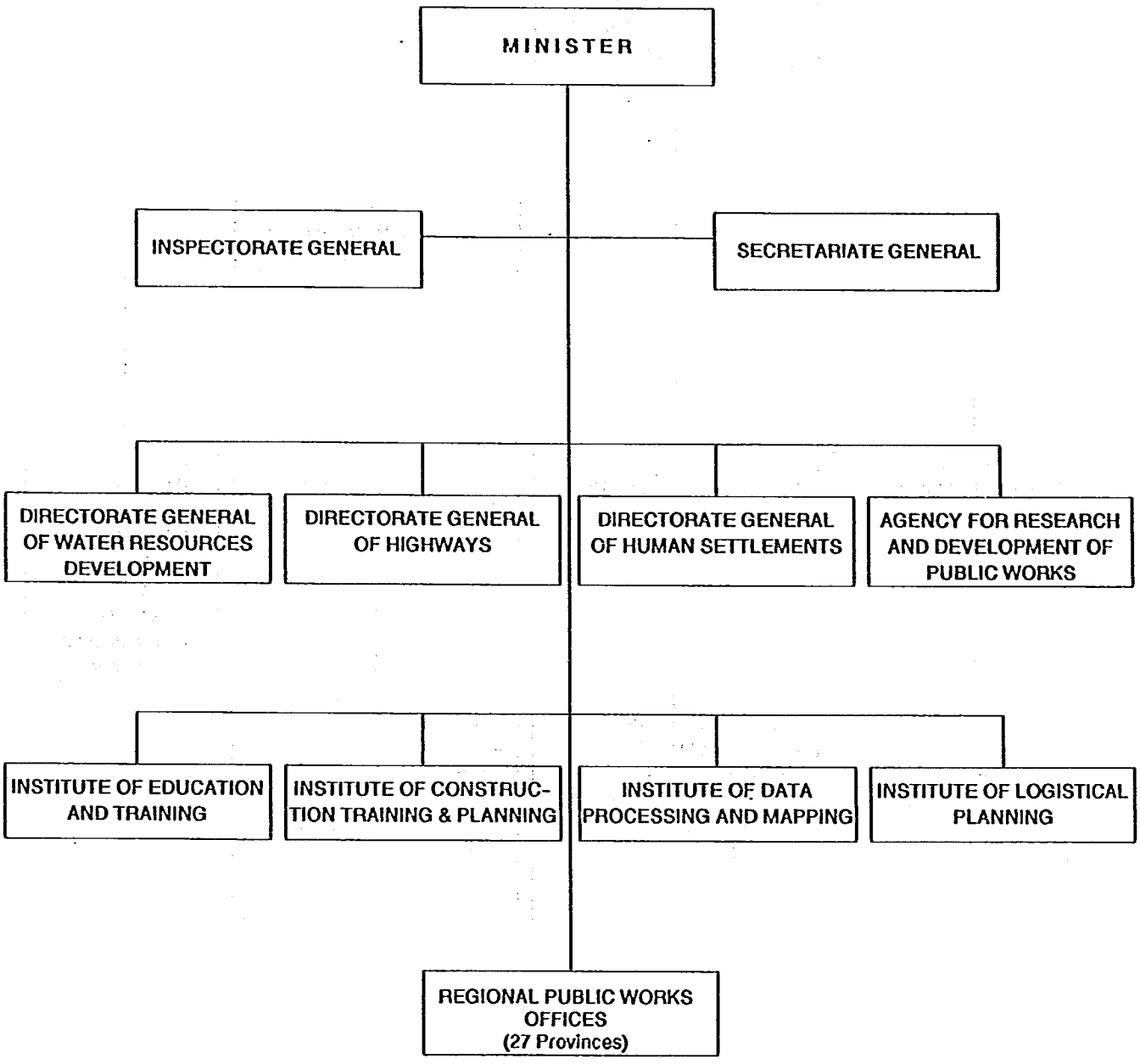
moreover since Cilacap has develoved to become a big harbor. Therefore, the transportation system should be kept serviceable. The road passes several unstable areas. Some are on an antiklin ground with disadvantageous slope of the soil layers and the condition of a hilly morphological land. Therefore, geometrically and stability are not sufficient, as land slides happen all year round and must be overcome.

Landslides mostly occur on road which is constructed on a slope, a part of the pavement lies on a cut ground slope. The ground slides rotationally with its top at the pavement facing the slope. Moreover surface and subsurface water can worsen the condition.

Methods of remedy such as constructing retaining walls, managing the drainage have to be designed carefully according to geotechnical investigation data, the depth of sliding surface and the level of ground water table.

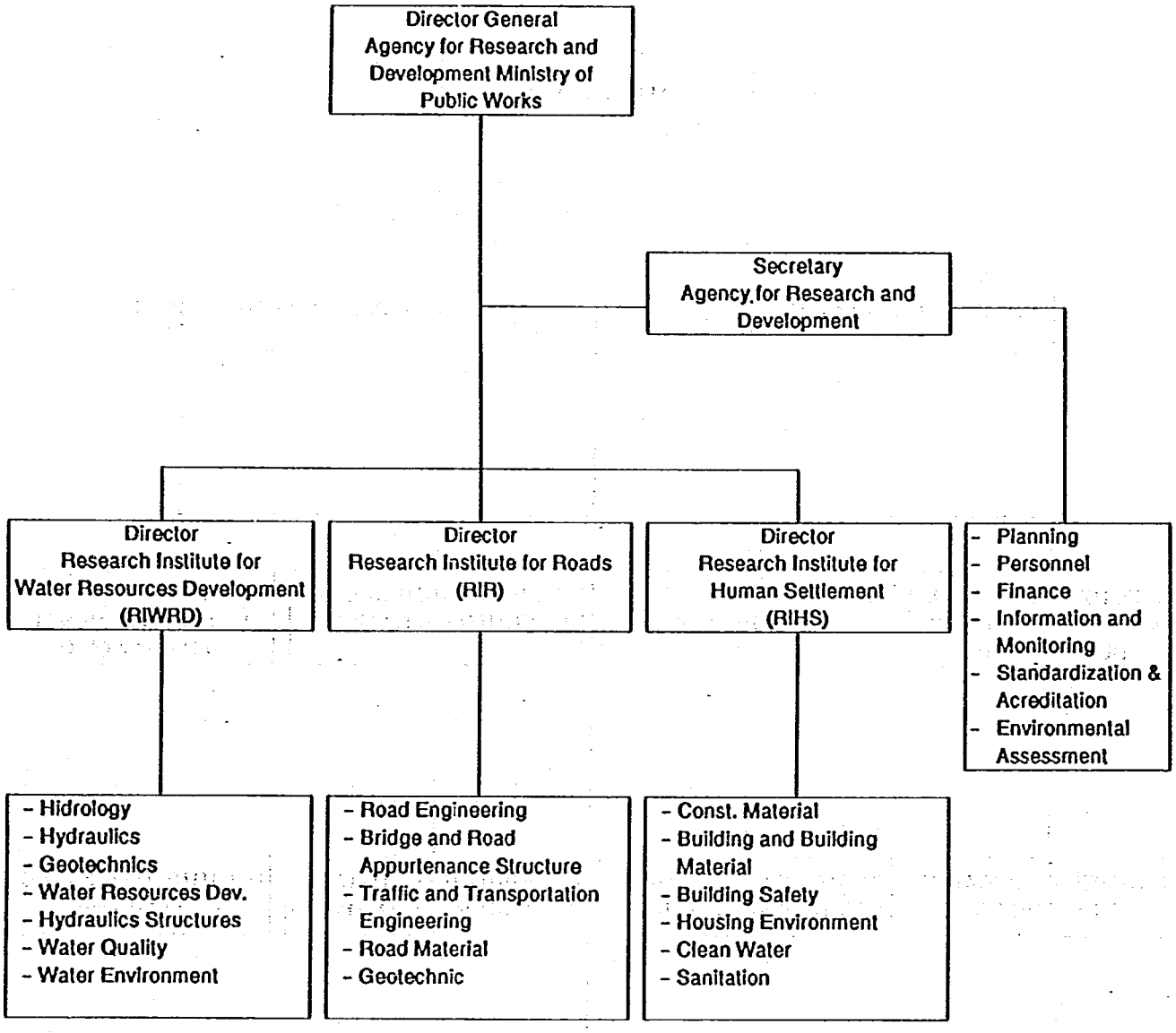

THAILAND
VIETNAM
PHILIPPINES
MALAYSIA
Malacca Strait
South China Sea
Sulu Sea
Sulawesi Sea
PACIFIC OCEAN
NATUNA SEA
Kalimantan
Maluku Sea
Halmahera Sea
Seram Sea
Sulawesi
Irian Jaya (West Irian)
Java Sea
Banda Sea
Flores Sea
Aru Sea
Arafuru Sea
SAWU SEA
Timor Sea
INDIAN OCEAN
AUSTRALIA
MOU 1974
Carpentaria Bay
TERRITORIAL MAP OF INDONESIA'S SOVEREIGNTY AND JURISDICTION
SCALE 1 : 10.000.000
Projection : MERCATOR
LEGEND
State Capital
Provincial Capital
District Capital
State Boundary
Provincial Boundary
Continental Shelf Boundary
200 miles Territorial Sea Frontier Borderline EEZ
Special Border Mark
Malaysian Shoreline Base Axis
Indonesia – PNG Border Mark
Malaysian Traditional Fishing Area
Land Territory

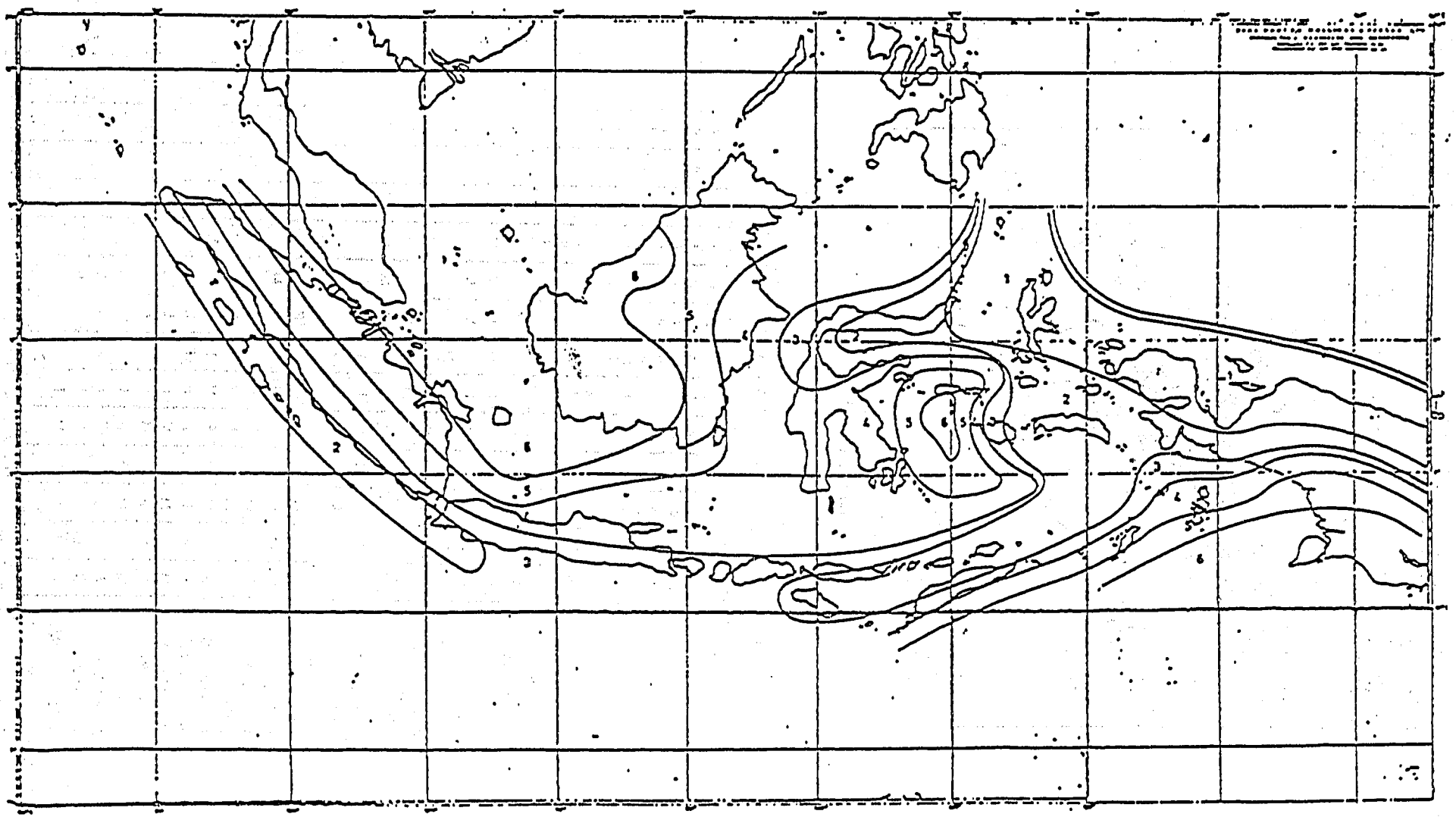
ORGANIZATION STRUCTURE OF MINISTRY OF PUBLIC WORKS



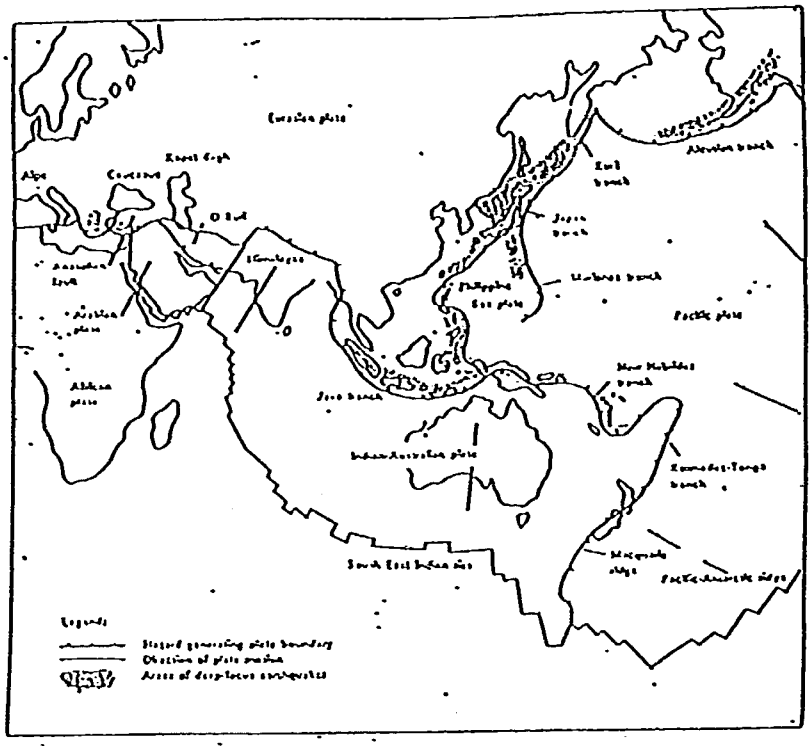
Appendix 3.

Organization Structure of The Agency for Research and Development





Earthquake area division in Indonesia which is divided into six (6) areas, based on their intensities



Earthquake Line in Asia Pacific

Relative Intensity of Disaster in Asia Pacific Countries

	Flood	Earthquake	Drought	Volcano	Cyclone	Landslide	Tsunami	Fire	Epidemic	Treecutting	Strikes	Snow	Accident
AUSTRALIA	F	L			F			F					
BANGLADESH	F	L	F		F	L	L	L	M	M	M		L
CHINA	F	F	F		M	L		M	L				L
COOK ISLANDS	L	L	F		M	L	M						L
FIJI	F	M	M		F	F	F			M			
HONGKONG	L				M	M		M		M	L		L
INDIA	F	M	F		M	L		M	M	M	M		M
INDONESIA	M	F	M	M	L	L	L	M	L				
LAOS	M		L										
MALAYSIA	M					L		L		M			
MYANMAR	M	F	M		M			F					
NEPAL	M	M	M			M		M	M				
PAKISTAN	F	F	M		L	L		L	L		L	L	L
P N G	F	F	M	F	L	F	F	L	L	M	L	L	L
PHILIPPINES	F	F	M	M	F	M	L	F	L	L	M		L
SOLOMON IS.	F	F	L	F	F	F	F	L	L				
SRI LANGKA	M		M		M	F		L	L	L	F		
THAILAND	F	L	F		M	L		L		F			M
TONGA	M	F	M	F	F	L							
VANUATU	F	F	L	F	F	F		L	L				M
VIETNAM	F	L	L		F	L		L	L	L			
WESTRN SAMOA	F	M	L	L	M	F							

Note : F = frequent; M = medium; L = low

Source : Asian Disaster Preparedness Center, Compiled by S.P. Gupta

III. Republic of Korea

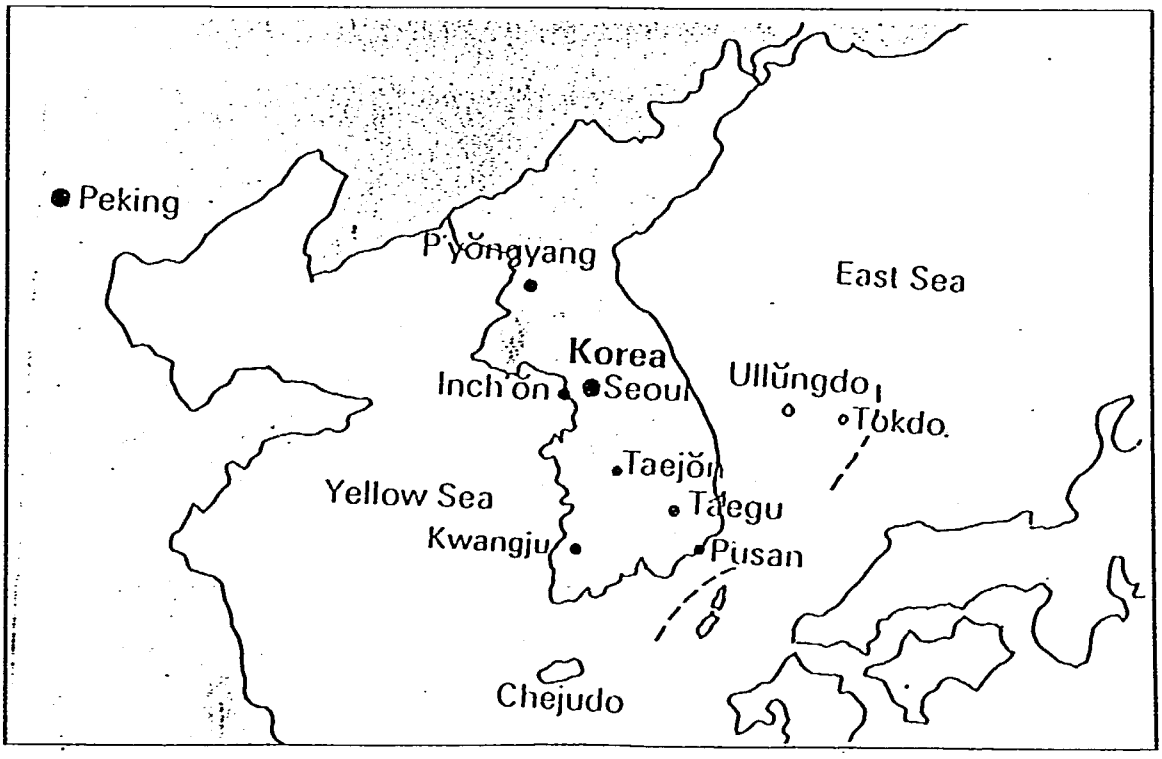
Dr. Keung-Hwan Kim,
Director, Planning & Coordination Division,
Korea Institute of Construction Technology

1. The Outline of Korea

1.1 Description of the land

The Korean peninsula extends southward from the northeastern section of the vast Asian continent. Spanning 1,000 kilomiters north to south, the size of the peninsular is about 221,000km^2. It shares most of its northern border with People's Republic of China and touches the Republic of Russia. And three sides are surrounded with the East Sea, Yellow Sea and South Sea.

Since 1948, the peninsula has been divided into two parts, the Republic of Korea in the south and Democratic People's Replic of Korea in the north. Korea has a varied terrai, which is largely mountainous(70%), with small valleys, and narrow coastal plains. The spectacular Taeback Sanmeak(mountains) runs the full length of the east coast, where the lashing tides of the East Sea have carved out sheer cliffs and rocky islets. Principal rivers, such as Han, Kum and Nakdong, all have their sources in the Taeback Mountains, and they flow between the ranges. The western and southern slopes are very gentle, forming plains and many offshore islands honeycombed with inlets. The irregular shoreline is dotted with over 3,000 islands.



1. 2 Climate

Because the Korean peninsula is located in latitude 33° -43° North and Taeback -Sanmeak extends in a north-south direction, the temperature difference among east, west, south and north is marginally. Because of the Temperate Zone and continental influences, change of season is clear in Korea. It has hot, humid summer and long, dry and cold winter. Spring and autumn are rather short, but very pleasant with crisp weather and many days of sunshine.

Temparatures range from as low as -12° C(10° F) in winter to as high as 37° C(98° F) in summer. The three months of June, July and August have the heaviest rains, with July usually the wettest month of the year. Winter starts in late November and lasts until early March. It is dominated by a high pressure zone caused by cold blasts of air from Siberia. There is little precipitation and the sky is usually clear. Winter in South Korea is generally not as severe as North Korea.

Belonged to zone of moisture climate, Korea get a lot of rain. A rainfall range 1,400 - 1,500mm in south coast, 1,200mm in middle and 800 - 900mm in north region. The seasonal variation is also remarkable with 70 percent of annual rainfall is concentrated from June to Sempember.

A rainfall of rainy season and typoon in August decide total precipitation duriong Summer. Snow generally becomes major precipitation from November to February.

1. 3 Population

The Republic of Korea had a population of 43.3 million in 1991, registering a density of 437 persons per square kilometer. The population of North Korea was about 21 million in 1991.

Rapid population growth was once a serious social problem in the Republic as in most other developing nations. Owing to successful family planning campaigns and changing attitudes, however, population growth has been curbed remarkably in recent years, though still not quite low enough. The annual growth rate was 0.92 percent in 1991.

A notable trend in the population structure is that it is getting increasingly younger. The 1985 census showed that 55.7 percent of the total population was under 25. The number of people of productive age, namely 14 and above, rose from 20,918,000 in 1975 to 29,648,000 in 1991.

Another distinction, but unwelcome phenomenon, is the continuing migration of rural residents to cities. It causes high urbanization rate. Currently, one fourth of Koreans live in Seoul. By the year 2,000, specialists predict that the urbanization rate will increase to 77 percent from the present 69.9 percent. To cope with the growing urban problems caused by such an imbalance, the government has prepared a long-term manpower development plan. The plan aims at dispersing population to provincial areas through the relocation of economic activities and balanced land development.

Minority groups are almost not exist in Korea, apart from some 30,000 Chinese, who are mostly long-term residents in the capital area.

AREA AND POPULATION(South Korea)

Area km², Population in thousand

YEAR	WHOLE AREA	ESTIMATES OF MID-YEAR POPULATION			RATE OF INCREASE
		Total	Male	Female	
1989	99,262.63	42,380	21,359	21,021	0.97
1990	99,273.70	42,869	21,568	21,301	0.93
1991	99,299.80	43,268	21,775	21,493	0.92

1.4 History

Korea remained a "hermit kingdom" with 5,000 years of history adamantly closed against the Western demands for diplomatic and trade relations in the 19th century. Korea adhered to its alliance with China, which was fighting for its own life against Western encroachment and could not help Korea. Japan, which had risen as a new industrial power, eventually stepped in to the power vacuum and annexed Korea. The Choson Kongdom(Yi Dynasty) fell in 1910.

Before the end of the World War II, the allies at Yalta had secretly decided that Korea, like Germany, would become a trustee of the allied victors. In accordance with this exclusive pact, the United States and the Soviet Union occupied Korea after the war and brought with them the cold war rivalry, which

later divided the peninsula.

In 1948, general election were held in the southern half of the peninsula to found the Republic of Korea with Sungman Rhee as President. In North Korea, a communist regime was established under Kim Il-sung.

Most Koreans were enraged with the division of their country which brought on the tragic Korean War(1950-53). The entire land was devastated and millions of people were left homeless and separated from their families during war. A cease-fire was signed in July 1953, and both sides have since gone through enormous changes in their efforts at rehabilitation.

Reunification remains a sacred goal for people on both sides of the vigilantly guarded Military Demarcation Line. Nevertheless, the entangled superpower interests surrounding the peninsula and the deep ideological differences among Koreans themselves conspire to keep the fortified boundary as impenetrable as ever.

1.5 Economy

Over the last quarter century, the Republic of Korea has achieved what is widely acclaimed as "the economic miracle of the century." Since Korea embarked on economic development in earnest in 1962, its economy has grown at one of the fastest paces in the world. As a result, Korea, for long one of the world's poorest agrarian societies, has emerged as an upper middle-income, fast-industrializing country.

During only three decades from 1962 to 1991, Korea's gross national product increased from US $2.3 billion to US $207.5 billion, with per capita GNP soaring from US $87 to US $6,498. The key to this success was the adoption of an outward-looking development strategy making exports the engine of growth. This strategy reflected Korea's insufficient natural endowments, its limited domestic market, and its abundant, well-educated, industrious manpower.

The economic structure was radically trasnsformed as a result of the successful execution of several phases of 5 years socio-economic development plans, during these years. The manufacturing sector increased its share of GNP from 14.5 percent to over 39.3 percent in 1991. The domestic savings rate rose to 36.1 percent from 3.3 percent during the same period. After Korea marked a surplus in international trade in 1986 for the first time in history, its

economy progressed rapidly in the manufacturing and mining sectors. Export-oriented manufacturing, which received strong governmental support was particularly successful, and the country's balance of payments improved in recent years.

Of course there are several thorny problems that need to tackle. One is rising labor costs that threaten to erode the competitiveness of Korean products. Another is mounting protectionism of the industrialized countries, especially in Korea's major trading partners. But those ploblems can be overcome by accelerating industrial adjustment toward high value-added technology and knowledge intensive products, combined with greater market diversification. The governmental support for technology development is rising step by step. And Korea has been continuously putting many efforts to enter the ranks of the industrialized countries and assume an increasing role in international endeavors for progress and prosperity.

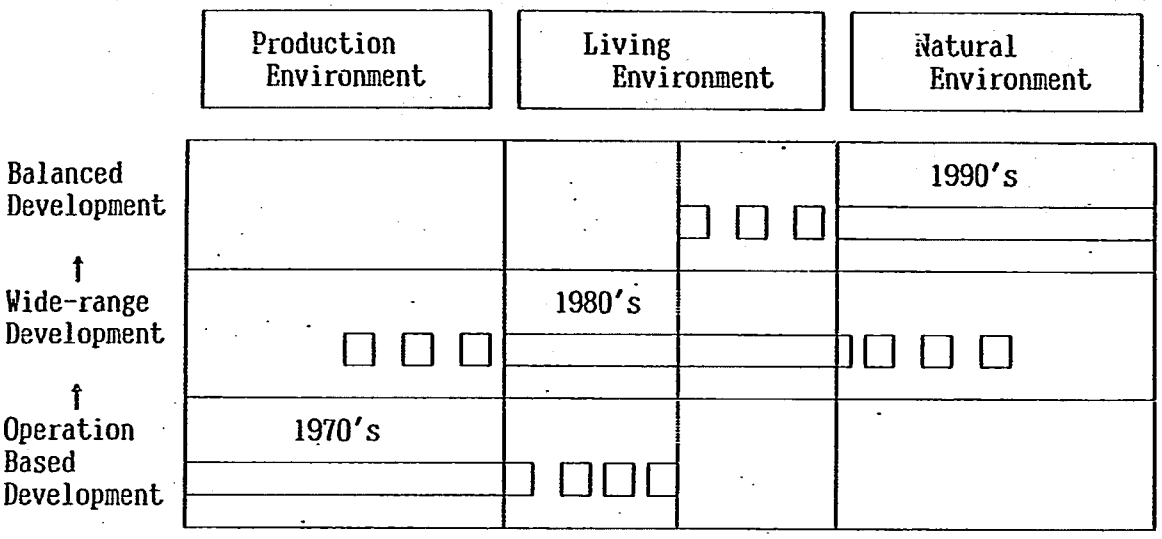
2. National Development and Public Works

2.1 The comprehensive national physical planning

○ Basis of the planning

- Promulgate the law of in 1963
- Establish the basic plan in 1968
- UNDP/SF team investigated the plan for 2 years
- A Presidential Decree No. 26(1971.10.26) to execute the 1st plan

○ Phase of the plan



A. 1st the comprehensive national physical planning(1972-1981)

Division	Achievements
Industrial Complex	· Industrial area 102㎢ → 332㎢ · Industrial water facility 648,000㎥/day→1,903,000㎥/day · Construction of the industrial complex - Pohang, Ulsan, Changwon, Yucheon (whole country level) - 24 provinces including Chungju, Kunsan, Kwangju, etc.
Traffic	· Traffic capacity - passenger : 32billion/㎞ → 86.7bil./㎞ - freight : 16billion ton/㎞ → 23.2bil. ton/㎞ · Construction of highway : 7 lines including Seoul-Pusan, etc. · Construction and pavement of national road : 3,250 ㎞
Water Resources & Land Use	· Soyang-dam, Andong-dam, Dacheong-dam, etc.(4.1bil.㎥) · Setting up 'Green Belt' for environment conservation

B. 2nd The comprehensive national physical planning(1982-1991)

Division	Achievements
Population Disperse Policy	· Assignment of specific regions (Jeju Island, Taebaek Mt. etc) · Setting up agricultural industry area (24.3 km²) · Working out a master plan for arrangement of metropolitan region
Traffic, the Use of National Land	· Expansion of six highways including 88 Olympic Highway : 491.3 km - Completed, 679.7 km - to be started · Construction and pavement of national road : 589 km · Reclamation of land by drainage · Setting up large scale industrial areas
Citizen's Welfare	· Water supply capacity 15.7 mil. ton/day ratio of diffusion : 78%, area, 524 cities · Housing construction : 2.2 mil. units · Construction of new towns · Telephone expansion : 11.7mil. lines
Environment Conservation	· Expansion of national parks : 2,794 km² → 6,440 km² · River improvement : 30.6% → 54.1% · Setting up conservation area of national land:52,138km² · Construction of multipurpose dam including Chungju, etc. [Water demand : 29.4 bil. ton [Water supply : 27.6 bil. ton

C. 3rd The comprehensive national physical planning(1992-2001)

Division	Plan
Assignment of New Industrial Area	· - Asan Bay, Daejeon, Cheongju - Kunsan, Janghang, Iri, Junju - Kwangju, Kwangyang Bay] 3 Areas are intensively industrialized in connection the west sea area development · Setting up small industrial complex · Setting up high tech industrial areas
Traffic	· Construct X shape road net · Construct highway (1,500km) · Double track railroad (27% → 54%) · Railway electrification (17% → 50%) · Construct new airports in Yongjondo, Chongju, etc.
Preparation for National Unification between North and South Koreas	· Development of DMZ area · Restoration of railway and national road · Joint development of economic co-operation complex in demilitarized zone

Division	Plan
Environment Conservation	· Strangthening the standards of environment conservation · Investment for environment : 0.15%→1.5% of GNP by 2001
Housing Construction	· Construct 5.4 mil. housing units : supply ratio up to 92.8% · Construct 2.15 mil. rental house(40% of the newly built)
Water Supply and Sewage	· Construct 18 wide range water supply system · Construct 180 sewage disposal plants · Construct 10 multipurpose Dams
Financial Resources	· Total investment : 320-370 tril. won('85 fixed price) or 16-18% of GNP · - Central government : 27% - Local government : 19% - Nongovernmental : 50% - Others : 4%

2. 2 Budget for Construction Investment

unit : bil. won

Year	GNP	Increase Rate(%)	Budget for Constrution	Increase Rate(%)
1973	32273.8		3331.4	
1974	34903.6	8.2	4001.0	20.1
1975	37143.3	6.4	4251.7	6.3
1976	42001.6	13.1	4789.6	12.7
1977	46135.4	9.8	5969.8	24.6
1978	50645.6	9.8	7591.4	27.2
1979	54289.5	7.2	8093.6	6.6
1980	52260.8	-3.7	7793.5	-3.7
1981	55354.3	5.9	7035.6	-9.7
1982	59322.2	7.2	8443.1	20.0
1983	66803.0	12.6	10657.7	26.2
1984	73004.0	9.3	11436.4	7.3
1985	78088.4	6.9	12011.1	5.1
1986	88173.5	12.9	12338.2	2.7
1987	99611.6	13.0	13761.8	11.5
1988	111979.9	12.4	16106.5	17.0
1989	119534.8	6.8	19429.1	20.6
1990	130373.5	9.1	25199.4	29.7

note) 1985 fixed price

2. 3 Organizations Concerned with Public Works

Project owner	Names of organizations
Center Government	· central government and its affiliated organization, the legislature, the judicature, military units, national schools, etc.
Local Government	· Seoul metropolitan government, Pusan and four cities, each province and districts, Board of education in provinceial districts, Public shcools, etc.
Government-invested corporation	· national banks, corporations, etc.
- Special bank	· the Bank of Korea, Industrial bank of Korea, etc.
- Corporation	· Korea power corporation, Korea Highway Corp., Korea Petroleum Development Corp., Korea Broadcasting Corp.,etc.
- Stock company	· Pohang Steel and Iron Copmany, etc.
Other public organization	
- Government supported institution	· Korea Advanced Institute of Science and Technology, Korea Korea Standards Research Institute, etc.
- Local governnt invested institution	· Seoul Kangnam Hospital, etc.

2. 4 Major Infrastructures and Public Works

2. 4. 1 the Present Status of Social Overhead Capital(SOC)

- SOC Stock of 1987 was 70.2 tril. won which is four times higher than 1977's. But the ratio of industrial total capital stock has decreased to 22% from 24% during some period.
- The stock of water resources and telecommunication increased 20% annually, while traffic and living facility 11-14% only.
- Traffic facilitiy of highway, railroad, harbor, etc. increased 11.9% annually while the ratio of stock has decreased to 38% in '87from 49% in '77.

the Social Overhead Capital Stock

(Unit : bil. won, %)

	1977		1987		increase '77-'87	
	amount	ratio of GNP	amount	ratio of GNP		annual increase rate
· Traffic	3,594 (48.8)	20.2	26,697 (38.1)	25.2	3.1	11.9
Highway	2,163 (29.4)	12.1	15,119 (21.5)	14.3	2.9	11.3
Railroad	1,286 (17.4)	7.2	9,859 (14.1)	9.3	3.2	12.3
Harbor	125 (1.7)	0.7	1,376 (2.0)	1.3	4.6	16.4
Airport	20 (0.3)	0.1	343 (0.5)	0.3	7.1	21.7
· Living Facilities	2,020 (27.4)	11.3	18,225 (26.0)	17.2	3.8	14.1
Water Supply and Sewage Treatment	374 (5.1)	2.1	2,971 (4.2)	2.8	3.3	12.7
Electricity and Gas	1,646 (22.3)	9.2	15,254 (21.8)	14.4	3.9	14.4
· Telecommunication	745 (10.1)	4.2	10,545 (15.0)	9.9	5.9	19.4
· Water Resources and Flood Control	1,005 (13.7)	5.6	14,697 (20.9)	13.9	6.1	19.8
Social Overhead Capital(A)	7,364 (100.0)	40.4	70,164 (100.0)	66.1	4.0	14.8
Industrial Total Stock (B)	30,314		312,412		4.3	15.7
(A/B)	(24.3)		(22.4)			

* Notes : fixed price

2. 4. 2 Highway

· Total road length : 56,715 km as of '90

- Automobile increased 2.6 times while road construction 1.2 times after '86
- Unpaved road is 16,170 km (28.5% of total length)

· Economic loss is seriously caused by heavy traffic congestion.

2. 4. 3 Railroad

· Total railroad length is 3,091.3 km as of '90

- the ratio of railway electrification : 17%
- the ratio of double lines : 27.4%

2. 4. 4 Habor and Sea transport

· 346 million tons of cargo is handled at harbor in 1990 with annual increase rate of 10.2% .

- Container with 2,393 TEU in 1990, increases 15% annually.
- Present capacity of cargo handling is 189.9 million tons and increases 9.7% annually.

2. 4. 5 Airport

- Domestic passenger is 110 mil. in '90 and has been increase 13.3% annually. Domestic cargo reaches 182 thousand ton with annual increase of 20.1%.
- International passenger is about 9,360 thousand
  - Kimpo Airport is expected to surpass its capacity in 1995 and Kimhae Airport in 1993 or thereafter.

2. 4. 6 Electric Power

- Power Consumption is 94,383 GWH in 1990 with average increase rate of 14.9%.
  - Max power in 1990 was 17,251 thousand KWH.
- Power demand is expected to increase on more large scale.

2. 4. 7 Water Resources

- Water Resource has balanced demand and supply at present with exceptions at Ulsan, Chungju, etc.
- Wide range water supply network is focused in metropolitan area (75% of total supply).
- The price of water supply is relatively low, which results in financial constraints to construct water facilities.
- 3.9 trillion won is supposed to be invested during 1992-2001.

Stock of Major Social Overhead Capital

Unit : km, thousand ton/day

Year	Highway	Railway	Harbor Capacity	Water Supply	Sewage Treatment Capacity
1982	53,936	6,113.4	87,423	8,076	822
1983	54,600	6,128.7	95,512	8,386	822
1984	51,004	6,168.1	100,317	9,498	822
1985	52,264	6,299.0	112,778	10,214	822
1986	53,654	6,323.6	118,413	11,505	973
1987	54,689	6,339.9	150,676	12,613	4,262.5
1988	55,778	6,456.2	168,774	14,442	4,644.5
1989	56,481	6,436.6	184,739	15,725	4,945
1990	56,719	6,434.6	189,926	16,274	5,097

2. 5 Major Project in Progress or in Planning

Unit : trillion won

Section	Main Works	Investment		
		Total	1992-1996	1997-2001
Highway	· highway [new construction 1,500km [extension 700km · national road [new construction 1,100km [extension 5,500km	39.3	18.5	20.8
Railway	· rapid-transit railroad 915.7km	18.9	6.092	5.588
	· metropolitan area electric railway 269.4km		1.737	0.159
	· subway in large city 536.4km		1.71	1.043
Harbor	· container, freight	7.5	3.088	4.401
Airport	· new airport	3.2	2.725	0.489
Distribution	· construction of complex terminal	0.7	0.434	0.3
Water Supply	· multipurpose-dam, wide range water supply, industrial water, etc.	3.9	2.826	1.045
Total		73.5		

* Notes : Nongovernmental 2.5 trillion won was excluded in habor project.

3. R & D Activities in Public Works

3.1 Status of construction technology

The Korean construction industry has executed many types of construction projects successfully, and has become the major industry with contribution to GNP of higher than 9%, however, this growth was mainly through labor intensive construction works and thus the level of construction technology is still fell behind comparing with that of advanced countries.

The level of construction technology of Korea was assessed for various of types of project and for various stages of construction activity by comparing with those of advanced countries. The results are quantitatively expressed in Table-1 for representative construction works by assuming the present technology level of the advanced countries as 100.

As appeared in this table, although the technology level of simple construction is fairly high for most types of project, level of technology intensive stages, such as planning, operation & maintenance and supervision, and also that of technology intensive construction works are still low.

The construction industry is willing to put every effort and to utilize the best technology in execution of many construction projects, such as expressway, main roads and other facilities of social overhead capital to leave artistic construction products as the legacy to our descendants.

Level of construction technology
(Index : level of advanced country = 100)

Facility	Stage of construction activity				
	Planning Investigation	Design	Construction	Supervision	Maintenance
Bridge	66	68	73	62	62
Nuclear Power Plant	45	45	60	45	55
Road & Airport	72	75	85	75	80
Railway	68	70	85	70	75

Facility	Stage of construction activity				
	Planning Investigation	Design	Construction	Supervision	Maintenance
Tunnel	65	68	83	65	68
Dam	64	62	77	62	65
Building	59	78	73	61	60
Highrise Building	58	60	73	58	58
Water and Sewerage Facilities	57	57	67	58	56
Hydroelectric Power Plant	71	69	72	53	45
Building Facilities	73	63	76	56	63

3. 2 Policy and strategy to improve construction technology

To improve the construction technology of Korea to the level of advanced countries and thus for the Korean construction firms to become more competitive, the Government of Korea has set up long term plans for R & D and technology development.

In 1987, the Korea Institute of Construction Technology (KICT) carried out a research project to propose Long Term Direction of Research and Development of Construction Technology with a sponsorship of the Ministry of Construction. Although the project was carried out by KICT, about four hundred experts from university, industry and government were involved in the project to share their experiences.

Many aspects of construction technology were reviewed in this project and the followings were the major contents of the proposed long term plan.

1) The demands for construction technology in 21st century to meet the upgraded demand for construction product were projected and the goals and directions of R & D were proposed to fullfill these projected demands.
2) Policies and systems to promote the development of construciton technology were proposed.
3) The directions of long-term and short-term plan for research and development by determining neccessary research subject, for various sub-research field in construction technology were set up.

4) The appropriate mechanisms and strategies to secure neccessary resources including facilities, manpower for R & D and financial resources were investigated.

5) The long term plan for development of information management system of construction technology was established.

The Construction Technology Management Law which was promulgated in 1987 and become effective 1988 covers many aspects of technology development including protection mechanism of new innovative construction technology and establishment of KICT as well as construction technology information center.

According to this law and also on the basis of the Long Term Direction of Research and Development of Construction Technology, 10 years basic plan was established in April, 1991. This plan consists of various policies and basic technology development plan for various area ; the various policies include 1) supporting system for technology development 2) management of technologist 3) supporting of research institutions 4) expansion of investment for thechnology development 5) establishment of technical information management system, and 6) extention of international technical cooperation. The technology development includes defining the major area of technology development, basic plan of R & D for each area and determining the amount of financial resources required.

The following step of 10 years' plan for promotion of construction technology is establishment of detailed implementation plans for the items mentioned in it. The 5 years' implementation plan for R & D of construction technology has just been announced by Ministry of Construction in January, 1993 and include all R & D activities related with construction technology which should be conducted by university, research institute, private sector and also government.

3.3 Public R & D institutes in construction field

Unit : million won, %

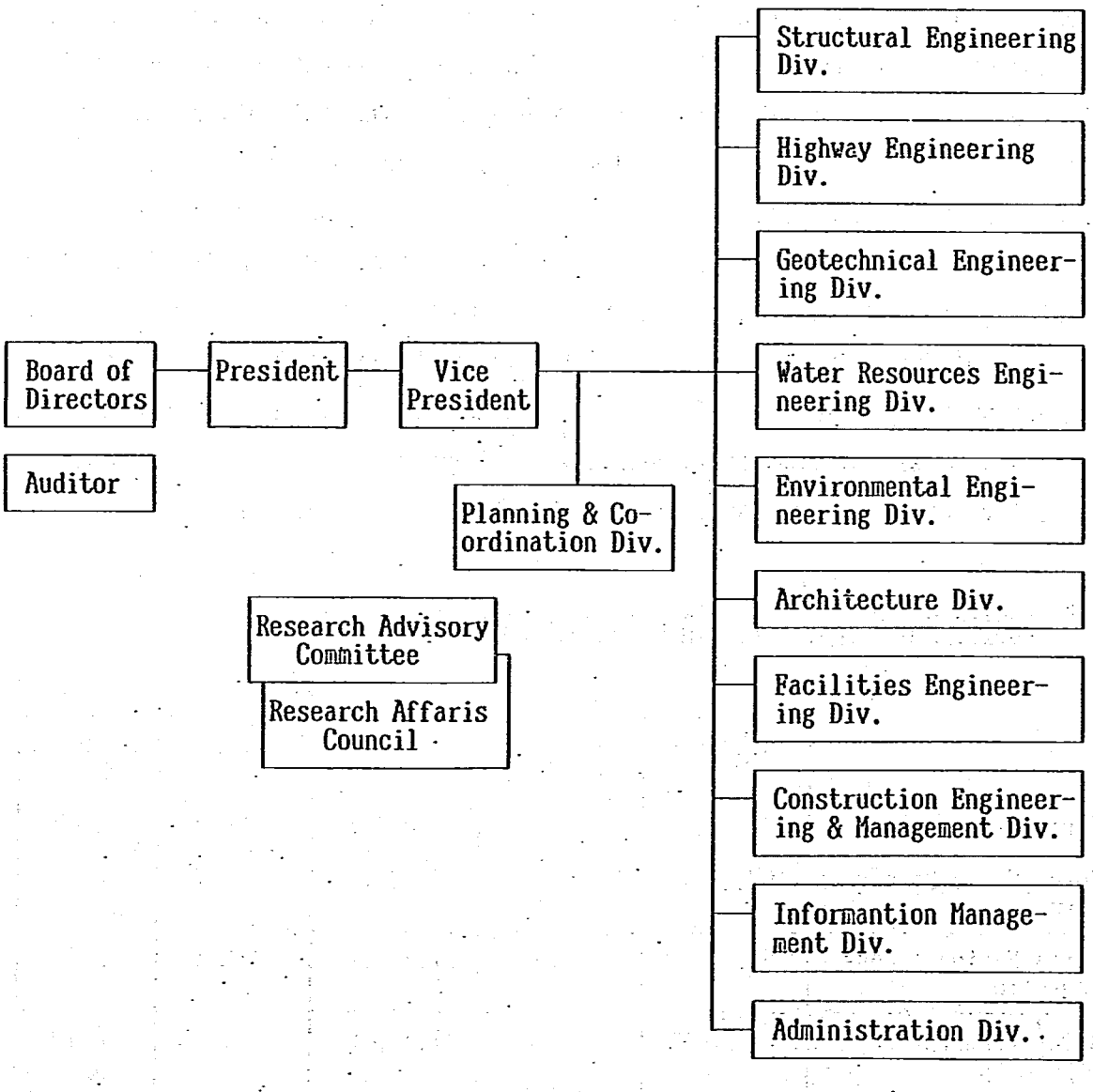
	Foundation Date	Number of R&D Staff	Net Scale	R&D Exp.	Ratio of R&D Exp.
Korea Highway Corp.	'69. 2.15	41	4,274.7	34.2	0.80
Korea Water Resources Corp.	'67.11.16	42	2,131.1	55.7	2.63
Korea National Housing Corp.	'62. 7	121	27,266.2	132.1	2.23
Korea Land Development Corp.	'79. 3.27	44	11,825.6	26.0	0.10

3. 4 Korea Institute of Construction Technology (KICT)

3. 4. 1 History

- May. 17. 1983 Inauguration of Board of Directors and enactment of the Articles of Association
  Elected Dr. Ahn, Kyung Mo as the first president of KICT
- Jun. 11. 1983 Opening of KICT as an incorporated foundation
- Sep. 1. 1986 Inaugurated Dr. Yoon, YongNam as the second president of KICT
- Jan. 8. 1988 Transformed to the government-supported institution, based on "Construction Technology Management Law". Article 7.
- Jan. 24. 1989 Inaugurated Lee, Yun Sik as the third president of KICT

3. 4. 2 Organization Chart



3. 4. 3 Number of staff member

· Regular staff

Executive	Research Technical Staff	Administrative Staff	Technician	Total
2	142	21	30	195

· Temporary staff : about 70 persons

3. 4. 4 Budget(1992) : 7,848 million

· Pesonnel Expenses : 2,510 mil. won

· Research Activities : 2,360 mil. won

· Management Expenses : 2,278 mil. won

· Construction Expenses of Laboratory : 700 mil. won

3. 4. 5 Recent achievements

KICT has completed 302 research projects during 1983 - 1992, which are composed of · KICT research 141

· Sponsored research 140

· Basic research and others

Research Field	Number of Project			
	KICT research	sponsered research	others	Total
Structural Eng.	17	23	1	41
Highway Eng.	8	10		18
Geotechnical Eng.	17	15	3	35
Water Resources Eng.	16	24	2	42
Environmental Eng.	16	32	2	50
Arcjotectire	23	15	1	39
Mechanical and Electrical Eng.	23	11	2	36
Construction Eng. and Management	13	5	8	26
Information Management	2	4		6
Common	6	1	2	9
Total	141	140	21	302

4. Major Research and Development Projects in KICT

4. 1 Title of the major research and development projects in 1993

- A study on chemical reaction of crushed aggregates
- Rehabilitation of earthquake-damaged structures
- A study on design and construction methods for long span bridges
- Early-age behavior and crack patterns of continuously reinforced concrete pavements(C.R.C.P) in Korea
- A study on automatic traffic identifications
- The evaluation of engineering characteristics for domestic marine clay
- A study on fiber-reinforced soil
- A study on property of frozen soil and pile foundation in permafrost
- A study for the groundwater management and conservation in Korea
- A study on assessment of hydrologic models
-
- A study on the improvements of sewer materials
- A study on the reuse and reclamation of treated wastewater
- A study on the use of aeration tank and soil filter adsorber for odor control in sewage treatment plants
- Development of energy conservation method for apartment housing
- Guidelines for maintenance and modernization of existing buildings
- A study on the heating system for residential building using low temperature waste heat
- A study on the power demand control system in office buildings
- A preliminary study on application of geographic information system for national facilities

4. 2 Project Summary

Structural Engineering Division

1. Research Projects

   A Study on Design and Construction Methods for Long Span Bridges

2. Period : 1993. 1. 1 ~ 1995. 12. 31

3. Background and Research Needs

   Nowadays, a number of long span Bridges (cable - stayed bridge, suspension bridge) are consturcted in our country. But the technology of the design and construction method about such type bridges remains in the underdeveloped stage in Korea. Therefore, research concerning the design as well as construction method is necessary to upgrade the technology of long span bridges.

4. Objectives

   - 1st step (1993) :
     - Investigation and analysis of research materials
     - Study on the design load
     - Study on the analysis method
   - 2nd step (1994) :
     - Study on the wind tunnel test and its standard
     - Study on the wind resistant design
     - Study on the earthquake resistant design
   - 3rd step (1995) :
     - Analysis of the construction method
     - Development of the anaylsis computer program
     - Development of computer program for the wind and earthquake resistant design
     - Development of pre and post processing system

5. Methodology

   - Design data and experience from designers
   - Constitution of an advisory committee
   - Analysis of the developed program
   - Investigation and use of the data base system

6. Anticipated Results

   - Application as a raw material of the design standard about long span bridge
   - Propagation of the long span bridge technology in Korea
   - Propagation of the useful software package for the long span bridge
   - Overall improvement of the long span bridge technology of our country

Highway Division

1. Research Project

   Early-Age Behavior and Crack Patterns of Continuously Reinforced Concrete Pavements(C.R.C.P) in Korea.

2. Period : 1993. 1. 1.~1993. 12. 31.

3. Background and Research Needs

   In order to use C.R.C.P. widely in Korea, it is needed to ascertain whether C.R.C.P. in Korea performs in accordance with the design and to compare the performances of Korean C.R.C.P. with those of other countries.

4. Objectives

   The objects of this study are to review the construction procedure and design standard of C.R.C.P. in Korea, and provide recommendations for the suitable construction.

5. Methodology

   - Construction and monitoring of a test section.
   - Analysis and evaluation of the data collected from the test section
   - Comparison of the results with those from other countries.

6. Anticipated Results

   - Provide recommendations as to design and construction of C.R.C.P. in Korea
   - Establishment of initial data-base for the performance of C.R.C.P.
   - Provision of basic data for the performance of C.R.C.P. in Korea.

Geotechnical Engineering Division

1. Research Project

   Evaluation of Engineering Characteristics for Domestic Marine Clay

2. Period : 1993. 1. 1 ~ 1994. 12. 31

3. Background and Research Needs

   As a strategic domestic land development plan for coming 21st century, a systematic land utilization of coastal belt area along the west and south coasts of Korean Peninsula has been undertaken as one of the major program in the Third National Land Development Plan.

   Since this program includes the construction of diverse and massive infrastructures, such as new city, industrial complexes, airfields, harbors, and waste disposal site, on weak marine clay formations in the near coast areas, a comprehensive study on geotechnical characteristics of domestic marine clays is a prerequisite to provide appropriate and effective schemes for design, construction, and maintenance of structures to be built in the coastal area of weak marine clay.

4. Objectives

   The purpose of this research is to establish a systematic Data Bases on engineering properties of the domestic marine clays.

5. Methodology

   - Theoretical research on fundamental behaviour of marine clay soils and provision of the method to evaluate engineering properties of the marine clay.
   - Construction of Data Bases and study on the correlations between various engineering properties of the marine clay.

6. Anticipated Results

   - Provision of the systematic Data Bases for evaluation of engineering characteristics of the domestic marine clay.
   - Optimum design and construction scheme for the embankment and foundation.
   - Development of the method for the failure prediction and stability analyses.

E. Water Resources Engineering Division

1. Research Projects

   Development of a Method for Determination of Equilibrium River Profiles

2. Period : 1993. 1. 1 ~ 1993. 12. 31

3. Background and Research Needs

   - Existing methods for determining equilibrium river profiles lack a credibility and justification of their formulations.
   - These methods are being used for river maintenance works and planning.
   - Serious problems, such as excessive scours and depositions of the river, may occur due to the use of these uncertain methods.
   - Development of a new method for determining equilibrium river profiles, therefore, is necessary.

4. Objectives

   - Developing a new method for equilibrium river bed slope

5. Methodology

   - Investigation of the methods which have been used in calculating the equilibrium river bed slope in river engineering practice.
   - State of the art review
   - Analyzing the existing methods in its structural and logical viewpoint
   - Collecting and arranging the geometric and hydraulic data
   - Developing a new method for equilibrium river bed slope
   - Comparing with the result of some mathematical models

6. Anticipated Results

   - Developing a new method for equilibrium river bed slope, which will replace the existing ones.
   - Suggesting a reliable method for estimating equilibrium river bed slope for channel improvement or river planning.

Environmental Engineering Division

1. Research Projects

   A Study on the Use of Aeration Tank and Soil Filter Adsorber for Odor Control in Sewage Treatment Plants

2. Period : 1992. 1. 1 ~ 1993. 12. 31

3. Background and Research Needs

   - Sewage treatment plants are necessary facilities for water quality management but are regarded as disgusting ones
   - The odor problems at the existing plants threaten workers health and safety, cause lower laud value, declinig environmental quality, and other social problems.
   - Lack of basic data for design and operation of odor control facility
   - From the preliminary research for the odor problems at the existing sewage treatment plants, it was proposed that the best alternative for the odor control is the use of aeration tank and the soil filter adsorber
   - Therefore, it is necessary to make research on establishing an odor control in detail by using the aeration tank & the soil filter adsorber.

4. Objectives

   - Proving odor causing substances according to the processes at a sewage treatment plant
   - Feasibility study for the employment of microbial odor control technique
   - Find design & operation factors for the odor control facility by employing aeration tank and soil filter adsorber supply
   - Develop odor-control process for the design of odor-control facility at a sewage treatment plant

5. Methodology

   - Literature search
   - Investigate the reality by surveying field facilities
   - Laboratory analysis by Bench-Scale & Pilot-Plant operation

6. Anticipated Results

   - Improvement of work condition & health environment for the operators at STP
   - Eliminate public discontent, improve living environment, and restore amenity value around the treatment plant
   - Use the results as basic data for odor-control facility design
   - Propagation of odor-control facility in conjunction with economical control process development.

Architecture Division

1. Research Project

   Guidelines for Maintenance and Modernization of Existing Buildings

2. Period : 1993. 1. 1 - 1995. 12. 31

3. Backgrounds and Research Needs

   There has been growing recognition that existing buildings represent sizeable economic resources and thus should be managed and maintained in the way to extend their usable life. This has led to greater attention on building maintenance and modernization activities. Despite this growing recognition and increasing amount of current building stocks, only a few research works have been reported regarding this subject.

4. Objectives

   This research project aims mainly at three objectives as follows.

   - Part A - Standards for the evaluation of building deterioration
   - Part B - Technical skills for building repair
   - Part C - Development of a maintenance program

5. Methodology

   In order to meet the above mentioned objectives and to establish maintenance computerization, related data will be collected using survey methods as follows.

   - Survey 1 will focus on current practices regarding building repairs, maintenance, and management.
   - Survey 2 will be a case survey about prior developments of repair computerization and maintenance operations.

6. Anticipated Results

   - Practical guidelines for the evaluation of building deterioration
   - Skills and methods for building maintenance and modernization.

Ⅲ. Mechanical & Electrical Engineering Division

1. Research Projects

   A study on the Heating System for Residential Building Using Low Temperature Waste Heat

2. Period : 1993. 1. 1 ~ 1993. 12. 31

3. Background and Research Needs

   The conventional waste heat utilization has been the use of high temperature waste heat in the industrial fields.

   However, a huge amount of the low temperature waste heat is actually exhausted from urban facilities, office and residential buildings.

   According as the ratio of energy demand for urban living is highly increasing, it in urgently required to study the technology to recover the low temperature waste heat.

4. Objectives

   It becomes a ultimate goal to seize the amount of the low temperature wast heat, which has been unused energy source in urban areas, and to purse the possibility of utilization.

   Eventually, the results of this project will assist in developing innovative energy saving system for residential buildings.

5. Methodology

   A small residential building model will be constructed to simulate the expected heating energy consumption on the various selected systems and strategies.

6. Anticipated Results

   This project is intended to be used as a general guide for designers, consultants, and building owners or operators who desire to retrofit or install new heating systems for energy saving in residential building.

Construction Engineering & Management Division

1. Research Projects

   A Preliminary Study on Application of Geographic Information System for National Facilities

2. Period : 1993. 1. 1 ~ 1993. 12. 31

3. Background and Research Needs

   - Efficient maintenance and management of national facilities by utilizing Geographic Information System
   - Necessity of integrating national facility information
   - Minimizing environmental and traffic impact of national facilities

4. Objectives

   - Search for the fundamental list of national facilities management information
   - Preliminary study on the maintenance and management of national facilities by utilizng Geographic Information System
   - Preliminary study on the application of Geographic Information System for environmental and traffic impact assessment

5. Methodology

   - Investigating foreign cases
   - Analizing national facility management operation
   - Building a pilot system

6. Anticipated Results

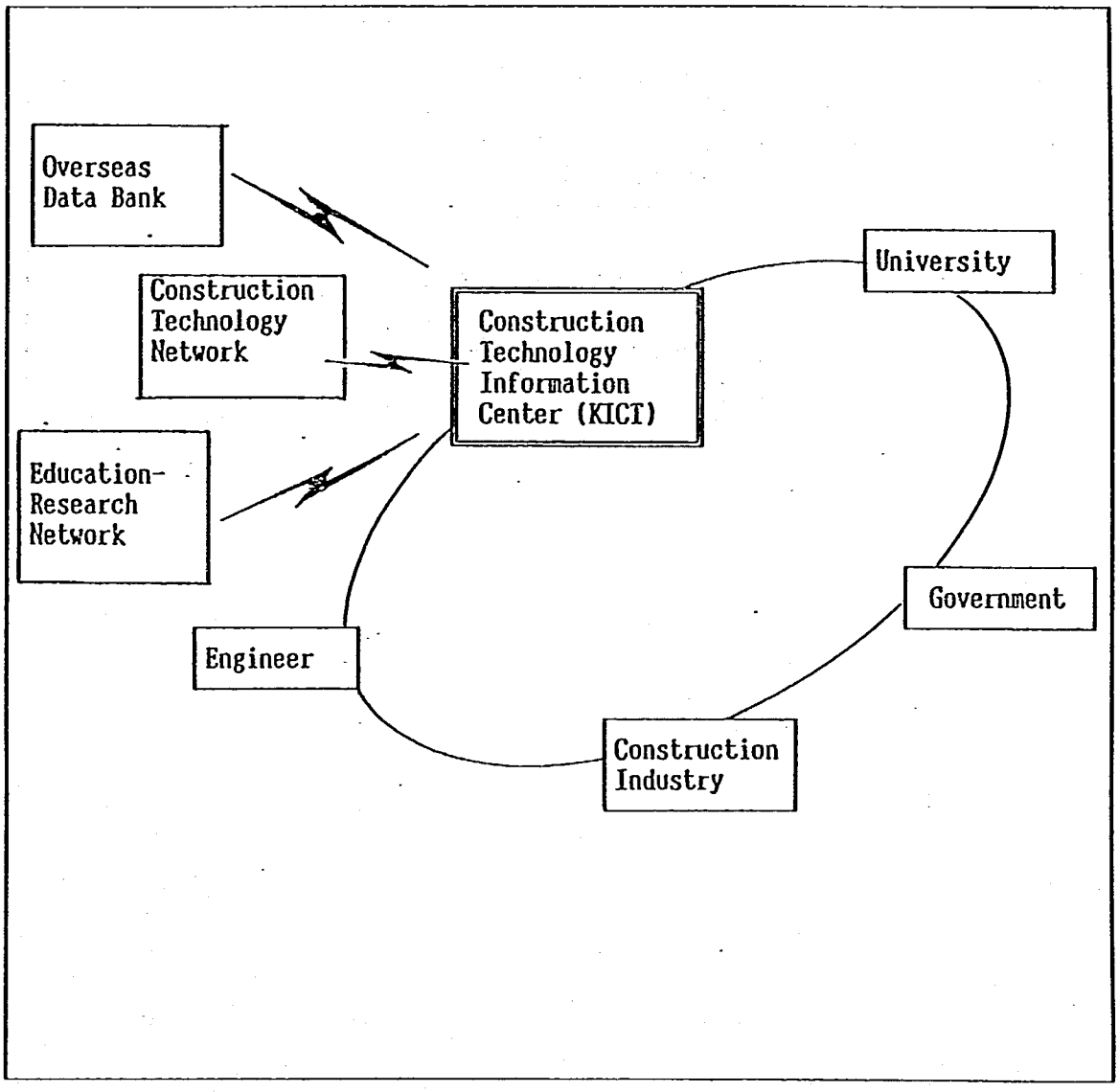
   - Efficient national facility information management
   - Prompt repair service for national facilities

4. 3 Construction Technology Information Center

1. Objectives

In order to improve the quality of construction products and to improve the international competitiveness toward the 21st century, the construction industry requires to have well-defined information system for construction technologies which would collect the information of Korea as well as abroad. The information system is mainly composed of the following ; · Data collection & Management, · Database Establishment, · Information Dissemination & Circulation and · Computer system management.

2. Basic strategy for information management



3. Plan for development of technology information system

The development of the information management system will be accomplished in 3 phases as shown in the Table-2 with a target year of 2001.

Table-2 : Development of technology information system

Phase I Preparation phase ('88 -'91)	Phase II Establishment of information center ('92 - '96)	Phase III Operation and further development ('97 - 2001)
· Investigate the sources of construction technology information	· Systematic management scheme for informations	· Establishment of On-line service system through information communication network
· Internationa cooperation & Exchange	· Development and expansion of D/B system	: Commencement of full service
· Extablishment of joint exchange and utilization between related organization	· Commencement of information service to government, construction industry and other related organization	
· Development of D/B system	· Participate in international information Service Network and test run	

5. International Cooperation

5. 1 Present Situation

KICT has maintained cooperation relationships with 58 major organizations in advanced countries related to construction technology.

KICT will continue to promote a series of cooperation programs, i.e., information and personal exchange, joint research, international seminar, etc. in the fields of mutual concern by keeping a close line of communication with these organizations.

- International seminars on construction technology
  - 1st seminar : 1983. 11. 22, Seoul, Korea
  - 2nd seminar : 1984. 1. 27, Seoul
  - 3rd seminar : 1984. 6. 22, Seoul
  - 4th seminar : 1984. 10. 30-31, Seoul
- Joint research with NIST
  - Agreement in cooperation relationship : 1984. 10. 4, USA
  - joint research : 1984-1988
- KICT/MIT joint workshop
  - Agreement in research exchange : 1984. 10. 5, USA
  - KICT/MIT joint workshop : 1985. 8. 27-28, Seoul
- International symposium on special problems of alluvial rivers
  - 1991. 9. 16-19, Seoul

5. 2 JICE (Japan Institute of Construction Engineering, Japan)

- 1989. 6. 3 KICT, JICE have a mutual agreement in research exchange.
- 1990. 9. 5 1st Korea-Japan Construction Technology Seminar in Seoul
- 1991. 8. 27 2nd Korea-Japan Construction Technology Seminar in Tokyo
- 1992. 9.2-3 3rd Korea-Japan Construction Technology Seminar in Seoul
- 1993. 8. 31 - 9. 1 4th Korea-Japan Construction Technology Seminar (scheduled in Tokyo)

5. 3 PI (Permafrost Institute, Russia)

- 1990. 2. 21 Holding international seminar on 'Construction Technology for Cold Regins'(Seoul)
- 1990. 9. 25 Cooperation Agreement between KICT and PI

- 1991. 9.-1992. 9. KICT dispatched a researcher to PI for joint research
- 1992. 11.17 Holding a seminar 'Problems of Construction in the Permafrost Area'(Seoul)

5. 4 VTT (Technicial Research of Finland, Filand)

- 1991. 12. Minister of Construction(Korea) visited to Finland, agreed technical cooperation between two contries.
- 1992. 9. President of KICT visited to VTT, discussed the technical cooperation.

5. 5 PWRI (Public Works Research Institute, Japan)

- 1987. 12.20 Ministry of Construction(Korea) and PWRI discussed technical exchange between Japan and Korea.
- 1989. 12. KICT dispatched a researcher to PWRI for one month.(the field of environment)
- 1990. 8. The Vice President of KICT visited to PWRI, discussed the technical cooperation
- 1990. 9. KICT dispatched a researcher to PWRI for one month.(the field of highway)

5. 6 Other organizations in contact with KICT

Organization	Country	Field of cooperation
·Reunion Internatioale das Laboratoires Dessais dt Recherches Sur les Materiau et Les Constructions	France	Architecture
·International Council for Building Research, Studies and Documentation	Netherland	Architecture
·International Water Resources Association	USA	Water Resources
·Americal Society of Civil Engineers	USA	Construction
·American Geophysical Union	USA	Water Resources
·American Water Works Association	USA	Water Resources
·Instrument Society of America	USA	Architecture

Organization	Country	Field of cooperation
·American Concrete Inst.	USA	Architecture
·American Society of Heating, Refrigerating and Air-Conditioning Eng.	USA	Civil Engineering
·International Association on Water Pollution Research and Control	UK	Environment
·Water Research Centre	UK	Water Resources
·Japan Society of Civil Engineers	Japan	Civil Engineering, Architecture & Building
·Building Research Inst., Ministry of Construction	Japan	Architecture & Building
·Japanese Society of Soil Mechanics and Foundation Eng.	Japan	Geotechnical Engineering
·Hydrologic Eng. Center	USA	Water Resources
·Water Eng. Research Lab.	USA	Environment
·Construciton Industry Inst.	USA	Construction
·Water Resouces Research Center	USA	Water Resources
·Construction Eng. Research Lab.	USA	Construction
·Argicultural Research Service	USA	Water Resources
·Soil Conservation Service	USA	Geotechnical Engineering
·National Building Technology Centre	USA	Construction
·Transportation Research Board	USA	Highway Engineering
·Massachusetts Inst. of Technology	USA	Civil Engineering
·Texas A & M Univ.	USA	Civil Engineering
·Univ. of Texas at Austin	USA	Civil Engineering
·Research Inst. of Shimizu Construction Co. Ltd.	Japan	Construction
·Research Center Daisei Corporation	Japan	Construction
·Kajima Inst. of Construction Technology	Japan	Construciton
·Inst. of Construction Eng	Japan	Construction
·Disaster Prevention Research Inst.(Kyoto Univ.)	Japan	Construction
·Inst. of Hudrology	UK	Water Resources
·Transport and Road Research Lab.	UK	Highway Engineering
·Federal Inst. for Materials Testing	Germany	Architecture & Materials
·Federal Highway Research Inst.	Germany	Highway Engineering
·Federal Inst.of Hydrology	Germany	Water Resources

Organization	Country	Field of cooperation
·Statens Byggeforsknings Inst.	Germany	Architecture
·Centre National de La Recherche Scientifique	France	Construction
·International Tranining Centre for Water Resources Management	France	Water Resources
·Centre Scientifique et Technique du Batiment	France	Architecture
·International Commission on Large Dams	France	Water Resources
·Danish Building Research Inst.	Denmark	Construction
·Centrl Building Research Inst.	India	Architecture
·National Council for Cement and Building Materials	India	Architecture
·Ret-Ser Eng. Agency	Taiwan	Construction Management
·Houstin & Development Board	Singapore	Architecture
·Hungarian Inat. for Building Science	Hungarry	Architecture
·Technical Univ. of Buda pest	Hungary	Civil Engineering
·Inst. for Research in Construction	Canada	Construction

6. Disaster and Disaster Prevention in Korea

6.1 Introduction

Major natural disasters in Korea are caused by floods. Since extremely heavy rainfalls frequently occur during the rainy season, plains often are flooded. Typhoons also strike the peninsula usually two or three times a year and cause severe damages. In addition, this country is occasionally striked by heavy snowfalls, hails, tidal waves, thunderstorms, earthquakes and others.

The central and local governments support various disaster prevention and preparedness activities: weather and flood forecasting; improvement of rivers; construction of embankment and drainage facilities for lowlands; and implementation of many educational programmes for inhabitants and related staffs. In spite of such efforts, numer of losses in human lives and amounts of property damages have increased significantly in recent years.

Annually, during the recent ten-year period, losses of 283 human lives and about 550 million U.S. dollars worth of property damages occurred, and 450 million U.S. dollars were spent for the disaster relief and restoration works.

6.2 Natural Disasters in Korea

6. 2. 1 Hydrological Circumstances

a. The average annual precipitation is 1,274 mm (50.2 inches).

b. About two-thirds of the annual precipitation occurs during the summer season (June, July and August) because of monsoonal rainfalls.

c. Regional flash floods frequently occur in recent years.

d. Rain storms rush into rivers due to the geographical characteristics of the peninsula, and subsequent floods often occur in low areas.

6. 2. 2 Socio-Economical Backgrounds

a. Population growth and urban development increased the use of flood-liable lowlands and landslide-liable hillsides in the outskirts of cities and created potential severe problems.

b. Rapid urbanization and forest developments increased the volume and velocity of runoff and produced higher peaks in flood discharges than ever occurred in the past.

c. Embankment and improvement works for rivers have not been done sufficiently.

d. Many tributaries do not have sufficient flood control structures/facilities.

6. 2. 3 Direct Causes of Disasters

More than half of the disasters are caused by heavy rainfalls and typhoons. Major causes of disasters are briefly discussed as follows.

a. Floods

Korean rivers are relatively short and steep that the velocity of river flow is high, and as a result the shape of flood hydrograph is extremely sharp.

b. Typhoons

Tropical depression which originates in the West Pacific around 5 to 15 degrees of North Latitude with maximun wind speed of 17m/sec, is referred to as a typhoon. Typhoons usually occur 30 times an year, and 70 percent of them from July to October. The typhoons occurring from July and October could approach the Korean Peninsular. Two or three times every year the typhoons bring direct rainstorms, rain front and heavy precipitation.

c. Debris Flows and Landslides

The Korean peninsula has many areas of brittle soils. Futhermore, as developments are pursued even in the mountain areas or hillsides, numer f disasters caused by debris flows are increased continuously. The debris flows are subsequent results of landslides and collapse of steep slopes.

d. High Tides and Tsunamies

The shoreline of Korea is very long, and considerable property is concentrated along the shoreline. Thus damages are likely to occur by high waves in a rather great extended areas. The waves which wreak such damage are classified into swells by typhoons, tsunamies by volcano activities, high tides and others.

6. 2. 4 Statistics in Natural Disasters

Table 1 shows number of natural disasters occurred for the different types of causes during the period from 1904 to 1991. The annual damages caused by the

natural disasters in recent 10 years are summerized in Table 2.

Table 1. Numer of natural disasters occurred in Korea (1904-1991).

Cause	total	typhoon	heavy rain	heavy snow	hail	tidal waves	storm	earth-quake
No. of strike	1,568	263	429	224	89	49	435	79
Annual average	17.8	3	4.9	2.5	1	0.6	4.9	0.9
Percent (%)	100	17	27	14	6	3	28	5

Table 2. Damages occurred from natural disasters (1981-1990).

Year	Loss of Life (per-son	Suffer-rers (per-son)	Inunda-ted Area (ha)	Property Damage (in million U.S dollars)					
				Build-ing	Farm-land	Crops	Public Facili-ties	Others	Total
1981	216	18306	149583	5.29	17.67	26.74	130.26	18.93	198.89
1982	121	6609	37008	1.25	6.85	42.32	62.69	14.03	127.14
1983	91	1355	24851	3.21	0.14	15.44	6.61	4.73	30.13
1984	265	364236	140199	13.67	28.39	96.80	186.21	54.82	379.89
1985	250	72257	126291	1.83	2.42	109.12	67.45	28.67	209.49
1986	156	99114	86701	2.99	2.55	268.47	60.81	31.08	365.90
1987	1022	272277	300453	21.29	104.70	350.08	836.69	327.34	1640.10
1988	143	5053	17988	0.89	15.95	20.48	124.93	21.81	184.06
1989	307	92593	121060	8.80	21.76	342.68	303.80	141.34	818.38
1990	257	203314	124276	13.17	64.19	829.02	394.66	246.46	1547.50
Total	2828	1135114	112841	72.39	264.62	2101.2	2174.1	889.2	5501.5
Arith-matic Mean	283	113511	112841	7.24	26.46	210.12	217.41	88.92	550.15

Note: The property damage does not cover the losses of materials for production, products and household goods.

6. 3 '93 Research Projects in KICT Concerning Disaster and Disaster Prevention

T I T L E	PERIOD
• Rehabilitation of Earthquake-Damaged Structures	93. 1 - 94.12
• Development of Method for Seismic Damage Prediction of Existing Structures	92.11 - 93. 7
• Guidelines for Dam Safety Evaluation and Maintenance	92. 9 - 93. 3
• A Study on Accessments of Hydrologic Models	92. 1 - 93.12
• Development of a Method for Determination of Equilibrium River Profiles	93. 1 - 93.12
• Guidelines for designing Hydraulic Structures in Rivers	92. 4 - 93.12
• Direction for Water Rources of the 21st Century	92.11 - 93.11
• Improvement of Flood Forecasting Program in the Han River Basin	92.11 - 93.12
• Development of Techniques for Water Resources Management	93. 5 - 93.12
• A Research of Flood Forecastiong and Warning System Basin Design for Anseong-stream and Hyungsan-River	93. 5 - 93.12
• A Research and Development of River-Environment management Techniquew	93. 5 - 93.12
• Improvement of Flow Forecasting and Warning System of Nak-Dong River Basin	93. 6 - 94. 3

6. 4 Natural Disaster Prevention and Preparedness

6. 4. 1 Institutional Framework

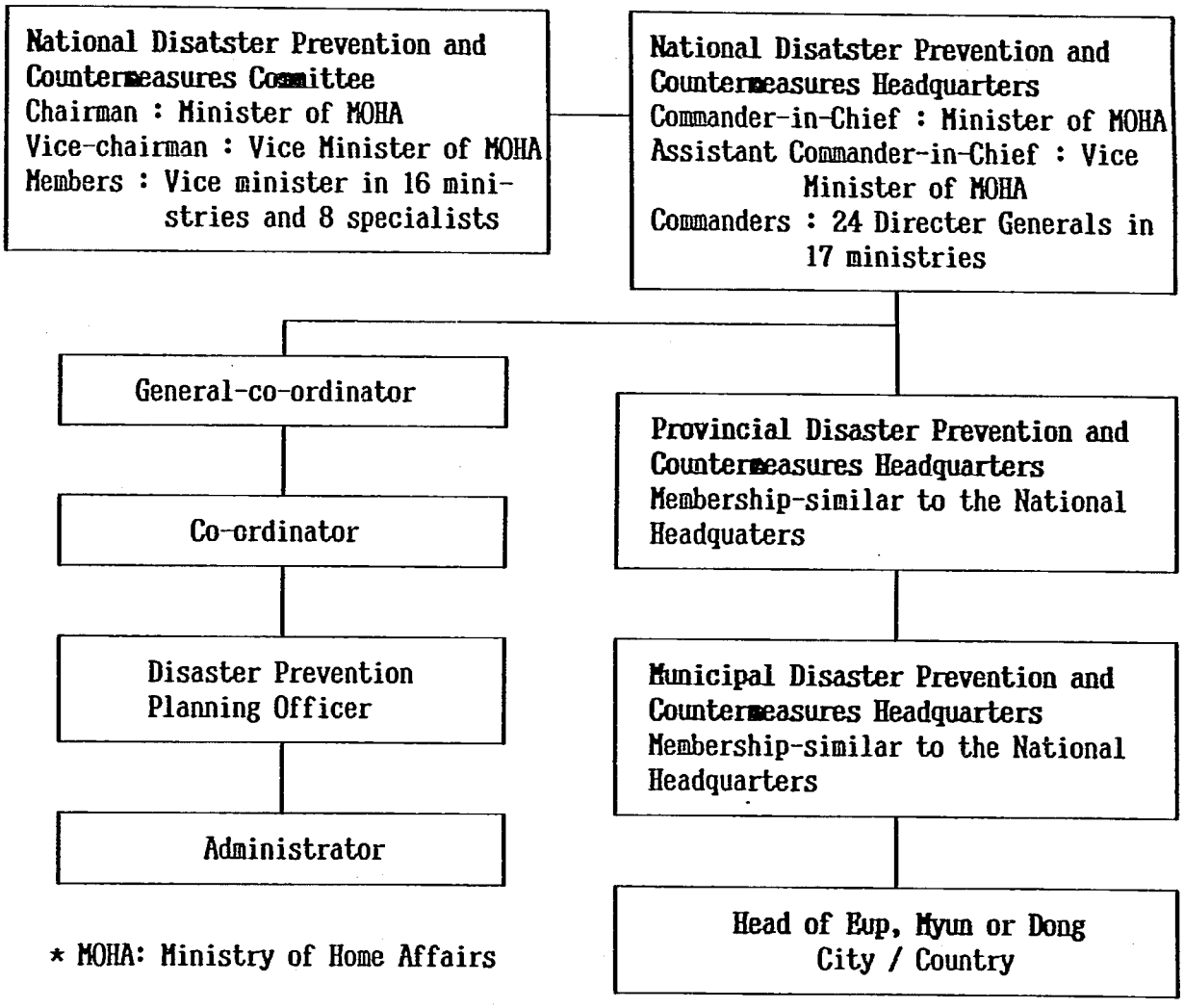
The National Disaster Prevention and Countermeasures Headquarters, which is now under the Ministry of Home Affairs but under the Ministry of Construction before April 23, 1991, is the central organization tasked for national natural disaster prevention and preparedness. This headquarters has responsibilities for government-level plans and activities against natural disasters, and for international co-operations.

In addition, the headquarters formulates and carries out mid-and-long term

national disaster mitigation programmes.

Figure 1 shows the disaster prevention organization systems in Korea. The National Disater Prevention and Countermasures Headquarters is supported by the National Disaster Prevention and Countermeasures Committee, of which Chairman is the Minister of Home Affairs (MOHA) and Vice Chairman is the Vice Minister of the MOHA. This committee is composed of 17 ministerial officials and 8 other specialists.

Figure 1. Institutional Framework



In addition, as a supreme executive council in working level, the Headquarters Committee is constituted under the National Disaster Prevention and Countermeasures Committee. The Headquarters Committee is chaired by the Minister of Home Affairs and assisted by two vice chairmen, the Vice Minister of MOHA and the Vice Minister of MOC. The members include 24 director-generals from 17 ministries and the Korea Meteorological Administration. Once a major disaster

occurs, the headquarters is activated and coordinates the activities of the ministries/agencies and their supporting units concerned to the disasters.

At the provincial, municipal and county levels, similar organizations are established with the same composition and responsibilities as the Disaster Prevention and Countermeasures Headquarters have.

6. 4. 2 Long-Term Countermeasures for Disaster Prevention

Measures, which prevent or mitigate adverse effects of the nation's land, human lives and properties caused by various disasters, are classified into follows: preventative measures; urgent countermeasures when a disaster has occurred; restoration and rehabilitation after disasters; and research for development of preventative science and technology.

a. River Improvement

In order to prevent inundation caused by floods, the government has carried out river improvement works including widening of rivers, strengthening of river banks, and construction of flood channels, retarding basins and pumping stations.

The government has invested about 330 million U.S. dollars for the river improvement works in recent five years, and as a result the ratio of improved length (19,690km) to the total length (30,222km) of rivers reaches 55 percent. Table 3 shows investments for the river improvements in recent 5 years.

Table 3. Government's investment for river improvement in recent 5 years

(In million U.S. dollars)

Fiscal Years	Average	1986	1987	1988	1989	1990
Length of rivers improved in kilometers	204	230	202	189	201	200
Investment in million U.S. dollars	66.0	59.4	51.2	62.1	70.2	86.9

b. Construction of Multi-purpose Dams

The multi-purpose dams take the great role of flood control in Korea. These dams are usually located in the headwaters of rivers and have several other purposes such as water supply for various uses, hydropower genera-

tion and others. The current status and future plans about the multi-purpose dams are as follows:

- Operated : 8 sites (1.7 billion cubic meters of flood control capability)
- Under construction: 2 sites (350 million cubic meters of flood control capability)
- Planned: 7 sites

After the year 2011, the total number of multi-purpose dams will be 17 sites with flood control capability of 2.7 billion cubic meters.

c. Preventive Works for Steep Slope Failures

To prevent the failure of steep slopes in urban or densely built-up areas, the construction of retaining walls and other means of slope protection are being carried out.

d. Improving Restoration Works

Improving restoration works are carried out in order to prevent similar disasters which would be occurred at the same place again if restoration works are made to recover the original damages only.

6. 4. 3 Short-Term Disaster Planning and Mitigation Programmes

a. Short-term Plans/Programmes

Various short-term disaster mitigation plans and programmes are prepared and carried out for the rainy season. They include:

- Repair of hazardous facilities and designation of their responsible personnel.
- Removal of obstructive materials in rivers.
- Designation of observers for flood-liable rivers.
- Designation of superintendents for important hydraulic facilities and structures.
- Education on advanced skills and knowledges about natural disaster prevention for the related staffs.
- Planning and education of evacuation for disaster-vulnerable communities.
- Various media coverages for public awareness on the vulnerability.
- Enforcing the pre-exercises for natural disasters.

b. Temporary Actions to Reduce Disasters.

In response to the existence of a known hazard, and especially in response

to prediction and/or warning of impeding events, many emergency measures are usually planned and performed. These measures include:

- 24-hour nation-wide TV networks coverage.
- Evacuation of people and properties in disater-vulnerable areas.
- Preparatory releases of stored water from reservoirs.
- Embargo on fishery boats and ocean-going ships.
- Stand-bys of flood-fighters, civil defence corps and staffs in the national, provincial, municipal and county disaster prevention and countermeasures headquarters.

7. WATER POLLUTION CONTROL IN KOREA

7.1 FOREWORD

During the last 3 decades, through successful execution of 6 phases of Five-year Economic and Social Development Plan, Korea has enjoyed an unparalleled period of economic growth, industrialization and rising living standards. The rapid industrialization and urbanization, however, have also increased the pollution sources resulting in serious environmental problem.

Despite of increasing quantity of wastewaters and pollutants from various sources, construction of water pollution control facilities have been limited until very recently. Many cities have poor sewer systmes and yet the sewage treatment rate is still low. Although the most industries have industrial wastewater treatment plant, the performance of these treatment plants is not acceptable.

Korea has limited water resources. The average annual rainfall exceeds world average, however, since about two-thirds of annual rainfall is concentratad in only about four months, the water pollution becomes more serious during dry season while the surface water run-off during rainy season is being discharged into sea with flood.

To deal with this problem, large and numerous dams have been constructed to provide storage reservoirs, flood control and for energy production. However, due to long hydraulic retention time of the artificial lakes, water quality is deteriorated even further and eutrophication of water supply reservoir would soon become of major concern. The serious water pollution problem had been experienced mainly at the waterbodies near large cities and industrial complexes, however, the problem is now being experienced everywhere and they become nation-wide problem.

Recently Korea has experienced several episodes of drinking water contamiation which, in turn, has made the environmental problem to get major attention from public and also from private sectors. Concerning these, this paper has been prepared to introduce the current situation of water pollution and strategy for water pollution control in Korea.

7. 2 RIVERS AND LAKES

Under the River Act, rivers in Korea are classified as three classes : Class A rivers are directly administered by the Ministry of Construction while Class B rivers are administered by local government. Class C rivers are also administered by local government but are indirectly governed by the water Act.

Total number of rivers which are designated by the Act, including 62 Class A rivers, 55 Class B rivers and 3,847 Class C rivers is 3,964 with total extension of 30,426km as shown in Table-1. There are also 34,958 tributaires and small rivers with total extention of 39,110 km which are not disgnated by the Act.

Among the river basins listed in Table-1, Han River, Nakdong River, Keum River and Yongsan River are four major river basins which cover most of Korea.

Table-1 : Rivers in Korea by River basin

river basin	basin area (km2)	extension(km)							
		Total		Class A		Class B		Class C	
		No.	km	No.	km	No.	km	No.	km
Total	88,747.5	3,964	30,416	62	2,858	55	1,320	3,847	26,238
Han	26,018.0	705	7,257	15	814	12	553	678	5,890
Nakdong	23,817.3	825	7,460	10	830	10	191	805	6,440
Keum	9,810.4	503	3,742	11	402	20	362	472	2,998
Yongsan	3,371.3	185	1,472	5	197	2	46	178	1,229
Sumjin	4,896.5	284	2,071	3	237	1	22	280	1,812
others	20,834.0	1,462	8,414	18	379	10	146	1,434	789

Table-2 summarizes the pertinent dimensions of the major lakes in Korea. While there are more than 400 major lakes in Korea, the most major lakes are artificial lake. If the lake has hydraulic retention time of longer than 3.6 days with enough concentrations of nitrogen and phosphorus, the lake is considered to be readily become eutrophic lake. Accordingly, it can be said that the most artifical lakes in Korea are prone to become eutrophic since Table-2 indicates that hydraulic retention times of the major lakes are fairly long.

Table-2 : Pertinent Data of Major Lakes

Lake	Inflow (106m3/yr)	Total storage (106m3)	catchment area (km2)	Avg depth (m)	HRT (days)	surface area (km2)
Soyang	1,874.5	2,900	2,703	41.4	562	70.0
Paldang	16,505.2	244	23,800	6.7	5	36.5
chungju	4,610.3	2,750	6,648	28.4	217	97.0
Andong	1,098.5	1,230	1,584	23.9	410	51.5
Namgang	1,584.6	136	2,285	5.8	31	23.7
Hapcheon	641.4	794	925	28.8	435	27.6
Imka	852.9	1,060	1,230	22.1	456	48.6
Seomjingang	592.1	466	763	17.6	287	26.5
Juam	700.4	860	1,010	14.0	451	61.3
Daechung	2,864.8	1,490	4,134	20.5	190	72.8

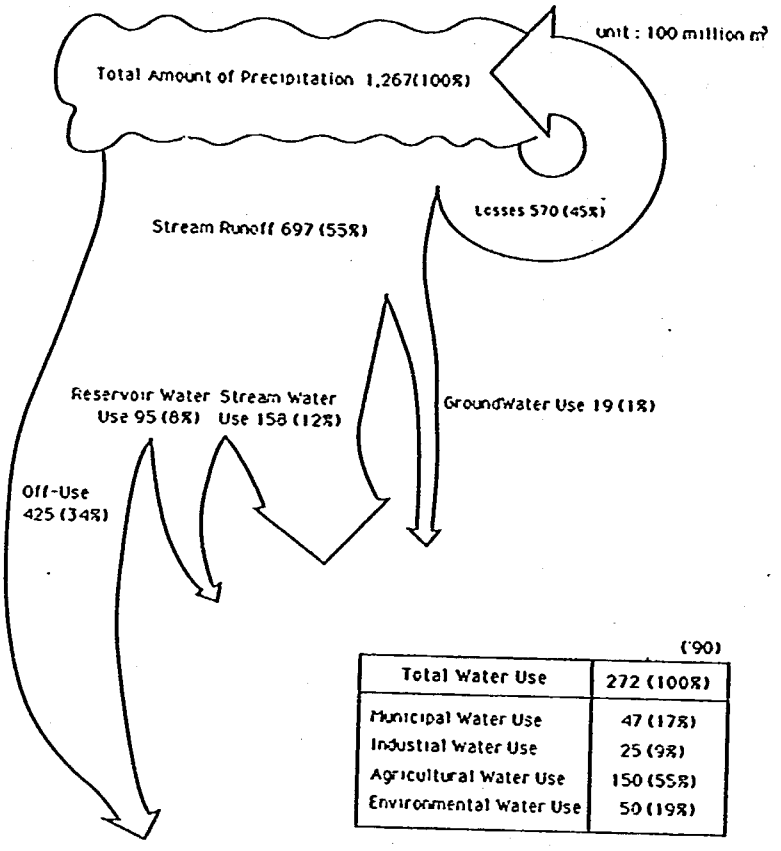
7.3 WATER RESOURCES AND WATER USE

The average annual rainfall of Korea is about 1,274mm which is 1.3 times of the world average of 973mm, however, annual runoff per capita in Korea is 3,000 m3 which is only one eleventh of the world average of 34,000m3. About 65% of annual rainfall is concentrated in four months, June to Semptember, and thus the most rainfalls during this season are lost with flood.

Figure-1 shows the water balance of Korea. Among total annual precipitation of 126.7 billion tons, 45% are lost through evaporation and/or infiltration, and the rest 55% (69.7 billion tons) become surface runoff. However, since 42.5 billion tons are directly discharged into the sea mainly due to flood, the available annual surface runoff becomes 25.3 billion tons which is only 20% of total annual precipitation.

It is now belived that there are at least 1.3 trillion tons of ground water, however, technical and economic feasibility of groundwater development is fairly limited consideriag the soil and ground conditions.

Water uses for various purpose are also shown in Figure-1 which indicates that agricultural use is still the major component while municipal use was 17% and industrial water use was 9% which will become tremendous amount of wastewater after uses.



('90)

Total Water Use	272 (100%)
Municipal Water Use	47 (17%)
Industrial Water Use	25 (9%)
Agricultural Water Use	150 (55%)
Environmental Water Use	50 (19%)

Figure-1 : Water Supply and Use (1990)

7. 4 POLLUTION OF RIVERS AND LAKES

7. 4. 1 Sources of pollution

The major source of water pollution are domestic sewage and industrial wastewater. As of the end of 1992, total generation of wastewater was 20,557 thousand tons per day, of which 60% was domestic sewage and 39.4% was industrial wastewater. Besides these major sources, various livestock wastes also make some contributions ; although volumetric contribution was only 0.6%, due to its high strength, contribution by BOD loading was 19.9%.

The number of industrial wastewater discharger had been increased from 3,984 in 1980 to 13,504 in 1990, as shown in Table-3. The rate of livestock wastewater generation has also been increased as more meats are now being consumed than before. Table-4 summarizes the changes in number of livestock animals between 1984 and 1992.

Table-3 : Industrial Wastewater Discharge by Year

Year	No. of Industry	Wastewater (103m3/day)
1980	3,984	1,962
1981	4,920	2,209
1982	5,671	2,760
1983	5,924	2,538
1984	6,422	2,729
1985	7,375	3,109
1986	7,900	4,489
1987	8,570	4,603
1988	9,522	5,983
1989	11,203	6,499
1990	13,504	7,280

However, the most of these livestock farms are small scale and thus the sources of livestock wastes are so scattered that the control of these wastes is very difficult while the most of them are discharged without being properly treated.

Table-4 : Number of livestock animals in Korea.

Year	Cattle	Pig	Poultry
1984	265	296	4,648
1987	239	428	5,932
1990	215	457	7,150
1992	257	546	7,332

Although some projections indicate that industrial wastewater would soon become the major water pollution source due to rapid growth rate of industrial production, i.e. 25% per year, domestic sewage will still be the major source as shown in Table-5 since industrial wastewater will not be increased very much with application of various innovative industrial waste management technology.

Table-5 : Wastewater generation in Korea

	1992		1996	
	Volume	BOD loading	Volume	BOD loading
Domestic sewage	12,323 (60)	2,485 (41.5)	15,713 (64.9)	2,881 (41.6)
Industrial wastewater	8,107 (39.4)	2,306 (38.6)	8,323 (34.4)	2,417 (34.9)
Livestock wastewater	127 (0.6)	1,190 (19.9)	174 (0.7)	1,630 (23.5)
Total	20,557 (100)	5,981 (100)	24,210 (100)	6,928 (100)

* unit : Volume 103 tons/day, BOD loading tons/day
* Percentage shown in ( )

7. 4. 2 Water Pollution Levels

Table-6 summarizes the BOD levels of upstream, midstream and downstream of 4 major rivers, i.e. Han River, Nakdong River, Keum River and Youngsan River.

Water qualitiy of upstream and midstream of Han River are fairly good, however, it becomes poor at downstream as it flows through Metropolitan Seoul and also as several heavily polluted tributaries are joined with Han River.

Table-6 : Water quality of major rivers

River	Point	Target	'90	'91	'92
Han	upstream (Ⅰ)	1.0	1.3	1.6	1.4
	upstream (Ⅱ)	1.0	1.1	0.9	1.1
	midstream	1.0	1.0	1.1	1.1
	downstream	6.0	4.7	4.8	4.3
Nakdong	upstream	1.0	1.0	1.1	1.1
	midstream	3.0	3.2	4.3	3.8
	downstream	3.0	3.3	3.7	3.5
Keum	upstream	1.0	1.5	1.6	1.4
	midstream	1.0	3.1	3.1	2.9
	downstream	3.0	3.1	3.0	3.2
Yongsan	upstream	1.0	1.2	1.1	1.4
	midstream	3.0	6.7	5.6	5.6
	downstream	3.0	1.2	1.5	2.1

Water quality of upstream Nakdong River is also good showing 1.1 mg BOD/L, however, as the river receives Keumho River which is heavily polluted with wastewater from City of Daegu and tremendous amount of various industrial wastewaters, the water quality is deteriorated. The water quality is slightly improved at downstream mainly by self purification of the river while there are no major pollution sources between midstream and downstream.

The water quality of Daechung Reservoir, which is located at upstream of Keum River and is the major source of public water supply for Central Korea, does not meet the First-Grade grade water quality standard(BOD < 1 mg/L) while those of midstream and downstream become even worse as sewage and industrial wastewater from various sources including City of Daejeon and Cheongju City are discharged to the river.

The length of Youngsan River is shortest among 4 major rivers and the river basin area is not very large, however, several reservoirs including Naju, Changsung and Kwangju reservoirs with total storage capacity of 256 million tons are located at upstream mainly for agricultural purpose. Because of the reservoirs, the average flow rate of the river becomes rather low and thus BOD at the junction of the river and Kwangju Chun is very high, i.e. about 5.6 mg/L, since Kwangju Chun is heavily polluted with sewage and industrial westewater from City of Kwangju. Table-6, however, shows that the water quality is again improved at downstream.

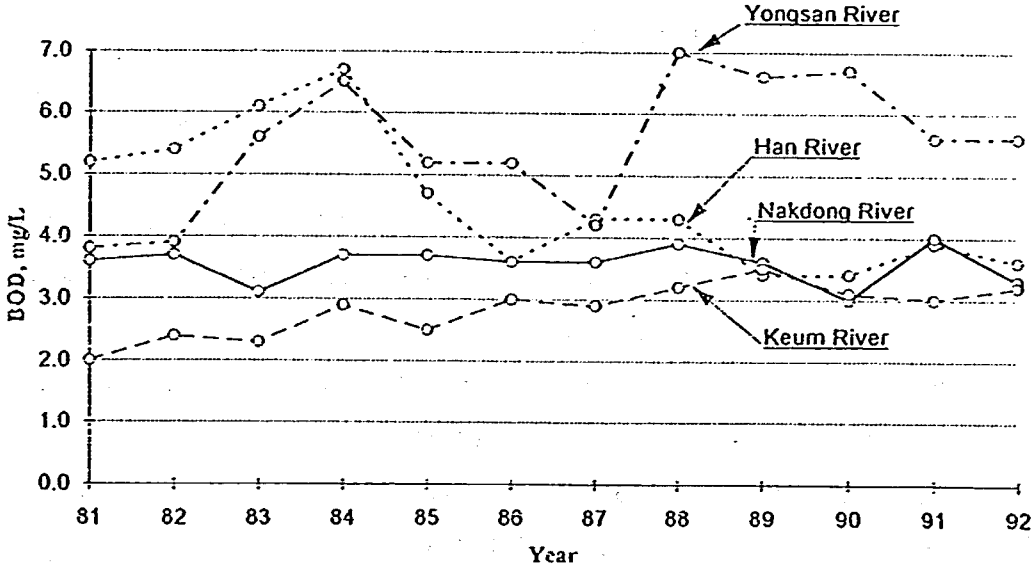


Figure-2 Water quality of 4 major rivers during last 10 years(1983-1992)

The changes in water quality of four major rivers during last 10 years are appeared in Figure-2. This figure shows that the water quality has been improved with execution of Han River Development Plan and also with completion of four large scale sewage treatment plants. Since 1990, water qualities of Nakdong and Keum have been fairly stable while that of Yongsan River has been continuously deteriorated as mentioned previously.

The water resources of Korea heavily depend on artificial reservoirs while the most regervoir are prone to become eutrophic as described earlier. Table-7 shows the concentrations of total nitrogen and total phosphorus of two major reservoirs, i.e. Paldang, which is drinking water source for Seoul area, and Daechung, which covers central part of Korea. As shown in this table, T-N and T-P concentrations have been increased in both reservoirs and these reservoirs have already been experiencing eutrophication problems.

Table-7 : Nutrient levels in two major reservoirs(Paldang & Daechung)

Year	T-N (mg/L)		T-N (mg/L)	
	Paldang	Daechung	Paldang	Daechung
'91. 3	0.517	0.754	0.039	0.023
'92. 3	0.937	1.506	0.045	0.054
'93. 3	1.281	1.485	0.042	0.095

7. 4. 3 Water Polltion Control Facilities

The domestic sewage and some industrial wastewater are being treated primarily with approx 14,000 septic tanks and 1,300 small scale treatment facilities. As of the end of 1992, 38 sewage treatment plant are in operation treating approx 7.0 million tons of sewage per day which is equivalent to 37% of total daily sewage generation in Korea.

Construction of sewage treatment plant had become very active only after 1980's and the priority was given to large cities and industrialized cities. Therefore, the most treatment plants are quite large ; few of them have treatment capacity of more than 1 million tons/day.

Conventional activated sludge system has been only one type of treatment process currently employed with few exceptions which employ only primary

treatment level. As construction of sewage treatment plants of large city and industrialized city has been completed, however, appropriate technology for small and medium size cities and advanced treatment process for the cities located in special region have become of major concern.

Appropriate treatment process are being selected considering efficiency, economics and relative difficulty of operation and maintenance besides local conditions. For the most inland cities, nutrient removal from wastewater has become very important and biological nutrient removal process has higher preference than physical/chemical treatment process because of its economical benefit and durability.

Table-8 summarizes the type of treatment methods currently employed in Korea to treat industrial wastewater. Although there are many industries which employ very simple treatment mothods, such as sedimentation, filtration or neutralization, some industries employ rather advaned technologies, such as A/C adsorption, ion exchange or membrane processes. However, many industries in industrial complex treat the wastewater at integrated industrial wastewater treatment plant or joint/combined treatment plant consisting of physial, chemical and biological treatment processes. As of the end of 1992, 8 integrated industrial wastewater treatment plants are in operation and 15 plants are ready for operation.

Table-8 : Type of treatment method for industrial wastewater

Type	Number	Capaiety(103 m3/day)
physical	1,338	120
physical + chemical	7,742	1,487
physical + biological	877	335
combined	708	5,093
Joint treatment	632	227
others	1,704	19

All existing integrated industrial wastewater treatment plant also employ activated sludge process. Since there are some persistent or recalcitrant organic/inorganic pollutant which are not readily removed by activated sludge process, more reliable and appropriate treatment technologies, which can effectively remove persistent pollutants, are being investigated to upgrade

industrial wastewater treatment plants.

Country wide, the percentage of flush toilets is 43% and the rest of approx 43,600m3/day nightsoils are being treated by several means before disposal. The large portion of nightsoils, approx 15,000m3/day, is treated at nightsoil treatment plants in urban area. About 3% of nightsoils are decomposed in tanks with long retention time, while the rest 19% are being handled in some other means, such as composting or ocean dumping.

Livestock farms which grow more than 1,000 pigs or more than 100 cattles or horses with the farm area larger than 1,400m2 or 1,200m2, respectively, should treat the wastewater to meet the effluent BOD and SS standards of 150mg/L. The wastewater discharged from the smaller farms with the area of 150~1,400m2 for pig farms and 350~1,200m2 for cattle or horse farms should meet the BOD standard of 1,500 mg/L. However, the most livestock farms are rather small scale, only 30% of the livestock wastewater are regulated by the laws and thus wastewater generated form 70% of livestock farms are not properly treated before disposal.

7. 5 STRATEGIC PLAN FOR WATER POLLUTION CONTROL

7. 5. 1 Five-year plan for improvement of environmental quality

The Ministry of Environment has established a Five-year ('92-'96) plan to improve environmental quality. The plan includes the following strategies to improve water quality of major water bodies ; a) Strongly implement the strategy to protect the water quality of areas designated as Special Conservation Region. b) Determine rational target of water quality for each river and lake and also establish the monitoring systems. c) Strengthen the control of wastewater discharges considering the water quality target. d) Implement the systematic treatment methodology of sewage and industrial wastewater, and e) Rehabilitate the rivers to recover the self-purification capacity of rivers and lakes and also to improve water quality.

The more details of the plan are follows ; Firstly to protect the water qualitics of Paldang Reservoir and Daechung Reservoir, which are the major

sources of water supply of Seoul area and Central Korea, the area around these two reservoirs have been designated as special conservation region. Any development works in these areas are limited, the wastewater discharge limits are strongly enforced and the construction of water pollution control facilities including sewage treatment plant in these areas has the highest priority in the Nation. This concept of special conservation region will be gradually applied to area around other important reservoirs.

Secondly the water quality control plans for each major river basin have been established. The plan will be strongly implemented to achieve the water quality tagct by expanding the water pollution control facilities including sewage treatment plant and combined treatment facilities of livestock wastewaters. With completion of this plan the proportion of waterbodies which meet the water qualty target will become 83% in 1997.

Thirdly more stringent but more rational discharge limit will be gradually established. For example trichloroethylene and tetrachloroethylene will be regulated from January 1, 1993 and discharge limits of nitrogen and phosphorus will be also applied to the treatment plants which discharge the effluent to the lakes designated by the Minister of Environment. The current and revised effluent discharge limit which will become effective from January 1, 1996 are shown in Table-9.

Table-9 : Effluent Discharge Limit

	Sewage Treatment Plant		*Intergrated Industrial Wastewater Treatment Plant	
	by'95.12.31	after'96.1.1	by'95.12.31	after'96.1.1
BOD(mg/L)	< 30	< 20	< 50	< 30
COD(mg/L)			< 50	< 40
SS(mg/L)	< 70	< 20	< 70	< 30
T-N(mg/L)		< 60		< 60
T-P(mg/L)		< 8		< 8

* Some other priority pollutants such as phenol, Chromium etc are also regulated.

During this period, it is planned to invest 3,873 billion wons to construct 76 sewage treatment plants for large cities and 152 small scale treatment plants for smaller cities(Eup's) as shown in Table-10. And construction plan

of other treatment facilities are also included in this table. After completion of this plan the sewage treatment rate will be raised to 65% by 1996 while the newly revised target for sewage treatment rate is 73% by 1997.

Table-10 : Construction plan of various wastewater treatment plants('92-'96)

Type	Number	Capacity(103m3/day)
Sewage treatment plant	76(18)3	9,307 1,098
Integrated industrial wastewater treatment plant	10(2)	934
Combined wastewater treatment plant for agroindustrial complex	128	41.2
Livestock waste treatment plant	32	4.75
Niphtsoil treatment plant	34(50)	3.95

* Number of plants with expansion work is shown in ( ).

The investment plan also include the excavation of bottom sediment of polluted rivers as well as the institutional and regulatory improvement so that the water quality of major rivers will be improved to maintain at least 2nd Grade level. After accomplishing this plan, the percentage of drinking water intake for First Grade sources will be increaced from 34% to 70%

7. 5. 2 Long term strategy for water quality conservation

It is now almost impossible to maintain water quality of all waterbodies to the level of drinkable water and it is not economical even in the advanced conuntries. Therefore it is very important to maintain water quality clean enough to protect beneficial uses and ecosystems of the waterbodies. For this porpose, the environmental capacity of the waterbody should be determined and all the dischargers should be regulated to discharge the polluants load which will not over this capacity. The long term plan, therefore, includes the following essential idea.

a. Determine the environmental capacity of each river basin and develop the economically achievable and stepwise target for reduction of pollutant load. Table-11 summarizes the projected BOD load and reduction plan for

4 major river basins which was based on extensive investigation of environmental capacity of river basins and various pollution sources.

Table-11 : Target ('96) for BOD loading reduction by river basin

River basin	BOD loading (kg/day)		reduction rate (%)
	Projected	To be reduced	
Han River	1,059,541	759,759	71.9
Nakdong River	484,903	340,384	70.1
Keum River	358,433	213,747	59.6
Yongsan River	183,585	71,774	39.1

However, for more rational pollution reduction plan, beneficial use of waterbodies should be investigated consistently and more logical methodology for load allocation should be developed. For this propose, not only environmental data but also many hydraulic data such as flowrate and pollutant emission rate should be accumulated.

b. Systematic plans should be developed and implemented for rehabilitation and/or construction of sewers to make sure all the wastewater generated are properly collected and transported to treatment plant

c. Wastewater reclamation technology should be employed to conserve the limited water resources by increasing reuse rate and also to reduce waste load to natural waterbodies. The standard for wastewater reclamation is now being prepared and some incentives for recleamatan, such as tax benefit, are also being considered.

d. To minimize the eutrophication of artifical lakes, which is the major water resources of Korea, the wastewater treatment should include the removal of nitrogen and phosphorus. It is believed that the effluent limit for T-N and T-P in Table-9 which will be applied in 1996 are too loose and thurs much more stringent limit should be applied considering the local conditions. It is also believed that application of biological nutrient removal process is very effective in nutrient removal and would not add much economic burden on execution of sewerage development plan.

e. For scattered area it may be more economical to have small scale wastewater treatment plant rather than constructing sewers.

f. In addition to improvement works of rivers, the riverside area can be used to construct in situ treatment facilities to lower the pollution level.

g. It would be more economical and effective to use 'pollution prevention technology (or clean technology)' rather than employing 'end-of-pipe treatment' which has been the major approach for pollution control. For this purpose, highly advanced technologies should be developed and/or introduced to the area of pollution control.

h. Long term plan for technology development of environmental control should be established and steadily carried out. It is fortunate that environmental control technology has been included in the category of the Highly Advanced Nationl Project for science and technology development(G7 project) and 15 high priority research projects including advanced water and wastewater treatment technology are being carried out.

7.6 CONCLUSIONS

Due to rapid industrialization and urbanization of Korea, the sewage and industrial wastewater generation has been increased remarkably to increase pollution load to natrual waterbodies. Furthermore, the socio-economic and natural conditions of Korea, such as high population density, limited water resources and rapid conversion rate of traditional toilet to flush toilet had worsen the water quality of rivers and reservoirs.

The Five-year plan for improvement of environmetal quality('92-'96) include rather intensive strategy to improve water quality by investing 3,873 billion wons during 5 years and it is expected that the water quality will be improved remarkably with completion of this plan.

However, for more effective water quality conservation, several other aspects should be considered, such as rehabilitation and construction of sewers, removal of nitrogen and phosphorus with advanced treatment technolgy to prevent the lakes from eutrophication, and also introduction of small scale treatment facilities for urbanized area and for livestock waste treatment.

It is also very important to convert the concept of pollution control from

end-of-pipe treatment to pollution prevention technology to reduce the pollution load from various dischargers.

The Government, Industry and citizens should realize that they are not just victims of pollution but also the major polluters and should do their best for water quality conservation.

▣ Appendix : '93 Research Projects in KICT Concerning Water Pollution Control

TITLE	PERIOD
• A Study for the Groundwater Management and Construction in Korea	93. 1 - 93.12
• A Study on Odor Control Using Aeration Tank and Soil Filter Absorber in Sewage Treatment Plants	92. 1 - 93.12
• A Study on the Reuse and Reclamation of Treated Wastewater	93. 1 - 94.12
• Development of Advanced Water Treatment System	92.11 - 93.11
• Development of a Water Treatment System Using Chlorine Dioxide and Ozone	92.11 - 93. 9
• A Research and Development of River-Environment Management Techniques	93. 5 - 94.12
• A Study on the Landfilled Solid Wastes at the Anyang-Pyungchon Residence Complex	92.11 - 93. 1
• Environmental Impact Assessment of Kyungpu highspeed railway	91.12 - 93. 6
• Development of Water Reuse Techniques in Korea	93. 3 - 94. 3
• A Study on the Development of Decision Making System for Water Pipes Rehabilitation in 1993	93. 8 - 94. 2
• A Study on the Cost Estimation of P/L Process and the Development of P/L-II Process	93. 9 - 94. 8

8. Proposals for Further Discussion

In regarding to the program of the first and second Conference, followings are proposed to be considered for next Conference.

8. 1 Duration of Conference

Duration of the first Confernce was 2 weeks, while 3 weeks for the second. It is a quite long period to stay abroad for the responsible person of any organization. Adjusting the conference schedule is recommended. It may be possible to shorten the study tour schedule. As a proposal, 7 - 10 days conference period looks appropriate such as most of international conferences.

8. 2 Program Organization

Current program of the Conference is organized as 3 major parts ; 1) presentation of country report 2) discussion on specific subjects 3) study tour.

8. 2. 1 Country Report

Current format of the country report is good enough as the first or second conference material. However, for the next conference, it is proposed to be modified, because many parts of the country reports are repeated. Country reports concentrated on any specific field of interest may be recommended.

8. 2. 2 Discussion on specific subjects

Specific subjects were concerning the disaster and environment for the first two conferences. Other topics such as proposed in country report of the first conference could be selected. Topics concerning research investment plan or research management may be suggested.

In selecting the specific subjects, how about to discuss and determine the next conference topics during the conference?

8. 2. 3 Study Tour

As mentioned in Section 8. 1, the period of study tour seems to be somewhat long. Visiting one or two construction sites and one or two research institutes may be appropriate.

IV. Malaysia

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1. OUTLINE OF MALAYSIA

1.1 Description of the Land

Malaysia comprises two regions, namely Peninsular Malaysia and the States of Sabah and Sarawak, separated by 540 km of the South China Sea. The capital, Kuala Lumpur, lies at latitude 3°12' N and longitude 101°43' E. The whole country covers an area of 329,758 sq. km. Peninsular covering 131,598 sq. km. has its frontiers with Thailand in the north and Singapore in the south, while Sabah with an area of 73,711 sq. km. and Sarawak, about 124,449 sq. km., border the territory of Kalimantan of Indonesia. The Peninsular Malaysia stretches 740 km from Perlis in the north to Straits of Johor in the south. The States of Sabah and Sarawak extend some 430 km and 760 km respectively. Please see attached map in Fig. 1.

1.2 Topography

Topographically, Peninsular Malaysia is characterized by a central mountain range surrounded by coastal plains with more than half of the total area being higher than 150 metres above sea level. Almost all rivers originate from this Main Range and flow either into the Straits of Malacca or the South China Sea. Sabah and Sarawak comprise mainly alluvial plains rising gently to rolling country and terminating in the mountain ranges in the interior. The Crocker Range, which runs close to and parallel to the coast, divides Sabah into two regions. In Sarawak, several mountain ranges divide the state from Indonesia. The largest river in Sabah, the Kinabatangan River cuts the interior highlands and runs to the northwest coast while in Sarawak, the Rajang River, Malaysia's longest river, originates from the central mountainous area and develops a vast flood plain in the southern part of the coastline. The streams in the upper reaches of Malaysian rivers are relatively short with steep gradients and flat and meandering in the lower reaches. Along the western coast of Peninsular Malaysia, the very gentle gradients of some rivers have resulted in large expanses of both tidal and freshwater swamps. Swamps in the east coast have developed where drainage has been impeded by beach ridges. Many of the smaller rivers disappear into these swamp.

1.3 Climate

The country has an equatorial climate with constantly high temperatures and high relative humidity. Monthly mean air temperature varies little throughout the year ranging from 25° C to 28° C in the coastal lowland and monthly mean relative humidity is usually high, varying between 75% and 90%. Much of the rainfall are received mainly during the South West and North East Monsoons. The North East Monsoon brings rains to the east coast of Peninsular Malaysia, east of Sabah and west Sarawak during November to February while the South West Monsoon prevails for the period of May to August at the west coast of Peninsular Malaysia. Localized thunder-storms occur all the year round and at times could be very intense particularly during the intermonsoon months of April-May and September-October. The average annual rainfall is 2,420 mm for Peninsular Malaysia, 2,630 mm for Sabah and 3,830

mm for Sarawak.

1.4 Demographics

Malaysia has a population of 18.6 million in 1992. About 82% of the population lives in Peninsular Malaysia, Sarawak 10% and Sabah 8%. Out of the total population, Malays and other indigenous groups comprise 61%, chinese 30%, Indian 8% and other ethnic groups less than 1 %. The average annual population growth has been maintained at 2.6%.

The urban population in Peninsular Malaysia in 1990 was assessed at 6.5 million and the annual urban growth rate is about 4.3%. By the year 2000, the population in the urban areas in Peninsular Malaysia is expected to reach 10.7 million. For the states of Sabah and Sarawak, there is also trend of urban migration, assessed at rates of 6.1% and 4.3% respectively.

The sex ratio of the population is 1,020 males to every 1,000 females. Residents below 15 years of age form 37% of the population while those 60 years and above form 6%.

1.5 Economy and Society

When Malaysia became independent in 1957, Peninsular Malaysia was the world's largest producer of tin and the second largest producer of natural rubber, while the economies in Sabah depended largely on its timber and Sarawak on its petroleum, rubber and pepper. The country's commanding position over these commodities was the source of prosperity, which it enjoyed and placed it well to the fore amongst Third World nations; at the same the nation was placed at the mercy of the fluctuations of the world market, especially in tin and rubber. To overcome this, successive administration since Independence has been diversifying the economy in the agricultural sector and promoting industrialisation in selected areas. The trend towards substantial industrialisation has been particularly marked in the present decade.

In the development of the national economy the Government plays a leading role, directly and indirectly. The general path of economic evolution has been mapped out in a series of five-year plans and since 1971 guided by the philosophy of the New Economic Policy (NEP). The NEP was launched with the introduction of the Second Malaysian Plan (1971-1975) with an avowed two-prong strategy `to reduce and eventually eradicate poverty, by raising income levels and increasing employment opportunities, irrespective of race' and by `accelerating the process of restructuring Malaysian society to correct economic imbalance, so as to reduce the eventually eliminate the identification of race with economic function'. The original target date for the achievement of these goals was scheduled for 1990, but the concepts behind the NEP is now being continued under the recently formulated National Development Policy.

Since 1988, Malaysia has been enjoying strong economic expansion with growth of GDP maintained at above 8%. This is expected to continue for 1993. Fig. 2 shows the export structure for the year 1992. The per capita GNP has increased from RM 6.796 in 1991 to RM 7,554 in 1992. It is forecasted to increase to RM 8,318 in 1993.

Malaysia has a labour force of about 7.5 million, of which about 1.83, 1.45 and 0.86 millions are in agricultural, manufacturing and government sectors respectively. Unemployment rates has decreased from 4.3% in 1991 to 4.1% in 1992 and is expected to reduce further to 4.0% in 1993.

2. A DESCRIPTION OF PUBLIC WORKS SYSTEM IN MALAYSIA

2.1 National Development Policy (NDP)

The objective of National Development Policy is to attain balanced development by eradicating poverty and restructuring society. National Development Policy which emphasizes growth with equity to enable all Malaysians to participate in the mainstream of economic activities ensures political stability and national unity. NDP encompasses the following :

- striking an optimum balance between the goals of economic growth and equity
- ensuring a balanced development of the major sectors of the economy so as to increase their mutual complementaries to optimise growth
- reducing and ultimately eliminating the social and economic inequalities and imbalances in the country to promote a fair and more equitable sharing of the benefits of economic growth by all Malaysians
- promoting and strengthening national integration by reducing the wide disparities in economic development between states and between urban and rural areas
- developing a progressive society in which all citizens enjoy greater material welfare, while simultaneously imbued with positive social and spiritual values, and an increased sense of national pride and consciousness
- promoting human resource development including creating a productive and disciplined skilled labour force to meet the challenges in industrial development through a culture of merit and excellence without jeopardising the structuring objectives
- making science and technology an integral component of socio-economic planning and development, which entails building competence in strategic and knowledged-based technologies, and promoting a science and technology

culture in the process of building a modern industrial economy

- ensuring that in the pursuit of economic development, adequate attention will be given to the protection of the environment and ecosystem so as to maintain the long-term sustainability of the country's development.

2.2 Budget for Investment in Construction

Under the Sixth Malaysia Plan (1991–1995), the transport and communications sector has been allocated a sum of MR 10,832 million or 19.7 percent of the total Federal Government allocation, in line with the objective to provide better infrastructure networks to meet the increased demand for the infrastructural facilities. Out of which, MR 7,585 million is being used for the expansion and upgrading of roads and bridges. MR 1,386 million has been allocated to the Malayan Railways for the purchase of rolling stocks, construction of double tracking system and modernisation of the signalling and communications system. The total allocation for the construction of new airports and improvement of existing airports will amount to MR 997 million.

The allocation of the water resources sector totals MR 4,083 million. The major proportion of this allocation, amounting to MR 2,305 million, is for the development and improvement of water supply schemes. As for the sewerage development, the allocation is increased to MR 1,248 million. A total of MR 530 million has been allocated for flood control.

In the energy sector, the bulk of the development expenditure of PETRONAS and TNB is financed from their internal funds. However, a sum of MR 979 million is allocated by the Federal Government, of which MR 765 is for the development of electricity in the rural areas. PETRONAS has budgetted about MR 10,800 million in the petroleum and gas sector. Investment allocation for the major projects includes MR 4,260 million for refinery projects in Malacca, MR 1,650 million for the expansion of the LNG plant in Bintulu and MR 1,480 million for petrochemical projects. Tenaga Nasional Berhad is spending about MR 11,000 million mainly for the power generation, transmission and distribution networks.

2.3 Organizations Concerned with Public Works in Civil Engineering Field

Ministry of Public Works	:	Roads and highways Airports Ports and harbours Water supply
Ministry of Agriculture	:	Flood control River conservancy Coastal protection Erosion control Agricultural infrastructure Trunk drainage in urban areas

Ministry of Energy, Telecommunication and Post	:	Improvement of electric power supply
Ministry of Housing and Local Government		Sewerage Parks and green Infrastructural drains in urban areas
Ministry of Health	:	Public health facilities
Ministry of Transport	:	Railways

2.4 History, Progress and Problems of the Development of Water Resources and Flood Control

Water Resources

In Malaysia, the annual average rainfall is estimated at 990 billion m^3, out of which 566 billion m^3 appears as surface runoff, 64 billion m^3 goes to groundwater recharge and the rest returns to atmosphere as evapotranspiration. Of the 566 billion m^3 of surface runoff, 147 billion m^3 is found in Peninsular Malaysia, 113 billion m^3 in Sabah and 306 billion m^3 in Sarawak.

Major uses of water resources in Malaysia are domestic and industrial water supplies, irrigation and hydropower generation. Systematic water supply started in the early 1800's when water treatment plants were built in all major towns. In 1959, the capital city of Kuala Lumpur was provided with the first major water supply service when a dam was built across the upper Klang River. By 1990, 96% of the urban population have access to piped water while the coverage reached 66% for the rural area population, the total water supply capacity being about 7900 Mld. As much as 97% of the total water supply come from the rivers while the rest from groundwater.

From early 1900's, rivers in Malaysia started to provide irrigation water for large scale rice cultivation, and from 1960 onwards, the irrigation service was stepped up when a number of rice granaries were developed. In Malaysia, Agriculture service is always provided in an integrated manner, which means apart from irrigation service, facilities such as farm roads, farmer development centers, etc are provided at the same time. Today, Malaysia is 70% self sufficient in rice, in keeping with the national policy of rice production.

The water demands for water supply and irrigation (in billion m^3/year) are as shown below:

Year	Water Supply	Irrigation	Total
1980	0.8	7.4	8.2
1993	2.0	9.6	11.6
2000	4.8	10.4	15.2

The total water demand, even by the year 2000, is small compared with the available water resources in the country. However, water stresses have been experienced in the more populated areas as well as certain rice areas such as the Muda Irrigation Scheme. This is mostly due to the uneven temporal and spatial distribution of rainfall and the fact that the infrastructure have not been developed adequately yet in all parts of the country.

In the case of hydropower development, in 1930 the first hydropower station was constructed at Chenderoh with a capacity of 27,000 kW. Since then the rivers have continued to support the nation's energy needs as more dams were built. Today, hydropower contributes roughly a quarter of the total energy production in the country.

Flood Control

Flood is a negative aspect of water resources. A large part of the flood problems is inherent in the fact that many population centers and settlements have developed in coastal areas and inland valleys prone to flooding. Forest conversion to agricultural land, and rapid urbanisation have in many instances aggravated the flooding situation. Flood damage costs have increased with time due to the growth of prosperity and wealth in these flood prone areas. The flood prone areas was estimated in 1982 as 29,000 km^2 or 9% of the total land area. This figure has since been reduced with the implementation of flood mitigation programme as well as the construction of a number of hydropower dams which also serve the purpose of flood control. After the 1971 flood event when Kuala Lumpur and a large part of the country elsewhere were severely flooded, flood mitigation measures have been systematically stepped up when increasing financial allocation has been given to alleviate flooding and to reduce flood losses in both agricultural and urban areas. The expenditures for flood mitigation works has increased from RM 14 million under the Second Malaysia Plan (1971–1975) to RM 56 million under the Third Malaysia Plan (1976–1980), RM 141 million under the Fourth Malaysia Plan (1981–1985) and RM 142 million under the Fifth Malaysia Plan (1986–1990). For the Sixth Malaysia Plan period (1991–1995), a total of RM 530 million has been allocated to DID to implement flood mitigation projects in both urban and non–urban areas.

2.5 Major Project in Progress – (Kuala Lumpur Flood Mitigation Project)

As a result of the disastrous January 1971 flood, a Permanent Flood Control Commission was established to formulate policy and to monitor the implementation of flood mitigation works throughout the country. The Kuala Lumpur Flood Mitigation was one of the earliest river engineering projects to be undertaken by the Federal Government through the Department of Irrigation and Drainage. The project comprises the following components : –

(i) Construction of dams – enlargement of the existing Klang Gates Dam and construction of two new dams on the upper catchments of the Batu and Gombak Rivers for flood control and water supply purposes;

(ii) River canalization and revetment works – canalization of some 47 km of the existing Klang, Batu and Gombak Rivers to cater for the 100-year return period flood discharge;

(iii) Urban drainage works – upgrading of about 360 km of the existing urban drainage system and construction of new trunk drains within the Kuala Lumpur metropolitan area to alleviate flash floods.

The raising of the Klang Gates Dam by 3 metres was completed in 1980 and this has effectively controlled floods from the upper Klang River. The construction of the Batu Dam was completed in 1987. The proposed Gombak Dam has been dropped and replaced by a proposed flood retention pond using an ex-mining pond. Channel improvement works on the Batu, Gombak and Klang Rivers within the city centre which began in 1978 are about 30% completed with a total expenditure to date of about RM 210 million.

The cost of the project is estimated to be RM 760 million. The project is scheduled to be completed in the year 2007.

4. MAJOR RESEARCH AND DEVELOPMENT PROJECTS IN D.I.D.

Since its establishment in 1932, the Department of Irrigation and Drainage has been closely associated with applied hydraulic research because of its involvement in the provision of irrigation, drainage, river conservancy, flood mitigation, hydrology, river and coastal engineering services. As an engineering department, it does not carry out basic research. The Research Branch of the Department was operational since 1951 and has been fairly active in the field of physical modelling of prototype hydraulic structures, river and port engineering works.

However, D.I.D., in fact Malaysia as a whole, is still heavily dependent on foreign expertise for more complex research support services, although local universities, in particular the National University of Technology, are fast developing in the past decade in hydraulic and water resources fields. To meet the national needs, the Government has recently approved the establishment of a National Hydraulic Research Institute whose principal objective is to build up a group of expertise to provide research needed for the planning, design and implementation of the water resources projects. The Institute also serves as a national focal point to coordinate all the research activities in the field of hydraulics including coastal engineering. The primary scope of services of the Institute is listed as follows :

Hydraulic Engineering

- Hydraulic studies and modelling
- Sediment transport and morphology
- Estuarine hydraulics
- Hydraulic structures
- River engineering and river regulations
- Salinity intrusion

Hydraulic analysis of pipe system

Coastal Engineering
- Wave and coastal dynamics
- Oceanography
- Offshore technology
- Ports and harbour layout
- Dredging technology
- Coastal erosion and control
- Coastal zone planning

Water Resources Management
- River basin development and planning
- Irrigation and drainage
- Hydrologic modelling
- Groundwater modelling
- Reservoir design and operation
- System planning and optimisation

Water Quality and Environment
- Water quality modelling
- Marine and coastal pollution
- Ecological modelling
- Environmental impact assessment
- Treatment technologies

5. INTERNATIONAL RESEARCH EXCHANGE PROGRAMME

D.I.D. along with other agencies and universities have been actively involved in the International Hydrological Programme. A number of projects have been enlisted under this programme inluding : -

a) Effects of landuse change on hydrological processes
b) Urban hydrology
c) Hydrology of small islands
d) Reservoir operation
e) Groundwater contamination
f) River quality monitoring
g) Highlands hydrology

However, except for the project on Urban Hudrology, the rest are awaiting financial support from donor agencies and therefore are currently of national interest only. The research project on Urban Hydrology is to start soon and will be carried out in collaboration with Swedish Agency of Internatinal Technical and Economic Cooperation. The objective of this research is to facilitate the development of

regionally relevant, economically efficient and ecologically sound methods of water management in urban areas situated in Humid Tropics.

6. DISASTER AND DISASTER PREVENTION

Malaysia has an equatorial climate with high precipitation from the north-east and south-west monsoon. The north-east monsoon has caused extensive flooding in the east coast states of Peninsular Malaysia and the states of Sabah and Sarawak. Being surrounded by the tectonically active countries like Indonesia and Phillipines, the country is occasionally affected by the tremors.

6.1 Flood

Floods occur quite frequently in Malaysia. The basic cause is the incidence of heavy rainfall and the resultant large concentration of run-off which are very much in excess of the capacities of the streams and rivers. In recent years, rapid development within river catchment have resulted in the gradual deterioration of the rivers as efficient conveyance of water and sediment, and frequently, this has resulted in an increase in the frequency and magnitude of flooding.

6.2 Flood Disaster

Steep topography, short river and heavy monsoon type precipitation are conducive to flooding and some areas has suffered flood damage almost every year. In 1926, the biggest flood in living memory has affected flooding to most of Peninsular Malaysia, causing extensive damage. Major flood events were subsequently recorded in 1931, 1947, 1954, 1957, 1971, 1973 and 1983 causing extensive damages. Flooded areas mapped for the recorded maximum flood events amount to some 29,000 sq. km. or about 9% of the total land area. About 2.7 million people are affected. The average annual flood damage is estimated at RM 100.0 million. This figure is expected to increase as the value of the properties has escalated.

6.3 Flood and Flood Disaster Prevention in Department of Irrigation and Drainage

Following the disastrous 1971 flood, the Government has designated flood mitigation as an additional function of the Department of Irrigation and Drainage. The Department is entrusted with the role to formulate river basin plans and to implement countermeasures for flood mitigation projects as well as flood forecasting and warning system. Since 1980, the Permanent Flood Control Commission is chaired by Hon. Minister of Agriculture and the Department of Irrigation and Drainage acts as the Secretariat.

6.4 Countermeasures

Following the disastrous 1971 flood, the Government took several positive steps to deal with the flood problems. Among these were :

(a) the establishment of Permanent Flood Control Commission

(b) the establishment of a Flood Disaster Relief Machinery

(c) carrying out river basin studies

(d) implementing structural measures

(e) implementing non-structural measures

6.4.1 Permanent Flood Control Commission

The Permanent Flood Control Commission was established by a decision of the Cabinet on 21st December 1971. Its task is to study short-term measures to prevent the occurrence of flood and long-term measures for flood mitigation. The Commission drew up specific terms of reference as follows :

(a) to take measures for flood control and to reduce the occurrence of floods; and

(b) in the event of floods, to minimise damage and loss of life and property.

Originally the Commission was headed by the Minister with Special Functions acting as the Minister of Information whilst the secretariat was at Social-Economic Research and Planning Unit, Prime Minister's Department. However, since the function of flood mitigation was entrusted to Department of Irrigation and Drainage, Ministry of Agriculture, the secretariat was moved to Ministry of Agriculture in 1980.

6.4.2 Flood Disaster Relief Machinery

This machinery was established with the objective of co-ordinating relief operations at the Federal, State and district levels so that assistance can be provided to flood victims in an orderly and effective manner. Overall the co-ordination of relief operations is the responsibility of the Natural Disaster Relief Committee. This Committee is headed by Minister of Information with its secretariat at the National Security Council. The Committee is empowered among others, to declare any District, State or even the whole nation in the state of disaster so as to be eligible for getting financial assistance from the Federal Government for remedial works in addition to allocation of funds under the operating budget. Most members of this Committee are governmental departments/agencies and social organizations which would provide shelter, rescue and food supplies in case of disaster. At least once a year, normally before Northeast Monsoon, this Committee will gather all members to ensure the machinery will run smoothly.

6.4.3 River Basin Studies

Since 1972, a number of river basin studies have been carried out for rivers where major flood problems exist. The objective of these studies is to draw up master plans for water resource development and measures for flood mitigation formed an important component. To date, studies that have been completed are Kuala Lumpur (1974), Pahang River (1974), Kelantan River (1978 & 1989), Terengganu River (1978), Limbang River (1978), Kinabatangan River (1982), Samarahan River (1983), Batu Pahat River (1984), Johor River (1985), Golok River (1985), Besut River (1988), Klang River (1989) and Penang Island (1991).

Realising the need for a long term water resources development strategy and master plan, the Government had carried out a National Water Resource Study (1982) to develop a comprehensive and coordinated water resources development programme for the country. The study has formulated a long term plan for flood mitigation works in various flood prone areas of the country. This includes improvement of 850 km of river channels, construction of 12 multi-purpose dams, 82 km of flood bypass, 12 ring bunds around urban centres and resettlement of about 10,000 people in flood prone areas. The whole plan estimate to cost RM 2.55 billion over a period of 20 year and will provide protection to some 1.8 million people.

A number of studies have also been carried out for alleviating flooding problems in various specific locations in the country. These include the Cukai Flood Mitigation Study, Lower Perak Flood Mitigation Study and the Kangar Flood Mitigation Study as well as Drainage Master Plan Study for the towns of Butterworth and Bukit Mertajam, Kuala Lumpur, Alor Setar, Sandakan/Tawau/Kota Kinabalu, Bintulu, Johor Bahru, Kelang and Port Kelang, Seremban, Melaka, Kuantan, Kota Bharu, Kuala Terengganu, Port Dickson and Muar.

6.4.4 Flood Mitigation Measures

From the various studies, both structural as well as non-structural measures have been proposed to alleviate the flood problem. Structural measures include channel improvement, construction of bunds, flood bypass, poldering, construction of flood storage dams and flood attenuation ponds, either singly or in combination.

Non-structural measures are proposed where engineering measures are not applicable or viable or where supplemental measures are required. They include restriction of development, land use change, resettlement of population, flood proofing and flood forecasting and flood warning systems.

6.4.5 Structural Measures

The structural measures used include the following:

Flood Control Dams

These dams are constructed to retain floodwater in order to protect areas downstream of the dams. Construction of storage dams solely for flood control purposes are generally economically not viable and such dams are frequently utilised for other purposes such as water supply. In addition dams constructed for hydro electric purposes also have a portion of the capacities for flood detention.

Canalisation and related works

Canalisation works include the widening and deepening of channels as well as lining the banks and beds of the channels. They also include the replacement of undersized structures such as bridges. These works are necessary as the original channels have become undersized as a result of the increase in flood flow caused by development.

Bunding

Bunding of rivers prevent overtopping and flooding of lowlying adjacent areas. This option may give rise to problems of internal drainage as a result of the bunding. Bunding an urban area introduces a high flood damage potential as any occurrence of flood would be very damaging.

Ponds for Flood Attenuation

Ponds such as disused mining pools can be used for flood storage. The objective is to divert the flood water through such ponds and thus regulate the outflow so that the flood peaks are attenuated.

Poldering (Ring Bund)

Poldering is the provision of ring bund surrounding the area to be protected. This is normally carried out for the area which has high damage potential yet the costs of an overall basin wide protection is prohibitive. It includes the provision of internal drainage for the area to be protected and the flood water to be evacuated by pumping during periods of high river flows.

The present strategy of using structural flood control measures such as above has proved effective in controlling floods and are usually the only options available for built up areas. However, structural measures usually incorporate "hard" engineering measures that result in bigger channels conveying high flows at high velocities. This would incur higher construction costs as well as substantial reserves for the channel.

6.4.6 Non-structural Measures

Restriction of Development in Flood Prone Areas

In flood-prone areas where structural measures cannot be economically justified, the potential for damage to property, works and public services as well as loss of life can be minimized or avoided by restricting development in such areas. In this connection, Malaysia has embarked on the preparation of a flood risk map for the upper Klang river basin as a pilot project.

Land Use Changes

One of the measures to reduce the damage potential to crops is to convert agricultural land use to less damage-susceptible crops, for example, converting paddy land to oil palm.

Resettlement of Population

One positive measure to reduce damage potential as well as loss of life in flood prone areas where floods would not significantly reduced by structural measures is to resettle the population. Since 1971, 1,672 families and 2,715 families have been resettled in the States of Kelantan and Pahang respectively.

Flood Proofing

This measure consists of implementation of protective works to prevent entry of flood water into individual houses and specific places, for example, by bunding a building with a wall so that the floor is not submerged during a flood and thereby reduce flood damage.

Flood Forecasting and Warning System

The provision of a flood forecasting and warning system is an important, practical and low-cost measure to minimis flood losses. Flood forecasts given early will enable people living in flood- prone areas to be warned so that they can evacuate themselves and their belongings before the arrival of the flood. This can considerably reduce flood loss and damage and above all the loss of human lives. Following the 1971 flood, telemetric forecasting systems have been installed in the basin of Kelantan, Pahang, Perak, Sadong, Kinabatangan, Klang, Terengganu, Besut, Dungun, and johor which are susceptible to major floods from time to time. Similar system was recently installed in Muar river basins in Johor and more are being planned for another 20 river systems. VHF flood forecasting systems have been established in smaller basins. In river basins which are subject to flash floods, little lead time is available for effective warning. Therefore flood warning sirens, which automatically trigger once the flood level reaches the critical point, have been installed at strategic locations along such rivers to alert the local residents of impending floods.

Since 1980, flood warning boards have been erected in the major river systems. Levels marked on these warning boards are correlated to the levels at the observation point upstream. The warning boards are located at flood prone villages downstream of the observation point and they enable the residents of the villages to assess themselves what the situation would be like in their areas, upon receiving the information of the water level through radio broadcasting, village heads or/and police.

6.4.7 Adopting Sound Watershed and Development Management System

While much efforts has been devoted to combat the flood "directly", another pro-active approach to alleviate flood problems from an "indirect" angle is the watershed and development management. This is an effective means of curtailing flood should rainfall of various degrees occur.

Malaysian governmental machinery is organised such that efficient coordination amongst various agencies concerned could be materialised. Ecomonic Planning Unit in the Prime Minister's Department coordinates all aspects as well as all stages of planning and implementation of projects related to water. The Ministry of Local Government through its Municipal Councils or City Halls, invites participation, comments and views of both public and private organisation as well as individuals before formulation of Structure Plan. Master Drainage Plan will be drawn up after taking into considerations the various details of the Structure Plan and will be incorporated in the overall Flood Mitigation Project in Department of Irrigation and Drainage. In 1977, the National Forest Policy was adopted by the National Forestry Council of which the function is to coordinate and uniform forest practices. This Policy provides the basis for the formulation of technical development policies and strategies specially for forest research, development and management.

6.4.8 Seismic Risk in Malaysia

Malaysia, apart from the state of Sabah and the extreme eastern portion of Sarawak, the major part of it lies along the eastern and western fringes of the Sunda Shelf which is a tectonically stable region. However the west coast states of Peninsular Malaysia are affected by the tremors originating from large earthquakes located over the Sumatra areas. On the other hand the state of Sabah is moderately active. A number of local earthquakes of small to medium magnitude occurred in the past. The larger ones resulted in minor cracks in masonry walls and narrow fissures in the ground.

With the national economy developing at a rapid pace, more and more high-rise buildings, large power plants, bridges, dams and other critical installations are being built. Coupled with higher concentration of population, the seismic risk is expected to increase progressively with time.

A number of seismological stations were set up by the Malaysian Meteorological Services to monitor the earthquake activities in the country.

6.4.9 Type of Strategy to Mitigate Seismic Risk

Malaysia is subject to the threat of earthquake damages. The best solution is readiness. This calls for earthquake hazard zoning of the country, the incorporation of earthquake resistant features in the design and construction of buildings and other engineering structures that are susceptible to earthquake damages.

Strategies identified to be implemented are the introduction of earthquake codes, land use planning and regulations and the need for disaster planning. It is felt that earthquake hazard management effort hold focus on large cities and on civil engineering projects which are most vulnerable to long period waves of distant earthquakes.

The Malaysian Meteorological Services is taking steps to link up its seismological stations to a computer system at its head office in Petaling Jaya by dial-up telephone lines. Earthquake epicentral values can then be speedily determined and any rescue action if warrant, can be immediately initiated.

7. HARMONY BETWEEN THE ENVIRONMENT AND IMPROVEMENT OF INFRASTRUCTURE

7.1 Introduction

As the country has undergone rapid growth in urbanisation and industrialisation, the people are faced with a number of environmental concerns as direct or indirect consequences. Amongst these are air pollution, water pollution and noise disturbance. Air has been polluted by the emission from the motor vehicles and industries as well as open burning. River water has been contaminated by the improper disposal of sewerage mainly from both domestic and animal waste, heavy metal discharge from industries and silt from land clearings, road and housing construction, mining, timber logging and certain unregulated development.

7.2 Environmental Policy

In 1974, the Environmental Quality Act (EQA) was enacted and the subsequent formation of the Department of Environment (DOE) in 1976. In the Third Malaysia Plan (1976-1980), Malaysia's overall environmental policy objectives have always intended to `... balance the goals for socio-economic development and the need to bring the benefits of development to a wide spectrum of population ... against the maintenance of sound environmental conditions'. The plan also saw the introduction of Environmental Impact Assessment (EIA) as a tool for assisting decision-makers with respect to development projects which are likely to cause negative impacts to the environment. Further to this, the National Development Policy of the Second Outline Perspective Plan (1991-2000) categorically states that "adequate attention will be given to the protection of the environment and ecology so as to maintain the long-

term sustainability of the country's development". Also outlined in the First Statement in Malaysia's Vision 2020 is that in the pursuit of economic development, Malaysia will also "ensure that her valuable natural resources are not wasted. The land must remain productive and fertile, the atmosphere clear and clean, the water unpolluted, the forest resources capable of regeneration, able to yield the needs of the natural development". The beauty of the land must not be desecrated : for its own sake and for its economic advancement".

7.3 State of Environment

River Water Quality

In 1992, monitoring of the water quality of 87 rivers has been carried out and a total of 3118 samples were collected by the Department of Environment. Appraisal of the quality based on the Water Quality Index (WQI) for five parameters namely, Biochemical Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), Ammoniacal Nitrogen (NH_3N), Suspended Solids (SS) and pH showed that the river water quality has deteriorated at a rate of 1.17%. Although the number of very polluted rivers remained unchanged as 6, the number of slightly polluted rivers had increased from 51% in 1991 to 64% in 1992, while the number of clean rivers had decreased from 43% to 29%. Fig. 3 shows status of river water quality in Malaysia.

Assessment of river water quality based on the parameters NH_3N, BOD_5, and SS revealed that NH_3N has deteriorated at a rate of 2.17%, SS at a rate of 0.88% and BOD_5 at a rate of 0.10%. This analysis indicates that organic loadings (especially from sewerage and animal wastes) and silt (from soil erosion) were still the major contributors to the river pollution.

The heavy metal level like mercury, lead and zinc were found to have exceeded the tolerable limits in the standards in certain rivers. Out of 50 rivers monitored by the Department of Environment, 9 rivers recorded mercury level exceeding the tolerable limit of 0.004 mg/l. 12 rivers were found to have exceeded the limit of the standard value of 0.02 mg/l.

Air Pollution

The quality of air is very much influenced by the degree of urbanisation, concentrating particulates, either suspended or respirable, in the cities within the industrial corridor of Peninsular Malaysia's West Coast, from Pulau Pinang to Johor Bahru. Gaseous pollutants such as carbon monoxide, nitrogen oxide and sulphur dioxide still remained at safe levels, notwithstanding the current rate of increase in motor vehicles, which certainly warrants caution in the future.

Vehicle and industrial emissions as well as open burning are the major contributors to air pollution. 79.8% of air pollution comes from vehicle emission, 16.8% from industries and 3.4% from open burning.

Noise

Monitoring of noise throughout the year by Department of Environment on areas of heavy traffic revealed that low average noise levels in the range of 64.9 to 78.8 dB(A), in most major towns.

7.3.1 Measures for River Water Quality Improvement

From the appraisal report by the Department of Environment on river water quality, the major contributors for the river pollution were sewage and silt. Under the Sixth Malaysian Plan (1991–1995), the Government has allocated RM 1,248 million to construct central sewerage system in urban centres to prevent direct discharge of domestic sewage into the rivers. The Government is also making a move to privatise sewerage services. This is made possible by a recent approval of the Sewerage Service Bill by the Parliament, which allows the Federal Government to take control of the operation of sewerage service, which have been under the jurisdiction of the Local Authorities.

Major earthwork projects such as land clearing, road and highway construction and housing development have generated large amount of silt. Mitigation measures such as terracing, use of silt trap and turfing are normally imposed as conditions of approval, the enforcement of which, however, needs to be stepped up. Logging is also another major source of silt. Mitigation measures include selective logging and reforestation.

7.4 Environmental Impact Assessment

The objective of the Environmental Impact Assessment (EIA) is to identify, predict, evaluate and communicate information about the impacts on the environment of a proposed project and to detail out the mitigating measures prior to project approval and implementation. Since the Third Malaysian Plan (1976–1980), EIA has been put forward as a requirement for the relevant projects proposed by both the private and public sectors. Environmental Quality Act 1974 states that any person intending to carry out any of the activities which are prescribed are required to submit EIA report to the Director General of Environmental Quality for approval prior to the granting of approval of the activity by the relevant approving authority. The categories of activities that are prescribed are as follows :

* Agricultural
* Airport
* Drainage and irrigation
* Land reclamation
* Fisheries
* Forestry
* Housing
* Industry
* Infrastructure
* Ports

* Mining
* Petroleum
* Power generation
* Quarries
* Railways
* Transportation
* Resort and recreational development
* Waste treatment and disposal, and,
* Water supply

The strategies embodied in the Environmental Quality Act 1974 is to prevent, abate and regulate any form of pollution. To bring the law and other environment–related laws into effect, the following regulations and orders have been introduced and enforced :

Control of Agro–Based Water Pollution

- Environmental Quality (Licensing) Regulations 1977
- Environmental Quality (Prescribed Premises)(Crude Palm Oil) Regulations 1977
- Environmental Quality (Prescribed Premises)(Raw Natural Rubber) Regulations 1977

Control of Municipal and Industrial Waste Water Pollution

- Environmental Quality (Sewerage and Industrial Effluents) Regulations 1979

Control of Industrial Emission

- Environmental Quality (Clean Air) Regulations 1978
- Environmental Quality (Compounding of Offences) Rules 1978

Control of Motor Vehicle Emissions

- Motor Vehicles (Control of Smoke and Gas Emission) Rules 1977
- Environmental Quality (Control of Lead Concentration in Motor Gasoline) Regulations 1985
- Environmental Quality (Motor Vehicles Noise) Regulations 1987

Control of Toxic & Hazardous Waste Management

- Environmental Quality (Scheduled Wastes) Regulations 1989
- Environmental Quality (Prescribed Premises)(Scheduled Wastes Treatment and Disposal Facilities) Order 1989
- Promotion of Investments (Promoted Activities and Products)(Ammedments)(No.10) Order 1990

Integration of Environment and Development

- Environmental Quality (Prescribed Activities)(Environmental Impact Assessment) Order 1987, and,

Control of Substances that Deplete the Ozone Layer

- Customs Duties (Amendment)(No.35) Order 1989

7.5 Activities in D.I.D. to Promote Sustainable Development

The Department of Irrigation and Drainage is committed towards sustainable development and has been complying with the EIA requirement since its inception in 1987. The following categories are applicable to D.I.D.'s works : –

a) Construction of dams and manmade lakes and the artificial enlargement of lakes with surface area of 200 hectares or more.

b) Drainage of wetland, wild–life habitat or virgin forest covering an area of 100 hectares or more.

c) Irrigation schemes covering an area of 5000 hectares or more.

d) Dams with either or both of the following :

   i) Dams over 15 metres high and ancilliary structures covering an area in excess of 40 hectares.

   ii) Reservoirs with a surface area in excess of 400 hectares.

e) Groundwater development for agricultural purposes of greater than 4500 cubic metres per day.

Additionally, the Department also contributes towards the enhancement of the river environment as follows : –

(i) Landscaping in rivers

D.I.D. in cooperation with the local authorities has placed great emphasis on incorporating landscaping and beautification/recreational facilities during the implementation of river improvement works especially in the urban areas. These beautification works can include the laying of footwalks/jogging tracks along river banks, the use of old river courses and ox–bow lakes as lakes for water–related recreation, the design of river revetments giving due consideration to aesthetic and recreational requirements, and the development of land within river reserves into mini parks or playgrounds.

(ii) Conservation of river reserve

River corridor management which serves to protect the river from undesirable activities on the banks and in the channels as well as to provide adequate space for present and future river works.

(iii) Campaign

In 1993, D.I.D. has jointly with other agencies carried out a nation wide "Love Our River" campaign to inculcate awareness of the general public regarding

the role of rivers in preserving the environment and the standard of living of society so that they are seen as an important resource of our country. The activities include river watch, river adoption, river expedition, public education and an international symposium "management of River for the Future".

(iv) Rehabilitation of river

D.I.D and other governmental organizations are undertaking a 10 year programme for cleaning of Klang river. The programme includes river improvement and maintenance works, desilting of the river, beautification of river environment, resettlement of squatters within the river reserve, relocation of pig farms within the catchment, reviving the aquatic habitant, improvement of river water quality and inculcate public awareness.

(v) Rehabilitation of catchment

One of the projects undertaken by D.I.D. is to rehabilitate the catchment of Kinta River. The catchment covers an area of 2,540 sq. km. The lower valley comprises tin-bearing alluvium up to 70 m thick. Mining dates back to more than 150 years, with the main mining methods being dredging and gravel pumping. Up until the collapse of the tin price in the mid-1980's, the annual production averaged about 40,000 tonnes per year. The mining activities had resulted a total of 30,000 ha of ex-mining land and 1250 ex-mining ponds covering 13,000 ha, which has caused extensive environmental degradation.

Past crop research, field trials and commercial cropping schemes have demonstrated the feasibility of establishing sustainable cropping on ex-mining land. The rehabilitation land use pattern comprises a diversity of productive agriculture including (1800 ha), fruit trees (4500 ha), along with forest and oil palm (8000 ha), conservation-type forest (12,500 ha), livestock and aquaculture.

(vi) Watershed management

D.I.D. provides technical advice and support to all the states and local governments on land and water development and in so doing, consideration is given to proper watershed management practices.

7.6 Conservation of National Resources

7.6.1 In line of the spirit of the Langkawi Declaration of Environment and the concern on the preservation of clean environment and sustainable development, the implemetation of sectoral programmes and projects will continue to focus on the necessity of maintaining a balance between demands of growth and sustainable development. Amongst these programmes and strategies are :

a) Designation additional forested areas as forest reserves, animal santuaries and national recreational parks which will ensure the ecological balance is

essential habitats and bio-diversity are preserved.

b) Large scale of reforestation programmes supported by agro-forestry programmes are carried out to balance the needs for economic growth and the needs for promoting ecological balance. Greater priority are given to efforts at providing the required budget for the research and development for reforestation as well as more strict enforcement.

c) Tree cover is expanded to preserve habitats, safeguard soil quality, to reduce siltation and erosion, sustain climate balance and also to absorb excess carbon dioxide released into the atmosphere. This programme is anticipated to moderate soil losses, droughts and floods, and to reduce disruption of water supplies and to replenish the natural productivity of land.

d) Projects in watershed areas for expamples dam construction and other major infrastructural projects which are likely to affect adversely the environment will be carefully planned and implemented. The preservation of unique species of flora and fauna and bio-diversity which may be endangered by such projects will be given due attention.

7.6.2 In giving effect to the National Forest Policy, a large proportion of Malaysia's natural forest is delineated as the Permanent Forest Reserve, to be maintained on a forever and ever basis. In addition, substantial forest areas have been set aside as national parks, wildlife sanctuaries and nature reserves. As an integral part of sustainable management, forest plantations are being established while rubber and oil palm plantations are increasingly utilised as additional sources of renewable timber and fibre material.

7.6.3 In Malaysia, the Permanent Forest Reserve totals 14.1 million hectares. Of this, the area designated as Protection Forest amounts to about 2.9 million hectares. No logging is permitted in the Protection Forest in order that it be kept in its natural state without disturbance. About 330,000 hectares of Protection Forest plus another 1.8 million hectares of forest outside of it constitute national parks, wildlife sanctuaries and nature reserves. Approximately 11.2 million hectares of the Permanent Forest Reserve are earmarked as Production Forest. Area within Production Forest are commercially logged on a rotational cycle, under a sustained-yield management system. Only a few mature and fully grown trees (generally 7-12 trees per hectare of forest) are marked for felling at each rotational round of harvesting giving sufficient lead time for the logged-over area to recover and regenerate before next round of harvesting takes place. Under selective logging, tropical forest have the ability to regenerate on their own and to return to their former state of eco-balance.

8. PROPOSAL FOR FURTHER DISCUSSION

In Malaysia, of major concern to river engineering service are the mitigation of floods and comprehensive management of rivers to enable the rivers to play their expected roles in a sustainable manner. The river roles include water resource, natural drainage, navigation, fishery, recreation, ecological as well as historical and cultural assets. It is believed that this concern is common to other participating countries. The following related issues are therefore proposed for discussion:

(a) Flood Control

Urbanisation aggravates river flooding. In return the urban areas need protection from being flooded, often of a higher standard because of the larger potential flood damage. Discussion is invited on :

(i) Storm retention
(ii) Standard of protection
(iii) Maintenance, especially desilting, of urban rivers

(b) Water resources management

Water resources is a limited entity. Demand increases rapidly with time leading to competition between various user sectors and also disparity in water resource supply–demand situation between different administrative boundaries. Interbasin and interstate and even international transfer of water; roles and relation of agencies concerned; Federal–State involvement etc. are water resources matters that need attention. In Malaysia, although there exists a fairly effective coordinating and implementing mechanism for water resources development, the need for legal revision is recognised, but the fact that it has yet to materialise shows the complexities involved.

(c) Enhancement of river environment

Sustainable development has become a well accepted objective, and is reflected in the national environmental policy. In the case of river environment, the issue quite often is one of improving instead of sustaining. Therefore efforts should also be on how to enhance the river environment. Two aspects are raised for discussion : –

(i) No amount of governmental effort will be adequate without the involvement of the general public as well as the private sector. It is recognised that this should go beyond the use of law such as inculcating a positive attitude towards rivers. Care for the rivers by all (governmental, private sector and individual) should be the objective, but how best to bring about this ?

(ii) In addition to the functional aspects of river works such as dam, levee, canalisation and control structure, often opportunity is available to

incorporate landscaping and beautification works as well as ecological considerations and make the design as environmentally friendly as feasible. How is this concept practised in the participating countries ?

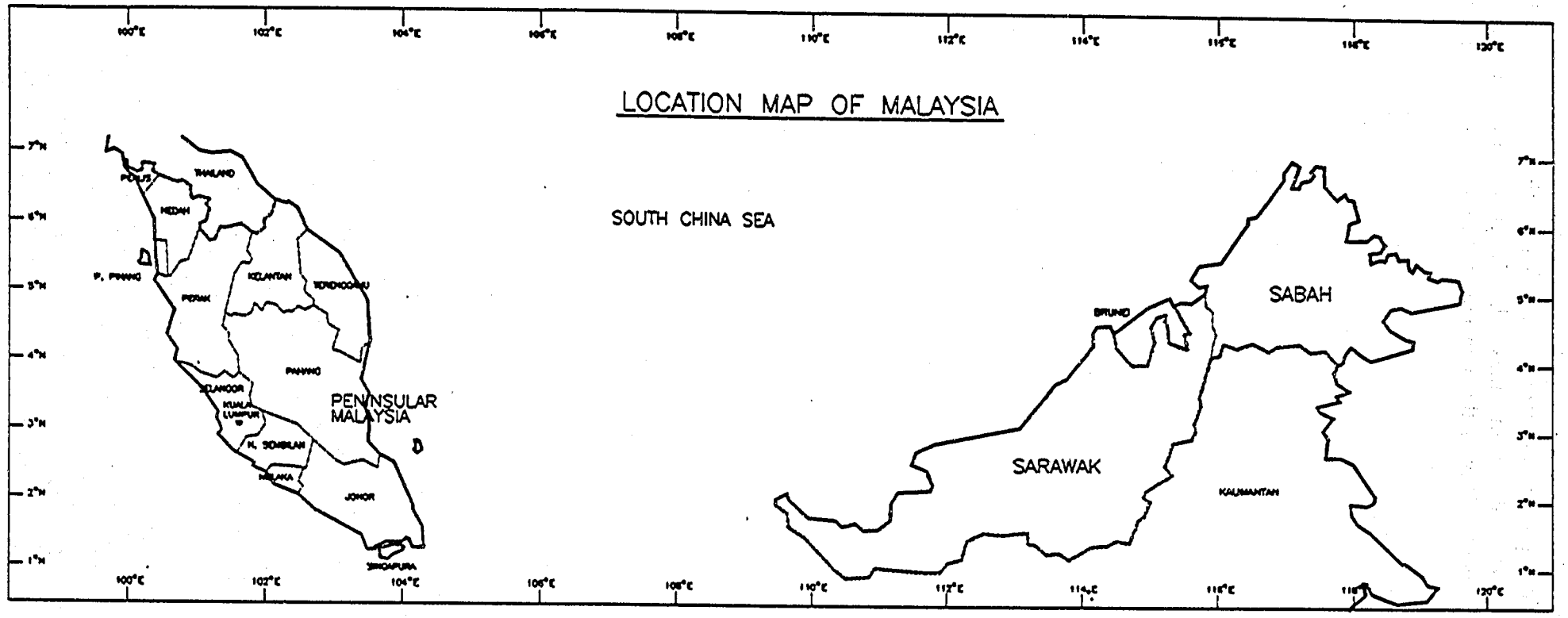


Fig. 1 : LOCATION MAP OF MALAYSIA

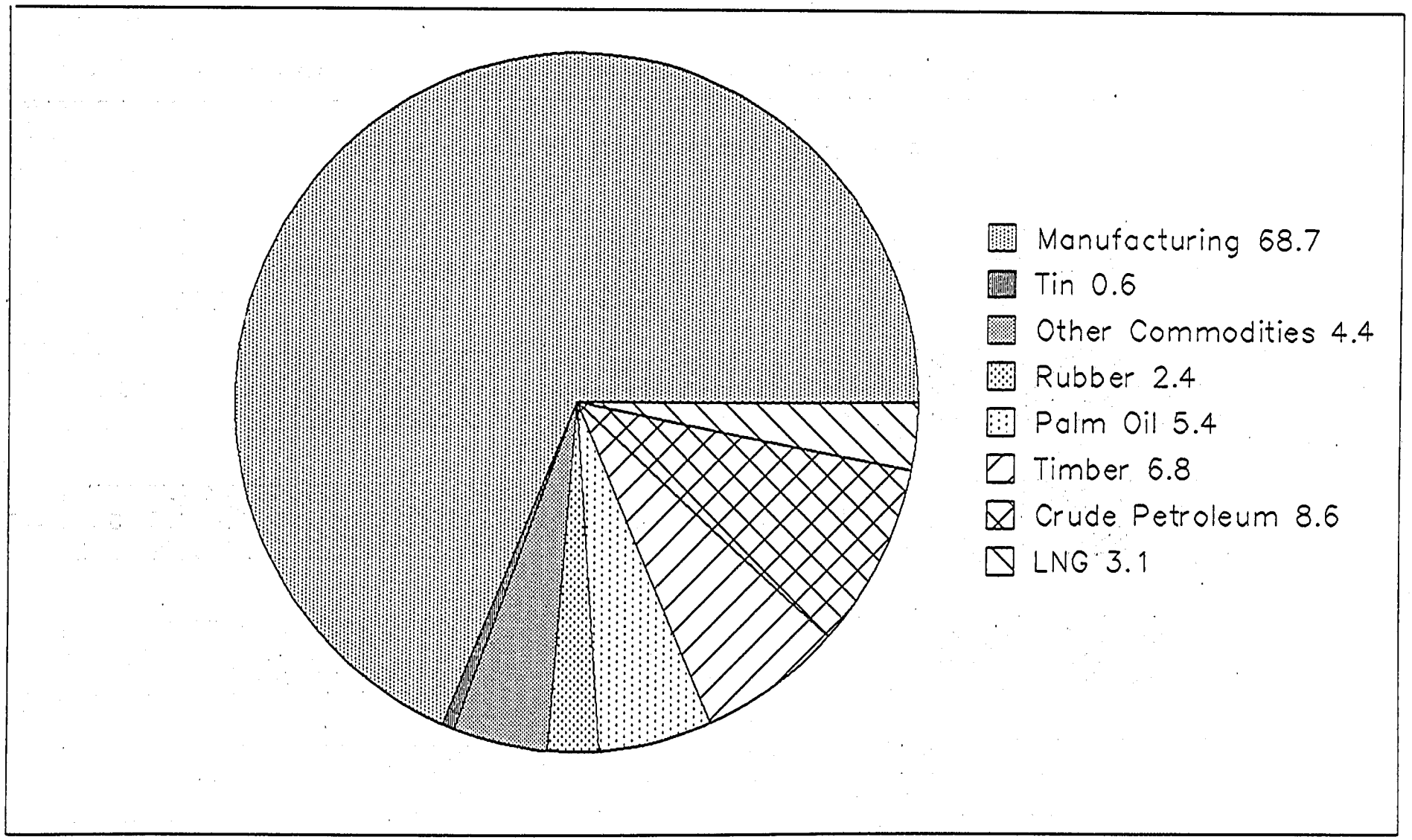


Figure 2 : Export Structure For 1992

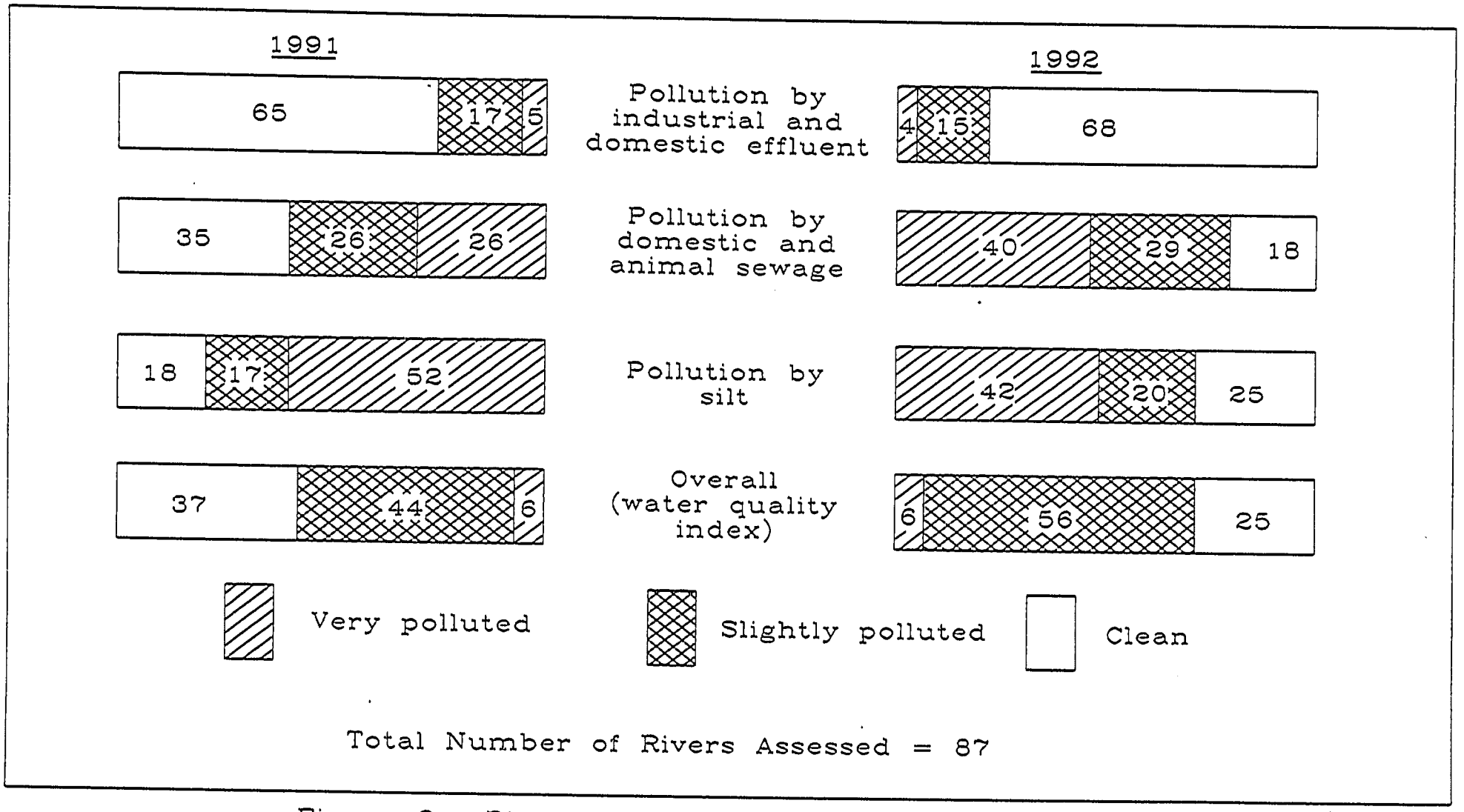


Figure 3 : River Water Quality, Malaysia, 1991–1992

V. Republic of the Philippines

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EXECUTIVE SEMINAR ON PUBLIC WORKS RESEARCH AND DEVELOPMENT

COUNTRY REPORT : PHILIPPINES

Part I

by:

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Director IV

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1. COUNTRY OUTLINE

1.1 Description of the Land

The Philippines, composed of about 7,100 islands,is one of the largest island groups in the world. It lies 966 kilometers off the southern coast of Asia between latitude 4^0 23' N and 21^0 25' N and between longtitude 116^0 E and 127^0 E.

The greatest length north to south of the archipelago is about 1,851 kilometers, and the greatest breath east to west of the archipelago is about 1,107 kilometers. It is bounded on the west by the South China Sea, Pacific Ocean on the east, Sulu and Celebes Seas in the south, and the Bashi Channel in the north (Please refer to Figure 1). Its northernmost islands are approximately 240 kilometers south of Taiwan, and the southernmost islands are about 24 kilometers from Borneo.

The total land area of the country is approximately 300,000 square kilometers, 92.30 percent of which is contained within the 11 largest islands. The Philippines is divided into three major island groups: Luzon, with an area of about 141,395 square kilometers; Visayas, with an area of about 56,606 square kilometers; and Mindanao with an area of about 101,999 square kilometers. These three groups are further divided into regions, regions into provinces, provinces into cities and municipalities, and cities and municipalities into barangays. Its capital is Manila.

The Philippines has a varied topography with lofty highlands and numerous valleys. It has four major lowland plains: the Central Plain and Cagayan Valley in Luzon, and the Agusan Valley and the Cotabato Valley in Mindanao. These lowlands contrast sharply with the adjacent high mountain ranges. The diversity of topography is further contributed by the existence of plateus, such as the Bukidnon and Lanao Plateus in Mindanao.

The Philippines has the longest discontinuous coastline in the world. Its extensive sea coasts are indented with good harbors, navigable rivers and lakes. There are about 61 natural harbors and about 132 rives found in 73 provinces aside from small streams that expand up to three times their size during the rainy season.

1.2 Climate

The climatic conditions of the country are varied due to the existence of mountains and plateaus in various parts. The differences in climatic conditions depend mainly on the local air currents, which are the result of the general air stream, the position of the islands, and the most usual storm tracks.

The basis for climate classification of the country are the type of rainfall, the presence or absence of a dry season and the maximum rain period. Climate is classified into four types:

First Type: There are two pronounced seasons: dry from November to April, and wet to the rest of the year.

Second Type: There is no dry season, and the maximum rain period is from November to January.

Third Type: The seasons are not very pronounced: relatively dry from November to April and wet the rest of the year. The maximum rain periods are not very pronounced, but the short dry season lasts from one to three months.

Fourth Type: Rainfall is more or less evenly distributed throughout the year.

1.3 Demographics

From a total population of 48.30 million persons in 1980, the total population has increased to 60.67 million in 1990 and is projected to grow to 66.415 million in 1995.

Bulk of the population was concentrated in Southern Tagalog and Metropolitan Manila Area with 12.72 percent and 12.32 percent of the total population. In terms of annual growth rates, six regions exceeded the national rate of 2.71 percent as follows: Western Mindanao (4.31), Southern Mindanao (4.28), Northern Mindanao (3.58), Metropolitan Manila Area (3.58), Southern Tagalog (3.25), and Cagayan Valley (2.76). High growth rates in most of these areas are mainly due to high in-migration rates. In contrast, one of the most depressed regions in the country, Eastern Visayas, registered the least growth rate of 1.49 percent.

The population of the country's 60 cities in 1980 constituted 21.17 percent of the country's population or about 10.18 million for a 1.45 million increase (16.68 percent) increase over the 1975 figure. According to the 1980 Philippine population census, the country had a national density of 160.3 oersons per square kilometer for an increase by 20.1 persons per square kilometer or 14.34 percent over the 1975 level. The Metropolitan Manila Area posted the highest density of about 9,317 persons per square kilometer, followed by Central Luzon with 263.4 persons per square kilometer.

1.4 Economy and Society

Agriculture, including fishery and forestry, remains one of the largest single contributors to the national economy. During the last two decades, agriculture has contributed a yearly average of P 24 Billion in Gross Value Added to the national economy. The agricultural sector contributed a yearly average share of about $ 1.65 Billion to export revenue from 1970 to 1990 for an annual average growth rate of 3.5 percent. Fishing, also provides a substantial contribution to the country's economy with the value of production increasing markedly from about P 14 Billion in 1982 to over P 46 Billion in 1989.

2.0 PUBLIC WORKS SYSTEM IN THE PHILIPPINES

2.1 Master Plan of National Land Development

In addressing the country's development concerns, the DPWH through its medium term infrastructure development program for 1993-1998, seeks to provide the physical foundation needed to support the national development goals of: (a) poverty alleviation, (b) reduction of inequality, (c) generation of productive employment opportunities, (d) comprehensive human development and (e) attainment of sustainable growth, in accordance with the Medium-Term Philippine Development Plan. These objectives shall be achieved through the pursuit of world competitiveness and people empowerment which shall serve as the springboard for the attainment of a more resolute economic recovery and sustained growth that will, in turn, ensure the protection of human welfare in the process of development. Concretely, the people empowerment strategy is envisaged to ensure the equal participation of women and men in relevant infrastructure development activities from project formulation to project monitoring.

2.2 Overall Investment Levels

The 1993-1998 infrastructure program entails a total investment of P167,246.6 Million, or about P27,874.4 Million a year, as shown in the summary of investments by project category in Table 1.

2.3 Organizations Concerned With Public Works

The infrastructure program of Government consist of the provision of physical facilities needed to prop-up the productive sector of the economy. It embraces the following: transportation, covering highways, railways, airports, ports, and urban transport; water resources, consisting of water supply, sewerage, sanitation and flood control and drainage; social infrastructure, covering school buildings, health facilities, national buildings, and urban community infrastructure; energy, involving energy resource development, power and rural electrification; and communications, consisting of telecommunications and postal communications.

The Government agencies concerned with public works and infrastructure, among others, are the following:

1. Department of Public Works and Highways
2. Metropolitan Waterworks and Sewerage System
3. Local Water Utilities Administration
4. National Water Resources Board
5. National Irrigation Administration
6. Department of Transportation and Communications
7. Philippine Ports Authority
8. Philippine National Railways
9. Department of Energy (newly created)
10. Department of Interior and Local Government
11. Department of Education and Culture
12. National Housing Authority

2.4 History, Progress, and Problems of Major Infrastructure

During the period 1987 to 1991, the infrastructure sector of the Philippines focused on strengthening basic and support facilities for improved quality of life and sustained economic growth. Priority was given to small scale, rural-based projects, and rehabilitation and maintenance of existing facilities. The Government instituted several policy measures to improve funds utilization and project administration and implementation. These included the involvement of local government units (LGUs) and non-governmental organizations (NGOs) in program/project implementation and monitoring, respectively. Active private sector participation in infrastructure development, specifically through Build-Operate-Transfer (BOT) and related schemes, was also encouraged.

In general, development efforts in the infrastructure sector have been hampered by some major problems which at present remain unresolved, as follows:

- Insufficient coordination among agencies/units in the implementation of infrastructure plans, policies, programs, and projects. This resulted among others in the perceived below-satisfactory performance in the implementation, and operation and maintenance (O & M) of projects and existing facilities;
- Budgetary constraints in the provision of funding for capital investments and O & M expenditures;
- Inadequate project preparation and lack of clear procedures on the resolution of environmental and community-related issues which affect project implementation; and
- Extensive damages upon infrastructure facilities caused by natural calamities.

2.5 Major Projects in Progress or in Planning

2.51 On-going (In progress)

- Metro Manila Circumferential Road 3 (C-3) Project, 16.8 km (P322.5 M), 1987 - 1994, 84.9% completed)
- West Leyte and Northwest Leyte Road Improvement Project, 198.0 km (P876.2 M, 1990 - 1993, 24.0% completed)

2.52 Proposed (In Planning)

- Marikina - Infanta Road, 132.9 km (P682.8 M, 1994 - 1998)
- Surigao - Davao Coastal Road, 545.0 km (P3,742.5 M, 1994 - 1998)

3.0 DPWH OFFICE IN CHARGE OF RESEARCH AND DEVELOPMENT OF PUBLIC WORKS

3.1 The DPWH office in charge of research and development of public works is the Bureau of Research and Standards (BRS).

3.2 The BRS was created in 1987 when the DPWH (then the Ministry of Public Works and Highways) was reorganized under Executive Order No. 124. Its mandate is to develop and set effective standards and reasonable guidelines to ensure the safety of all infrastructure facilities in the country and to assure effeciency and proper quality in the construction of government public works. In pursuit of this task, the BRS shall engage in research and development on all major areas pertinent to infrastructure development.

3.3 The organization chart of BRS is shown in Figure 2.

3.4 BRS has a total personnel of 167, headed by a Bureau Director. It has six (6) technical divisions, consisting mostly of civil engineers. Other positions include chemical engineer, chemist, statistician, geologist and laboratory technician. The breakdown of the personnel complement of BRS by division/office is presented in Table 2.

3.5 The BRS has a total budget of P23,362,300.00 for CY 1993. The breakdown is shown in Table 3.

3.6 In the management of research and development activities of the DPWH, the BRS initially conducts a research needs survey covering all DPWH field units and technical support units. The long list of research proposals are then prioritized considering the following criteria:

1. Urgency/Necessity of the project
2. Probability of success (risk factor) in attaining the desired outputs
3. Benefits derived from the project
4. Innovation

The ensuing prioritized list of research projects is then submitted to the DPWH Secretary for approval. Upon approval, funds sources for the projects are negotiated and secured from Government and external sources. Pilot projects are subsequently carried out and monitored to evaluate their actual performance. Results are disseminated to various DPWH offices in the form of guidelines, Department Orders, and other communications.

3.7 The research facilities of the BRS are located at its new building along EDSA, Diliman, Quezon City. It is equipped with the necessary testing equipment for almost all kinds of construction materials - soil, cement, asphalt, steel, concrete, etc. It recently acquired sophisticated equipment through a grant from Japan International Cooperation Agency (JICA) and Transport Research Laboratory (TRL) of the United kingdom, as well as office equipment such as computers, binding machine, and duplicating machine.

3.8 Recent Achievements

Consistent with the Bureau's mandate to engage in research and dveelopment on all major areas pertinent to infrastructure, the BRS had accomplished the following achievements:

a. Its research on the use of Fly Ash in Concrete Pavement Construction resulted to the issuance of a Department Order authorizing the use of fly ash as mineral admixture and as 20 percent replacement of Portland cement in concrete pavement construction. This was based on an extensive literature review, laboratory studies and long-term performance testing. This maximized the use of fly ash which is locally available and resulted to savings in Portland cement construction work.

b. Use of locally manufactured Portland Pozzolan Cement Type IP in concrete construction - This alleviated the problems on shortage and high cost of Portland cement during the peak period of construction. A Department Order was issued authorizing the use of said cement in DPWH projects.

c. Establishment of cold-mix design for emulsified asphalt-aggregate paving mixture for potholes patching - A Department Order was issued authorizing the use of bituminous cold-mix for potholes patching during the rainy/wet period wherein, during such period, the use of hot asphalt mix is generally not effective.

d. Use of ordinary soil types stabilized with cement/lime as substitute for aggregate subbase and base course materials - This alleviated the problem of scarcity/non-availability of conventional subbase and base course materials in some areas of the country and maximized the use of abundant local soil. A Department Order was issued auhtorizing the use of said materials.

e. Utilization of weathered limestone (Anapog) as road base material - This maximized the use of locally available and good quality weathered limestone and avoided delays in road construction arising from scarcity/non-availability of conventional base course materials in some areas of the country. A Department order was issued authorizing the use of blended anapog and granular materials in DPWH road projects.

f. Use of volcanic ash/sand in concrete hollow blocks (CHB) making - This identified application of volcanic ash/sand as useful construction materials considering that said material is presently very abundant in the country due to the Mt. Pinatubo eruption.

g. Establishment of effective asphalt content for bituminous mixes - This determined an economical proportion of aggregates and asphalt as well as blending and gradation of aggregates (within the limits of specification) to obtain a stable, workable, and durable mix.

i. Study to Mitigate the Hazards of Lahar and Mud Flows - The study was completed in April 1992 and the Technical Working Group (TWG), headed by the DPWH, represented by the BRS, came-up with immediate/short-term measures to reduce the hazards of such flows and to minize the damages caused by the same to the affected areas. The study incurred only a total cost of less than P1 M wherein the outputs are comparable to those of the foreign Consultants, which cost the government, on the average, P3 M.

h. Establishment of tie-ups with foreign organizations such as the JICA and TRL. JICA road pavement experts were dispatched to the Philippines to provide technical assistance on road researches/studies. A colloborative research with TRL on the most cost-effective method to rehabilitate deteriorated concrete pavement is currently on-going.

4.0 MAJOR RESEARCH AND DEVELOPMENT PROJECTS

4.1 Name/Title of Major Research and Development Projects

- 4.11 Pavement Maintenance/Flexible Pavement Mixture Design Using Recycled Asphalt Concrete
- 4.12 Determination of the Most Suitable Procedures and Materials for the Rehabilitation of Worn Concrete Pavements
- 4.13 Use of Lightweight Aggregates in Concrete Structures
- 4.14 Study to Mitigate the Hazards of Lahar and Mud Flows
- 4.15 Study on the Use of Volcanic Ash/Sand as Multi-purpose Blocks as Subbase and Base Course Materials in Pavement Construction and as Fine aggregates in Concrete Mixes
- 4.16 Use of Roller Compacted Concrete in Pavement Construction
- 4.17 Use of Sulfur as Asphalt Additive and Extender
- 4.18 Use of Beach Sand in Concrete Mix
- 4.19 Use of Rubber in Asphalt Pavement Construction as Partial Replacement of Asphalt
- 4.20 Use of Sand-Bitumen for Road Bases

4.2 Major Research and Development Project in Progress

4.21 Determination of the Most Suitable Procedures and Materials for the Rehabilitation of Worn Concrete Pavements

4.211 Background and Administrative - The BRS in 1992, has worked out for a colaborative reserch project on road pavements with the overseas unit (OU) of the Transport Research Laboratory (TRL), United Kingdom. The BRS and TRL had entered into a Memorandum of Agreement (MOA) and jointly commit their full cooperation for the successful implementation of the collaborative research project. The project is being undertaken by the research engineers of BRS and two experts from TRL, namely Mr. John David Parry and Mr. Tom Jones, in coordination with concerned DPWH field offices for the implementation of the pilot projects. The research is funded by the BRS and assistance from TRL in the form of grant-in-aid program which includes the provision of necessary equipment, that are not available in BRS.

4.212 Time Period - Completion date of Phase I is scheduled on 30 April 1994 (includes one year monitoring/evaluation of the pilot project in Teresa, Antipolo, Rizal. The project was completed in April 1993 and monitoring/evaluation of the project's actual performance is on-going.

4.213 Methodology - The collaborative research involves the identification and assessment of the causes of failures on road pavements and development of implementable measures/action plans to minimize/prevent such failures. Also, pilot projects will be constructed using different methods of rehabilitating worn concrete pavements, to be monitored for a minimum period of one year.

4.214 Possible Results - The research is an investment in the future since it aimed to determine the most effective way of dealing with the increasingly important problem of rehabilitating worn concrete pavements. The cost-benefits of each rehabilitation method will also be considered in drawing up conclusive results of the study.

4.215 Problems of Implementation - Delay in the delivery of construction materials. Also, works on the selected pilot section in Pampanga has been temporarily stopped since the District Office is concentrating efforts to relieve the effects of inundation of Mt. Pinatubo volcanic ash.

4.3 Problems in Promoting Research and Development

1. Government Policy Support and Commitment

   Research and Development programs as well as development programs, in general, should be carried-out within the context of national development objectives and policies. Government commitment, political will, and policies that support the attainment of programs and project objectives are critical to these activities.

2. Finance

   Sustainability in this area requires sufficient cash flow to cover implementation, operations, maintenance, and depreciation of investments. With the reality of scarce resources, competing demands from increasingly politicized groups, resource allocation has often been influenced by political expediency vis-a-vis economic rationality. Often, a major impediment to research and development programs has been the lack/insufficiency of funds for operations, maintenance, facilities, and depreciation.

3. Technological Factors

   State of the art technology are not properly acquired, tested, and piloted due to lack of training/retraining opportunities, research and development facilities, both Government and private, non-availability of specialized education/training in the country and even in the academe, testing equipment, and lack of financial support. Also, bulk of these technologies are available only from developed countries and are very expensive for the country to acquire.

4. External Factors

   Research and development programs and projects operate within the context of existing political, economic, and socio-cultural circumstances which are oftentimes beyond their influence and control. Political and economic instability often disrupt research and development program sustainability. Frequent political turn-over in political leadership, implementing agency leadership and organization; together with the negative impacts of inflation and escalation on budgets, foreign exchange instability, difficulties in the availability of capital equipment and spare parts, and fluctuations in foreign and domestic prices often result.

5.0 INTERNATIONAL RESEARCH ASSISTANCE/EXCHANGE PROGRAMME

5.1 Presently, the DPWH through the BRS is the recipient of research and development assistance from the government of Japan through its Japan International Cooperation Agency (JICA) and the British Government through its Overseas Unit of the Research Laboratory (TRL).

5.11 JICA's Mini-Project Type Technical Cooperation for Road Pavement

The objective of this technical cooperation is to enhance the technological capabilities of the BRS in the design, construction and maintenance of road pavements as well as on research and development. Two pavements experts were dispatched by the Government of Japan to the BRS. The scope of technical cooperation includes transfer of technologies on asphalt and concrete pavements, provision of seminars on design, testing and construction and counterpart training in Japan of the BRS staff involved in the project. In order to support the research activities of the Bureau, several equipment/apparatus on soil, asphalt and concrete were also donated by JICA.

5.12 Collaborative Research Between TRL and BRS, DPWH

The Bureau and TRL had entered into a Memorandum of Agreement (MOA) and jointly commit their cooperation for the successful implementation of the collaborative road research project. As stipulated in the MOA, the collborative research involves the identification and assessment of the causes of failures on road pavements and development of implementable measures/action plans to minimize/prevent such failures. Also, pilot projects will be constructed using different methods of rehabilitating worn concrete pavements, to be monitored to evaluate their effectiveness. A comparative cost analysis will also be made to evaluate its economic viability. A number of research equipment including a computer were also donated to BRS.

5.13 Exchange Programme of Technical Publications

In line with the BRS' research and standards-setting activities and promotion and dissemination of technical publications thrusts, it continuously engages in the exchange programme of technical publications with foreign organizations. These include the American Association of State Highway and Transportation Officials, (AASHTO), American Society for Testing Materials (ASTM), American Concrete Institute (ACI) and other organizations involved in research and public works.

5.2 Problems in Promotion

5.21 Need to Capitalize on the Current State of Communications and Information Systems/Networks

There is a need to avail, capitalize on, and integrate the continuing improvements in world communication networks and information systems in the promotion of research and development and scientific research as these become more sophisticated and advanced. A key feature of making cooperation possible is usually the much more developed state of development and communications.

5.22 Need to Properly Identify Areas of Assistance

There is a need to address the question of how to optimally identify the need for aid. This requires an enlightened economic planning and administration for a developing country which should appropriately address questions which are political and value judgemental in nature. The nature of development in general should concern calculating how much aid should the country employ as well as its timing. Thus, it is necessary for these government agencies to properly assess and state its objectives taking into account futuristic value judgement and sustainable levels of development.

5.23 Need for Effective Assistance

Donor countries at times make it a practice to attach conditions to aid, assistance, and exchange programmes. This is characterized by the phenomenon of "tying" whereby donors make available the assistance under certain conditions. Examples of these are: (i) project tying - whereby funds and/or assistance can only be spent or used for specific items of expenditure or areas of endeavor; and (ii) procurement tying - limiting the funds or assistance to goods and services that are supplied by a particular country, usually the donor country.

5.24 Limited Finances

It is also a fact that as developing countries receive more and more assistance in the form of loans, rather than grants, the burden to service these charges on the country's balance of payments also become larger and larger. Developing countries often find the debt problem a very acute and real problem.

5.25 Technology

State of the art technology are not properly acquired, tested, and piloted due to lack of: information on these developments per se, training/retraining, opportunities, research and development facilities, both Government and private, non-availability of specialized education/training in the country and even in the academe, testing equipment and facilities, and lack of financial support. This greatly affects the capacity to absorb, assimilate, and promote the fruits of the research and development and promotion endeavors.

5.3 Necessity for, and Problems Involved in Inter-Asian Research Exchange

Proposals for greater international cooperation and reforms (liberalization) of licensing and system and patent provisions are needed to truly address sustainable and more equitable development. These are envisaged to effect a lower overall research expenditure as well as the ability to recoup heavy research expenditure.

Exchange and flows will not optimally take place without the intervention of special machinery and procedures. Also, the terms and conditions under which such flows or exchange take place need to be administered. A coordinating body for inter-Asian research need to be established to unify objectives, policies, programs, and make them more effective; to coordinate the activities of various research and development and information dissemination organizations of participating countries; to stimulate reforms and new initiatives in this field; and to transfer the results of scientific research undertaken under its authority.

6.0 DISASTER AND DISASTER PREVENTION IN THE PHILIPPINES

6.1 Summary

6.11 Road Disaster

The Philippines has long been emphasizing the development of trunk roads in view of the overall socio-economic development program of the country and that along this approach a quantitative expansion of road network has been realized. Despite the achievements made, some of most important roads suffer many deficiencies due to disasters caused by slope failures, fall, landslide, debris flow, and the like which impair the efficiency of the road transport system.

6.12 Volcanic Eruptions

The eruptions of the Mt. Pinatubo in Central Luzon, Philippines during the period June 12-15 1991 and the subsequent onslaught of typhoons and lahar flows resulted in extensive damage to public infrastructure and private properties. This natural calamity caused almost the total destruction of several low-lying communities, laid waste to large areas of very productive agricultural lands, and considerably affected commerce and industry.

Based on preliminary estimates of the US Geologic Survey (USGS) and the Philippine Institute of Volcanolgy and Seismology (PHIVOLCS), the 15 June 1991 eruption ejected approximately seven billion cubic meters of pyroclastic materials, most of which were deposited on the highland slopes surrounding the volcano. So far, twenty percent of these materials have eroded resulting in the siltation of all eight major river systems surrounding the volcano and inundation of a significant land area. Up to 25 percent of pyroclastic deposits is expected to erode in the first three years, and up to 50 percent within ten years, which could cause extensive damages unless appropriate measures are put in place.

Mayon Volcano erupted unexpectedly with an explosion at 1311 hour on 2 February 1993, and additional emaissions on 3,6, and 12 February. The initial eruption generated a pyroclastic flow that travelled 6 km. SSE down the Bonga Gully and spread out over most of the fan built by 1984 pyroclastic flows killing at least 70 people and prompting the evacuation of over 60,000 others. The total volume of the flow, roughly 1-2x10E6 cu.m. is much less than that of the 1984 pyroclastic flows (30x10E6 cu.m.) As much as half of the volume of the 2 February 1993 flow may have been pre-1993 rock that was scoured from the gully as the flow descended.

The extent of damages reached to about P 0.35 Billion. Heavily affected was the agricultural land area. Ashfalls covered a few kilometers of national, provincial and municipal roads. Several infarstructures and personal properties were also damaged. Lahar is also a threat at the onslaught of rainy season.

6.13 Disaster Prevention Activities of the DPWH

6.131 Road Disaster

The recognition of the importance of road disaster prevention, the Government of the Philippines has planned the formulation of a long term program for road disaster prevention with the kind and benevolent assistance of the Government of Japan through Japan International Cooperation Agency (JICA).

Two disaster prevention feasibility projects were undertaken in 1983 (Stage I) and in 1985 (Stage II). Stage I has identified disaster spots and prioritized disaster sections along four national roads, namely: Maharlika Highway (Luzon and Samar, Leyte Section), Kenon Road, Agoo-Baguio City Road, and Naguillian Road.

On the basis of the prioritized sections, Phase II was conducted for the feasibility studies of the three sections, namely: Dalton Pass, Mahaplag-Sogod, (both along the Maharlika Highway), and Kennon Road.

The Stage II Study, "Philippine Road Disaster Prevention Project", covered feasibility studies of the three sections, namely: Lucena-Calauag Section, Allen-Calbayog Section, and Naguillan Road.

The typical countermeasures adopted in these projects are surface drain, subsurface drain, slope protection, anchoring, anchore wire net, stone masonry, retaining wall and realignment with catch wall.

6.132 Volcanic Eruptions Disaster

6.1321 *Mt. Pinatubo Affected Areas*

After the eruptions, emergency actions particularly on rescue, evacuation and relief operations were implemented through the various government agencies at all levels, with the participation of the non-government organizations including the private sector.

The emergency operations were immediately followed by a comprehensive rehabilitation, reconstruction and development program which include the rehabilitation and restoration of damaged infrastructure, the continuing provision of needed social services, the establishment of resettlement areas for evacuess who lost their properties and the restoration of jobs and creation of new livelihood opportunities.

6.1322 *Mayon Volcano Affected Areas*

Since the damage to infrastructure is only minimal as compared to that of Mt. Pinatubo, the DPWH is keeping the transport systems open and free from lahar. This will provide for uninterrupted movement of people, goods and services which would enhance speedy recovery and rehabilitation. The DPWH cleared the roadways of ashfalls and enhanced the effectiveness of the rescue, evacuation and relief operations during the calamity period.

6.14 Comprehensive Countermeasure Against Floods or Sediment-Related Disasters

The damages brought about by the 1991 eruptions of Mt. Pinatubo can not be overemphsized. Hundreds of lives perished and billion pesos worth of properties were lost. The threat of lahar is far from over and will remain at least for the next five to ten years. Out of the seven billion cubic meters of pyroclastic materials ejected on the slopes, only 20% so far have cascaded down. Every event of rain pesos danger to lives and properties.

As part of its emergency operations and countermeasures, the DPWH has been conducting and is focused on the following priorities:

a. Keeping transport systems open and lahar free, particularly major roads and river crossings to provide for uninterrupted movement of people, goods and services to enhance speedy recovery and rehabilitation.
b. Reconstruction and rehabilitation of schools and other public buildings (with upgraded designs) located outside areas affected by mudflows to restore the educational program and essential administrative services.
c. Support to other rehabilitation activites of other agencies by providing assistance to relief and social services and infrastructure support to resettlement and livelihood programs.
d. Protection of life, communities, agricultural and fishpond areas, and infrastructure from further destruction, and mitigation of the effects of potential damages, especially from lahar and floodwaters.

Based on studies made by PHIVOLCS which categorized the different areas and communities according to the degree of risk to lahar attracks, the corresponding strategies are being pursued:

i. High Risk or Group I Areas

These are areas which are very likely to be buried by lahar even with infrastructure works because of their location directly in the path of lahar, their low lying topography, and the enormous volume of potential lahar flow.

Strategies:

o Basically, let nature take its own course without any engineering intervention works.
o Evacuate the residents in High Risk Area and resettle them in safe new communities.
o Protect what can be reasonably protected such as town centers near the periphery of the High-Risk Areas in consultation with the people affected. This can be achieved thru strong engineering structures such as concrete-lined dikes and drainage systems. Also, as needed the channels should be maintained to allow the continuous flow of water.

ii. Medium-Risk or Group II Areas

These are areas which are likely be affected by lahar and can be protected by normal engineering works.

Strategies:

o Stop the sediments at its source.
o Convey the materials directly to the sea.
o Control the sediment as it moves from the mountain to the alluvial fans.

iii. Low-Risk or Group III Areas

These are areas at very little chance of being affected by lahar flow and may need only minimal engineering works. The strategies to be undertaken are the same measures for Group II but to a lesser extent as needed.

Also, the Technical Scientific Committee on Mt. Pinatubo Rehabilitation (composed of various government agencies), thru its Technical Working Group (TWG), headed by the Department of Public Works and Highways, with the Bureau of Research and Standards as the overall coordinator, conducted a study on the mitigation of lahar/mud flows and rehabilitation strategies. The committee came -up with short-term measures to reduce the hazards of lahar and mud flows to the affected areas.

The construction of engineering flood protection work is probably the most familiar response to flood hazard, and it is the one that has been most highly developed and heavily founded in technological societies. Some existing approaches on flood control, include the following:

a. In some parts of valley floods, levees on floodwalls may be built along river banks or around high values areas such as towns to keep floodwater in the channel or out of certain areas.

b. Channel improvements such as deepening, widening, lining or straightening the channel or clearing it of vegetation and debris can increase the conveyance capacity.
c. In some valleys when other flood protection methods are impossible or insufficient, a portion of the valley flow is set aside for diversion of flood waters during periods of exceptionally high water.
d. Provision of flood control reserviors.

6.2 *Present Situation and Problems in the Philippines*

6.21 *Road Disaster*

The Philippines has long been emphasizing the development of trunk roads in view of the overall socio-economic development program of the country and that along this approach a quantitative expansion of road network has been realized. Despite the achievements made, some of most important roads suffer many deficiencies due to disasters caused by slope failures, fall, landslide, debris flow, and the like which impair the efficiency of the road transport system.

Road disasters were clssified into five types:

a. Cut Slope Failure
This type is sub-classified into surface and deep failures. Surface failures are generally caused by erosion, weathering and structural weakness while deep failures are caused by scouring, rotational and translational failures.
b. Embankment Slope Failure
This type is sub-classified into surface failure due to erosion and deep failure due to scouring and saturation.
c. Fall
This type is sub-classified into rock and debris falls. The former is free fall of rocks detached from bedrocks, while the latter concerns unsupported pebbles, cobbles, and boulders on a slope.
d. Landslide
This is caused by the loss of balance between shear strength of materials and movement force along a specific slide plane. this is sub-classified into rock and soil landslides.
e. Debris Flow
This is induced by a force of flow caused by floods when there exists deposits on torrent or riverbed. This is sub-classified into debris and mud flows.

6.22 Eruption of Mt. Pinatubo and Its Lahar Threat

The eruptions of Mt. Pinatubo in Central Luzon, Philippines, during the period June 12-15, 1992 and the subsequent onslaught of typhoons and lahar flows resulted in extensive damage to public infrastructure and private properties. This natural calamity caused almost the total destruction of several low-lying communities, laid waste to large areas of very productive agricultural lands, and considerably affected commerce and industry.

Based on preliminary estimates of the US Geologic Survey (USGS) and the Philippines Institute of Volcanology and Seismology (PHIVOLCS), the 15 June 1991 eruption ejected approximately seven billion cubic meters of pyroclastic materials, most of which were deposited on the highland slopes surrounding the volcano (See Figure 3). These materials resulted to the siltation of all eight major river systems surrounding the volcano and inundation of a significant land area. Up to 25 percent of pyroclastic deposits is expected to erode in the first three years, and up to 50 percent within ten years, which could cause extensive damages unless appropriate measures are put in place.

The extent of damage to infrastructure is estimated, in terms of rehabilitation and reconstruction requirements, at P 8,215 Million. Flood control, including lahar, accounts for a about 42. 8 percent of the total damage at P 3,514 Million. Existing roads and bridges suffered heavy damage at P 1,525 Million and new alternate roads needed call for an additional P 2, 194 Million for a total P 3,719 Million or 45.3 percent of the total. Damage to schoolbuildings was also extensive at P 748 Million (9.1 percent), while damage to other public buildings amounted to P 234 Million (2.8 percent).

About 489 kilometers of major national and 163 kilometers of municipal roads were covered with volcanic fall ranging from 5 to 30 centimeters in thickness. Six major bridges collapsed immediately after the eruptions. Subsequent lahar flows destroyed bridges as well as approaches of several other bridges were damaged.

Damage to river control facilities included silted rivers, breached dikes, eroded waterways, clogged drains, and destroyed spur dikes within the immediate influence area of the eigth major river systems affected by the eruptions.

Some 4,665 classrooms were totally and partially destroyed mainly due to ashfalls. The eruptions caused the displacement of an estimated 236,686 pupils and 7,009 teachers. Ashfalls likewise caused total damage to 98 hospitals and health centers, 18 public markets, 13 municipal buildings and 70 other Government buildings.

About 645 persons were reported dead, 195 injured and 23 missing. The majority of these casualties were victims of collapsing residential houses due to ashfalls, drowning in the ensuing floods, and diseases in the evacuation centers. A total of 40,809 houses were totally destroyed while 67,395 houses were partially damaged.

Agricultural land area affected reached some 86,000 hectares while damage to crops, livestock, and fisheries is estimated at P 604.9 Million. About 18,000 hectares of forest land had been buried in ashfalls of approximately 25 centimeters. Nearly 19,799 hectares of newly forested areas were destroyed and some P 125 Million worth of tree seedlings were lost. Damaged natural forest covers and reforested areas extend to 43,801 hectares.

An estimated 651,000 employed persons have lost their sources of income either permanently or temporarily which is roughly 28 percent of the total employment level in Region III registered in April 1991. Heavily hit was the manufacturing sector and consequently the exporting sub-sector, affecting a total of 599 firms with total assests of P 850.6 Million.

6.3 *Disaster Prevention Activities of the DPWH*

6.31 Road Disaster Prevention Program

In recognition of the importance of road disaster prevention, the Government of the Philippines has planned the formulation of a long term program for troad disaster prevention with the kind and benevolent assistance of the Government of Japan through the Japan International Cooperation Agency (JICA).

Two disaster prevention feasibility projects were undertaken in 1983 (Stage I) and 1985 (Stage II) The Stage I Study,"Feasibility Study of the Philippine Road Disaster Prevention Project", consisted of Phases I and II. Phase I has identified disaster spots and prioritized disaster sections along four national roads, namely:

a. Maharlika Highway (Luzon and Samar, Leyte Section)
b. Kenon Road
c. Agoo-Baguio City Road, and
d. Maguillian Road

On the basis of the prioritized sections, Phase II was conducted for the feasibility studies of three sections, namely:

a. Dalton Pass
b. Mahaplag-Sogod (both along the Maharlika Highway), and
c. Kennon Road

The Stage II Study, "Philippine Road Disaster Prevention Project", covered feasibility studies of the following sections:

a. Lucena-Calauag Section
b. Allen-Calbayog Section, and
c. Maguillian Road

The typical countermeasures adopted in these projects are as follows:

a. Surface Drain - The main cause of cut slope and embankment slope failures is surface water. Various kinds of ditches were applied in many sections. Top slope ditches were placed where running water from adjacent hinterland area was expected and berm ditches were adopted everytime berms were proposed. Side ditches were applied as a prerequisite in all disaster spots because of the non-existence of drainage facilities.
b. Subsurface Drains - Horizontal drain hole and closed conduit were applied to check debris flow where the level of groundwater seems to be high and seepage water was observed.
c. Slope Protection - Except on slopes composed of hard rock not susceptible to erosion and scouring, protection works were generally applied for all kinds of slope. Slope protection with vegetation was applied for slopes with soil and weathered rocks where vegetation can grow. For other slopes, concrete spraying was applied.
d. Anchoring - Unstable rocks susceptible to fall on slopes were proposed to be fixed to the bedrocks by anchoring with rockbolts. This measure was applied on slopes where big size with a few number of rocks exist.
e. Anchor Wire Net - For slopes where small size with many unstable materials exist, anchor wire net was applied. Since this type cannot provide complete protection for the prevention of erosion and scouring of slope surface, this was adopted mainly on slopes composed of hard rocks.

f. Stone Masonry Retaining Wall - For steep embankment slopes where the slope gradient cannot be improved, stone masonry retaining wall with the re-filling was applied. It should be noted that side ditches were invariably provided at these spots.

g. Realignment With Catch Wall - Re-alignment was applied at spots where there is enough flat space to allow shifting of the existing road. This is almost always more economical than the slope protections applied directly on slope. The maximum shift adopted was about six meters. Catch walls were always used to prevent spreading of damage due to falling rocks.

6.32 DPWH Rehabilitation Plan

6.321 *Mt. Pinatubo Affected Areas*

After the eruptions, emergency actions particularly on rescue, evacuation and relief operations were implemented through the various government agencies at all levels, with the participation of the non-government organizations including the private sector.

The emergency operations were immediately followed by a comprehensive rehabilitation, reconstruction and development program which include the rehabilitation and restoration of damaged infrastructure, the continuing provision of needed social servcies, the establishment of resettlement areas for evacuees who lost their properties, and the restoration of jobs and creation of new livelihood opportunities.

In order that these activities be monitored and implemented properly, Republic Act No. 7637 was enacted into law creating the Mt. Pinatubo Assistance, Resettlement and Development Commission. This Act is intended to help the victims of the eruption of Mt. Pinatubo and its after effects. It aims to promote additional funds for the immediate relief of the victims; to establish resettlement centers, homesites and townsites for displaced families; to provide livehood and employment opportunities; to repair, reconstruct or replace government infrastructures damaged or destroyed by said disaster whenever economically, socially and advisable; and to construct new infrastructure facilities needed by the community.

6.322 *Mayon Volcano Affected Areas*

Since the damage to infrastructure is only minimal as compared to that of Mt. Pinatubo, the DPWH is keeping the transport systems open and free from lahar. This will provide for uninterrupted movement of people, goods and services which would enhance speedy recovery and rehabilitation. The DPWH cleared the roadways of ashfalls and enhanced the effectiveness of the rescue, evacuation and relief operations during the calamity period.

Drawn from the experience, results and recommendations from Stage I and II Studies on Road Disaster Prevention Program, related problem areas had been identified. Immediate solutions were applied so that further road deterioration which may lead to an eventual disaster can be avoided and/or minimized. The Government of the Philippines is, therefore, more determined to pursue the immediate implementation of road disaster prevention program along its major trunk roads nationwide as well as to continue the conduct of feasibility studies for other identified and yet to be identified disaster potential sections nationwide.

Typhoons, earthquakes, volcanic eruptions and other natural causes result in the destruction of infrastructure facilities, destruction to the environment, death and displacement of people, thereby affecting their socio-economic activities. The cost of disaster prevention and rehabilitation/reconstruction is very difficult to bear by the affected country in a developing country like the Philippines whose meager financial resources are already thinly stretched. Program of this magnitude, in most cases need a global response through international operation and assistance. Grants, scientific and technical know-how, special studies and monitoring, and concessionary loans for disaster prevention, rehabilitation and reconstruction should be made available by developed countries so that the disrupted effects of these phenomena can be minimized and prevented. Activites in this area can also serve as a platform for research on disaster prevention and mitigation on a joint cooperative endeavor so that similar occurences in any part of the world can be dealt with accordingly, at least financial cost and with minimum loss to lives and properties.

6.4 Comprehensive Countermeasures Against Floods or Sediment-Related Disasters

The damages brought about by the 1991 eruptions of Mt. Pinatubo can not be overemphaized. Hundreds of lives perished and billion pesos worth of properties were lost. The threat of lahar is far from over and will remain at least for the next five to ten years. Out of the seven billion cubic meters of pyroclastic materials ejected on the slopes, only 20% do far have cascaded down. Every event of rain pases danger to lives and properties.

As part of its emergency operations and countermeasures, the DPWH has been conducting and is focused on the following priorities:

a. Keeping transport systems open and lahar free, particularly major roads and river crossings to provide for uninterrupted movement of people, goods and services to enhance speedy recovery and rehabilitation.

i. Roads

Road sections which have become prone to inundations and traffic closures during heavy rains have been raised to an average of two meters to preclude traffic interruption. Declogging of roads and drainage facilities have become a continuous operation due to the effect of subsequent rains and floodings.

Also, under consideration as long term measures, are the construction of new alternate roads that are envisaged to provide undisrupted passage of people, goods and services.

ii. Bridges

As to bridge operations, due to the everchanging conditions, particularly relating to lahar action and its destructive effects on river channels, the following are being undertaken:

- o The reconstruction of permanent bridges has, in general, been initiated only where the conditions have stabilized;
- o Activities on bridges have been and will continue to be mostly limited to emergency repairs on damaged approaches and providing detours by fording and temporary structures with DPWH crews continuously monitoring these detour crossings to ensure their continuous passability;
- o Other bridges are being kept open thru continuous desilting on the bridge sites and their environs: and
- o River control works immediately upstream and downstream of bridges are included.

b. Reconstruction and rehabilitation of schools and other public buildings (with upgraded designs) located outside areas affected by mudflows to restore the educational program and essential administrative services.

To date,building rehabilitation program is almost completed, except for a few two-storey buildings and other public buildings scheduled for completion this 1993. Buildings were redesigned tp provide steeper roofs with no gutters, closer spacing of purlins for wall damage resistance and reconstruction will be at lahar-free sites.

c. Support to other rehabilitation activities of other agencies by providing assistance to relief and social services and infrastructure support to resettlement and livelihood programs.

This involves the clearing and site development, construction of access roads and road network within settlement areas, construction of schools, toilet and health facilities, shallow and deep wells and recreational facilities. It also includes the construction of productivity and various community centers.

d. Protection of life, communities, agricultural and fishpond areas, and infrastructure from further destruction,and mitigation of the effects of potential damages, especially from lahar and floodwaters.

Based on studies made by PHIVOLCS which categorized the different areas and communities according to the degree of risk to lahar attacks, the corresponding strategies are being pursued:

i. High Risk or Group I Areas

These are areas which are very likely to be buried by lahar even with infrastructure works because of their location directly in the path of lahar, their low lying topography, and the enormous volume of potential lahar flow. Thus, these areas cannot be saved even by on-going intervention measures.

Strategies:

- o Basically, let nature take its own course without any engineering intervention works.
- o Evacuate the residents in High Risk Area and resettle them in safe new communities.
- o Protect what can be reasonably protected such as town centers near the periphery of the High-Risk Area in consultation with the people affected. This can be achieved thru strong engineering structures such as concrete-lined dikes and drainage systems. Also, as needed the channels should be maintained to allow he continuous flow of water.

ii. Medium-Risk or Group II Areas

These are areas which are likely be affected by lahar and can be protected by normal engineering works.

Strategies:

- o Stop the sediments at its source.

  This is being done by building "sabo" or check dams in the upper reaches of the rivers at or near the pyroclastic deposits. The structures are designed to retain as much of the deposits as feasible and reduce their velocity to minimize their destructive effects downstream.
- o Convey the materials directly to the sea.

  This is being done through channel deepening, widening and dredging.
- o Control the sediment as it moves from the mountain to the alluvial fans.

  Measures being undertaken include restoration, desilting and dredging of channels; raising, rehabilitation and strengthening of dikes; construction of river training works, such as spur dikes, hurdles, traverse sills and consolidation dams; provision of sediment retention basins, sand pockets, and ring dikes.

iii. Low-Risk or Group III Areas

These are areas at very little chance of being affected by lahar flow and may need only minimal engineering works. The strategies to be undertaken are the same measures for Group II but to a lesser extent as needed.

Also, the Technical Scientific Committee on Mt. Pinatubo Rehabilitation (composed of various government agencies), thru its Technical Working Group (TWG), headed by the Department of Public Works and Highways, with the Bureau of Research and Standards, as the overall coordinator, conducted a study on the mitigation of lahar/mud flows and rehabilitation strategies. The Committee came-up with short-term measures to reduce the hazards of lahar/mud flows to the affected areas.

Presented in Annex 1 is the executive summary of the said study.

River meandering and inundation due to overbank flows are two of the major river control and flood problems affecting almost every river. These are attributed largely to partially implemented schemes, inandequate river training works, insufficient protection to existing dikes and structures, poorly designed structures, low bridges spanning major waterways, inadequate and silted waterways due to excessive sediment transport brought about by denuded watersheds, sluggish network of tidal streams at the mouth of major rivers and encroachment on the flood plains.

The construction of engineering flood protection work is probably the most familiar response to flood hazard, and it is the one that has been most highly developed and heavily founded in technological societies. Some existing approaches on flood control include the following:

1. In some parts of valley floods, levees or floodwalls may be built along river banks or around high values areas such as towns to keep floodwater in the channel or out of certain areas.

2. Channel improvements such as deepening, widening, lining or straightening the channel or clearing it of vegetation and debris can increase the conveyance capacity, so that high discharges can pass without the level of the water surface being raised to dangerous heights.

3. In some valley when other flood protection methods are impossible or insufficient, a portion of the valley flow is set aside for diversion of flood waters during periods of exceptionally high water. The channel diversions may lead the runoff back to the channel below a town or may lead it directly to the sea or a lake.

4. Flood-control reservoirs are the most popular of all flood protection measures. There are two major types of flood control reservoirs: flood detention reservoirs and multi-purpose storage reservoirs. The former are usually kept empty. When a flood occurs, a portion of the water is impounded behind the dam, and the remainder flows downstream through a pipe or over a spillway in the dam. Multi-purpose storage reservoirs are often constructed to improve walls for municipal supply, irrigation, recreation or power generation. During times of greatest flood potential, the level of the reservoir can be lowered to provide storage volume for flood runoff.

7. *Activities concerning "Harmony between the Environment and Improvement of Infrastructure"*

7.1 *SUMMARY*

Concern over pollution, public health and natural environment helped to raise awareness on the importance of environmental protection and management. Environmental problems today have been recognized as problems for the poor and rich countries alike. For many Third World Countries, including the Philippines, the need to incorporate environmental considerations to development planning and decision-making process gave rise to various planning tools, among which is the Environmental Impact Assessment (EIA).

EIA is a formal process of identifying and predicting the impacts of proposed action of environmental integrity and human welfare and communicating information about such impacts to planners and decision makers.

As a process, EIA normally entails two steps:

- preparation of a document, usually called Environmental Impact Statement (EIS), which provides information on the existing environment where the project will be located and the prediction and assessment of environmental effects on the projects; and
- review and evaluation of the EIS by government offices and the public to consider the accuracy of the EIS and recommend whether/how the proposal should proceed. This review is reported to whoever makes a decision about the proposal in some form of an assessment report.

It is in this regard, that EIA identified the environmentally critical infrastructure projects such as major dams, major power plants, major reclamation projects and major roads and bridges which need environmental concern and might within the environmentally critical areas such as:

The implementation of EIA in the Philippines is coped with problems. Foremost of which is the need to promote EIA not as another bureaucratic requirement but as important planning tool. Planners and decision-makers, in general, still have to accept the value of EIA and the value of prescribed mitigation measures resulting from the review process.

The integration of environmental consideration in the implementation of infrastructure projects involve a fundamental realignment of the overall objectives of development planning in the light of a new awareness of the environmental implications of development activities. Construction, reconstruction and restoration programs in the country had realized the importance of incoporating environmental protection measures. This is also contained in the concepts framework of Philippine Strategy for Sustainable Development (PSSD) whose aim is to achieve economic growth with adequate protection of the country's bilogical resources and its delivery, vital ecosystem functions and overall environmental quality.

The PSSD has for its core a number of implementing strategies. This is aimed at resolving and reconciling the diverse and sometimes conflicting environmental, demographic, economic and natural resource use issues arising from the country's development efforts.

Environmental assessment guidelines for Earthquake Reconstruction Project (ERP) and Infrastructure Restoration Program (IRP) reconstruction/rehabilitation/repair of selected infrastructure projects have been prepared. These guidelines were prepared to ensure that environmental dimensions/factors are given the needed considerations in all the reconstruction/rehabilitation efforts. Moreover, it is aimed to assist the local design engineers/consultants involved in the ERP/IRP in acquiring a more comprehensive and a deeper understanding of the significance and relevance of incorporating environmental protection/safeguard parameters into the reconstruction/rehabilitation of selected infrastructure projects.

Also, appropriate mitigation plan to reduce/offset assessed negative/adverse effects for infrastructure projects have been identified. Recommended mitigation measures include those for erosion/siltation/stagnant water, noise and vibrations, air pollution, water pollution, disturbances/displacement of human settlements, impacts on aesthetics and for socio-economic impacts.

7.2 *PRESENT SITUATION AND PROBLEMS IN THE PHILIPPINES*

Typhoons Sisang (1987), Unsang (1988), Uring (1991), Trining (1991), the July 1990 eartquake, June 1991 Mt. Pinatubo Eruption, and the February 1993 Mayon Volcano Eruption exacted tremendous and heavy toll in terms of damaged infrastructures and losses of human lives in the islands of Luzon and in Eastern Visayas. The infrastructure facilities destroyed or damaged by the aforecited natural disasters include bridges, highways/roads, housing, hospitals and health care facilities, irrigation systems, flood control drainage, water supply, school and government buildings and tertiary ports and wharves. As analyzed and concluded by experts/specialists, the extensive damage to infrastructure facilities was largely due to a) amplification of ground shaking as a result of local and regional differences in geology and topography; b) inadequate/inappropriate designs and construction; and c) a combination of both. Specifically, the identified principal causes of the damage were: channel overflowing and flooding, damming of rivers, surface faulting, ground failure due to liquefaction, landslides and debris flow, and ground shaking.

7.21 Environmental Impacts of Infrastructure Projects

7.211 For Highways/Roads/Bridges

- o Soil erosion/silt run-off from denuded hillsides and mountainsides, cut-and-fill areas, and unstable grasslands and brushlands; also landslides, mud and debris flow, and soil erosion from large-scale cutting and banking of ground.

- o Air pollution from suspended particulates (dusts, smoke) noise and vibrations, exhaust, odors and fumes, aerosols, toxic gases (CO_2, CO, NO) and other emissions.
- o Accidental spills of soils, grease, gas and other hazardous materials.
- o Impairment of aquatic ecology and other beneficial water uses. This includes water pollution (river systems and other bodies of water, and coastal zone), water utilization and changes in the water system.
- o Impairment or disturbance of wildlife, fisheries, natural vegetation, national parks and reserves, game refuge and sanctuaries of valuable faunal and floral assemblages.
- o Landscape views and aesthetics.
- o Socio-economic systems particularly business concern and employment patterns, social services, transportation and communication.
- o Ground subsidence due to excavation and embankment in soft soil (e.g. silt and peat soil).
- o Land use and settlement patterns.
- o Public health due to air pollution and potential accidents for the workers and the public in general.
- o Archeological, cultural and historical areas/monuments.

7.212 For Water Supply/Irrigation Projects.

- o Impact on quantity and quality of surface/ground water.
- o Potential reduction of water flow, disappearance of vegetation previously supported by the ground water, percolation, drying up of springs and marshes and land subsidence.
- o Potential effect of the reservoir/impoundment on the hydrological regime of watersheds, aquifer or stream flow.
- o Impact on aquatic ecology (rivers, streams. creeks, bays, lakes, mangroves, coral reefs and estuaries).
- o Environmental disturbance in the zone of water extraction, irrigated and non-irrigated areas.
- o Ground subsidence from excessive pumping.
- o Sludge water from treatment or water purification plants.
- o Settlement patterns and public health.
- o Socio-economic systems (business, income, livelihood, social services, life style, employment, demography, transportation and communication).
- o Archeological, cultural, and historical areas/monuments.

7.213 For Flood Control

- o Siltation and sedimentation due to earth moving activities (dredging, bank estabilization, soil compaction, etc.).
- o Impairment of the water quality of rivers which will eventually affect riparian flora and fauna.
- o Air pollution during the construction phase (noise and vibration, odors, fumes, and dusts).
- o Land use and settlement patterns.
- o Socio-economic systems (business, income, livelihood, social services, lifestyle, employment, demography, transportation and communication).
- o Landscape views and aesthetics.
- o Archeological, cultural, and historical areas/monuments.

7.214 For Ports and Wharves

- o Potential impairment on aquatic ecosystem (rivers, estuaries, bays, lakes, coastal water and coral reefs), water quality and quantity due to siltation and sedimentation.
- o Air pollution (noise and vibration, dusts, odors, fumes, gases).
- o Discharge of dredged spoils and handling of land filling materials.
- o Land use and settlement patterns.
- o Accidental spills of oils, grease and other hazardous materials/substances.
- o Socio-economic systems (business, income, livelihood, social services, employment, life style, demography, transportation and communication).
- o Landscape views and aesthetics.
- o Archeological, cultural, and historical areas/ monuments.

7.215 For Government and School Buildings.

- o Short-term air, water and land pollution during the construction phase.
- o Potential disruption of resources (e.g. water, land energy, flora and fauna).
- o Potential effects on natural vegetation, archeological, cultural and historical areas/monuments.
- o Accumulation of excavated soil, debris, and demolition spoils.

7.22 *THE PHILIPPINE STRATEGY FOR SUSTAINABLE DEVELOPMENT (PSSD)*

Sustainable development as defined by the World Commission on Environment and Development (WCED) "is meeting the needs and aspirations of the people without compromising the ability of future generations to meet theirs". Sustainable development stresses the need to view environmental protection and economic growth as mutually compatible. This implies that growth objectives should be compatible not only to the needs of society but also to the natural dynamics and carrying capacities of ecosystems. The Philippine response to environment and development issues is basically embodied in the Philippine Strategy for Sustainable Development (PSSD) which was formally approved by the Government in November

1989. The PSSD aims to achieve, maintain and disperse economic growth without depleting the stock of natural resources and degrading environmental quality. It has ten basic principles and policy directives to guide the country's programs, projects, and activities for environmentally sustainable development.

a. Integration of Environmental Considerations in Decision Making. Development planning objectives will be realigned to enable the merger of environmental and economic considerations in decision making. Analytical tools and methodologies such as natural resource accounting to emphasize the productive role of natural resources in the economic system, environmental impact assessment system to evaluate the environmental consequences of major projects and land use planning to determine optimum land use allocation based on environmental quality perspectives will be utilized to ensure that environmental considerations are integrated in decision making.

b. Proper Pricing of Natural resources. Resource management will be improved by properly pricing natural resources based on the cost of replenishing and increasing their supply and providing appropriate substitutes. The question of who pays for the damages to the environment will be defined. The question of who pays for damages to the environment will be defined with emphasis on the "polluters pay principle" and proper valuation of underpriced resources. The ultimate objective is to have a self regulating system where resource users make choices in a way that does not impair the quality of the resource base.

c. Proper Rights Reform. At the heart of the strategy is giving security of tenure to small-holder farmers and occupants over primary resources. This is envisioned to result in self-regulation by the concerned community or individuals in the exploitation of natural resource. However, proper management of such resources must be demonstrated by recipient individuals or communities as a basis for obtaining resource rights.

d. Conservation of Bio-diversity. The preservation of wild species and genetic diversity will be emphasized to provide increased capacities for future questions on survival and development in the face of rapidly changing global environments. Protected areas will be established for the conservation of wildlife and unique ecosystems and the preservation of their scientific, educational, cultural and historical values. Accordingly, existing national parks and reserves will be protected, rehabilitative strategies will be developed for degraded parks, and new areas for conservation will be identified.

e. Rehabilitation of Degraded Ecosystems. Since massive destruction has already occured and nature's regenerative capacity is not enough, projects will be implemented to rehabilitate degraded ecosystems. As pressures caused by increasing demands for both raw materials and products that come from natural resources intensify, so must the country's commitment and capability for rehabilitative action. Accordingly, programmes involving reforestation, denuded watersheds, mangrove planting, clean-up and control of pollution including revival of biologically-dead rivers, and seagrass transportation will be vigorously undertaken. These rehabilitation programmes, will be linked to ecosystems protection programmes, policy reforms and institutional strengthening in order to deal decisively with the socio-economic roots of ecosystem degradation.

f. Strengthening of Residuals Management. The problem of pollution will be addressed within a more comprehensive framework of materials policy which includes resource recovery, recycling, and appropriate product design that saves materials and energy. Rather than focusing on "end of pipe" control systems, the strategy will concentrate on adopting recent innovations in industrial process designs which are aimed at reducing waste streams. Reformulating products, developing saleable by-products from residuals, and redesigning or combining processes are some of the measures that will be implemented to reduce wastes and costs as well. Likewise, enforcement of appropriate pollution controls will be strengthened and supplemented by policy instruments such as economic incentives to encourage industries to install pollution control facilities.

g. Control of Pollution Growth and Development of Human Resources. The country's programme to control rapid population growth will not be limited to controlling numbers but will include health, education and rural development projects. It will be implemented as part of a comprehensive socio-economical programme at the regional and community levels. The programme will be based on methods consistent with the cultural and religious norms of the population.

h. Inducing Growth in the Rural Areas. Since economic recovery and long-term stability depend on increasing incomes and employment in the rural areas where majority of the people reside, special attention will be given to rural development. The economic, social and political potentials of the countryside will be harnessed in order to alleviate poverty and uplift the conditions of the rural poor. This rural development strategy will be characterized by: (a) empowerment of the rural poor through greater participation in policy making and project implementation; (b) accelerated implementation of land reform to achieve equity in the distribution of wealth and boosting producer incentives; (c) removal of economic policy and public investment biases against the rural sector; (d) provision of infrastructure and support services to increase rural productivity and expand markets; (e) establishment and reinforcement of growth centers to serve as bases for industrial and commercial activities; and (f) strengthening of social services such as education, health and nutrition.

i. Promotion of Environmental Education. Environmental education will be promoted to enable citizens to understand and appreciate the complex nature of the environment as well as the role played by a properly managed environment in economic development. The specific aims are: to develop social values that are strongly supportive of environmental protection; to create the commitment and political will to deal with difficult issued; and to develop a rational basis for the study of the environment by equipping people with the basic capability to make the best choices.

j. Strengthening of Citizen's participation. Non-governmental organizations (NGOs) will be mobilized and networks among NGOs and Government organizations will be formed to assist in organizing communities, public information campaigns, research/situation assessment, environmental surveillance and monitoring, and promotion of environmentally sound technologies.

7.3 *ACTIVITIES IN THE ORGANIZATION*

I. PROPOSED PROJECTS (To be started)

The following approaches/guides are observed and recommended for the initial/preliminary assessment of the potential environmental impacts/effects of new subprojects:

1. For Highways/Roads/Bridges
   - 1.1 Ascertain the conformity or relation of the subprojects to the applicable existing laws and government policies (e.g. the National, Regional and Local Development Framework Plans) through close consultations with the appropriate concerned government agencies.
   - 1.2 Preparation of a brief description of the proposed subproject with maps, tentative schedule, drawings and diagrams. Include the location/site of the subprojects.
   - 1.3 Development of an appropriate matrix of significant generic environmental impacts/effects from the proposed subprojects. The matrix should cover the construction and post-construction phases. The object is to adjust the balance between environmental and engineering factors to achieve the optimum design.
   - 1.4 Preparation of a list of (a) potential major environmental impacts associated with the subproject and (b) environmental impacts which may adversely or negatively affect the success of the subprojects (i.e. the national road may be located in high risk areas prone to flooding, erosion, landslides, liquefaction, hence, reducing the life of the project: the bridge may be located in a severely aggraded/eroded or silted/sedimented river systems.
   - 1.5 Checking if the subproject siting is on or near environmentally critical areas (as identified by Presidential Proclamation No. 2146 December 14, 1981) which fall within the scope of environmental impact statement (EIS) system established under Presidential Decree No 1586.
   - 1.6 After identifying/determining the potential major environmental issues related/associated with the subproject, make a rapid assessment of the effects/impacts according to the following criteria/grading system:

     small, moderate, major
     short-term - long term
     irreversible - reversible
     significant - not significant
     negative - positive

   This rapid assessment/evaluation is a judgemental process and can be undertaken by a multi-disciplinary group assembled for the purpose. Or it be done/approached through consultation with appropriate interested parties/experts who will give descriptive and in some cases numerical scores/values on the importance, severity, magnitude, and period/time frame of the subproject. These evaluations will allow the consultants to focus on the more significant impacts, eliminating those with no or negligible impacts.
   - 1.7 Check that the major environmental constraints are identified during the planning stage.
   - 1.8 Establish control/systems for reviewing on an on-going basis the effect of subproject contract variations and/or design changes.
   - 1.9 Set up an appropriate mitigation plan to reduce/ofset assessed negative/adverse effects specific irrelevant to the subprojects.
   - 1.10 Draw up and describe post construction maintenance, contingency and monitoring plans to ensure/guarantee contractor's compliance with specified constraints pertaining to, among others:
     - 1.10.1 Significant environmental hazards that may arise during and after the construction of the project through accidents or design failure such as accidental spills, fire, seismic activity, earthquake, etc. and how these could be contained and the probability of the occurence of such events be determined.
     - 1.10.2 Plans for detection (where applicable) of such accidental or natural events, remedial measures to be taken in response, including procedures and equipment to be employed in the response.
     - 1.10.3 Plans for environmental rehabilitation clean-up and restoration for such accidents.
     - 1.10.4 Plans for removal or disposition of temporary structures and facilities set up during the construction phase of the projects.
   - 1.11 Prepare an environmental or post-construction monitoring plan/program specific to the subproject and designed to achieve three primary objectives, namely: 1) compliance of the subproject to the conditions set forth in the relevant requirements of EIA: 2) provision of environmental data/information to decision makers, planners, agencies and the public as regards changes in impact trends and the corresponding control of said impacts; and 3) environmental briefing to all concerned sectors.

2. For Water Supply and Irrigation Projects

Most if not all of the water supply subprojects are relatively small and the seven irrigation subprojects identified under the ERP are deemed to be minimal environmental impacts with very short-term effect. However, during

the planning or pre-feasibility stage of new projects of this type, serious considerations, among other things already described in the appropriate sections in Appendices A and B, should be focused on the geotechnical and seismic conditions of the site or location of the subprojects.

For the approaches/guides in the assessment of the initial environmental impacts of these subprojects, the steps or items enumerated for highways/roads/bridges are also applicable and therefore may be recommended for the engineering/consultants to consider on a case to case basis.

3. For Flood Control and River Banks Protection

While erosion and siltation (largely induced by forest, denundation, watershed destruction and heavy precipitations) are the two natural processes which primarily impact on the river system, close attention should also be paid to the human settlement factor.

The approaches/guides for the highways/roads/bridges can also be employed, with minimal deviations/revisions as and where appropriate, in the initial environment impact assessment of these types of subprojects. (Please see I., Item No. 1).

4. For Ports and Wharves

Most of the tertiary ports and wharves under the IRP are relatively small whose reconstruction/repairs have already been completed. For new subprojects that may be identified later for inclusion in future financing, the environmental procedures to be followed in the initial assessment/evaluation of these types of subprojects are similar to those recommended for highways/roads/bridges with modifications to conform with the specific and unique requirements of the subprojects. (Please see I, Item No. 1).

5. For Government and School Buildings/Hospitals

Under the ERP and IRP, all validated subprojects of these types/categories are for reconstruction.repairs/restoration only. Except for those that are located in liquefaction-prone areas, the large number of these subprojects facilities are assessed to be of no significant environmental impact. For new ones that may be identified and included for future financing, the recommended, highways/roads/bridges environmental procedures for assessing impacts can be used with appropriate modifications to suit the subprojects.

II. ON-GOING PROJECTS

For on-going projects (mostly highways/roads and flood control, a few major bridges, hospitals, school buildings, irrigation, tertiary ports and wharves) the following approaches/guides are recommended to ensure that for the identified/determined environmental impacts/effects, the appropriate mitigation measures are instituted and strictly and fully implemented:

1. For Highways/Roads/Bridges
   - 1.1 Prepare a list of the potential environmental impact/effects of the project.
   - 1.2 Make a rapid assessment/evaluation of the potential environmental impacts/effects using the criteria or grading system described in I. Item 1.6 under NEW PROJECTS.
   - 1.3 Arrange for a regular monitoring of identified major environmental impacts/effects. Also assess the implications of project activity program changes (e.g. program slippage which leads to an extended construction period).
   - 1.4 Establish for large projects (national and provincial highways, bridges, flood control, irrigation) socio-economic monitoring program and community liaison groups.
   - 1.5 Set up an appropriate mitigation plan to reduce/offset the assessed negative/adverse environmental impacts/effects specific or relevant to the project. Careful and close attention should be focused on areas with incipient landslides and debris/mudflows deposits resulting from the July 16, 1990 earthquake and the 1991 Mt. Pinatubo eruption in the light of the onset of the rainy season. The landslide and debris/mudflow probe areas are along the Maharlika Highway stretch from Digdig junction up to Santa Fe. Most areas lying between the southern end of the N-S trending Luzon Cordillera Mountain Ranges and the Caraballo Mountain are also under continuing threat of landslides, debris/mudflows.
   - 1.6 Ensure that the evaluated construction hazards (air and water pollution, noise and vibrations, soil contamination, soil erosion/silt runoff, etc.) are adequately addressed and that the recommended mitigation/protection measures are put in place. Mitigation/protection measures should be centered on river bank protection and slope stabilization. This requires a very close monitoring/supervision of the engineers and consultants.

2. For Water Supply and Irrigation Projects
   - 2.1 Perform the activities as in II. Items 1.1, 1.2, 1.3, 1.4, 1.5 and 1.6. Since most on-going water supply projects (about 13 DPWH-implemented and about 5 LGU-implemented) and Irrigation facilities (about 5 DPWH-implemented) are located either on landslide/debris flows or liquefications prone areas, the mitigation measures should be concentrated on ground subsidence hazards, water pollution, impairment of aquatic terrestial ecology, water use conflicts, land use, etc.)

3. For Flood Control
   - 3.1 Perform the activities as in II. Items 1.1, 1.2, 1.3, 1.4 , 1.5 and 1.6. Based on the DPWH list, about 76 flood control facilities are in the "on-going" status. They are mostly located in the Central Plains of Luzon (Pangasinan, Nueva Ecija, Bataan and Tarlac) and CAR. Region II (Nueva Vizcaya, Quirirno and Isabela)

Benguet and Abra. Consequently, the hazards to which they are exposed or which are likely to affect them are erosion, landslides, debris/mudflows and liquefication. Mitigation measures that will focus on appropriate structural/engineering design that can withstand natural forces or additional load should be adequately instituted and operationalized. This will also require close monitoring and supervision.

4. For Ports and Wharves
   4.1 Perform the activities as in II, items 1.1 1.2 1.3 1.4, 1.5 and 1.6. Essentially only a handful of ports and wharves are under construction as most of them under ERP and IRP have been completely restored or replaced/reconstructed. The ERP DPWH-implemented on-going portworks are located in La Union and two in Region IV-A under the IRP. The small environmental impacts/effects that need to be mitigated/minimized are those related to air and water pollution, discharge of dredged spoils, handling of landfills, diminutions of natural beeches and effects on fisheries and other marine biota.
5. For Government/School Buildings and Hospitals
   5.1 Perform the activities as in II, items 1.1, 1.2, 1.3, 1.4, 1.5 and 1.6. except for about eight high school buildings nine stage colleges and universities and two hospitals in Nueva Ecija which are undergoing reconstruction/repairs, the school and government buildings and hospitals under the ERP have been completely reconstructed/repaired. The short term air, water and land pollution and the expected accumulation of excavated soil and demolition/construction debris are the environmental impacts/effects which can easily be mitigated/prevented by adopting the recommended protection and offsetting measures.

III. COMPLETED PROJECTS

Of the numerous completely reconstructed/restored infrastructure facilities under the ERP and IRP, roads, bridges, flood control and irrigation will critically need/require close post-construction monitoring to be able to assess/evaluate the actual environmental impacts/effects of the subprojects. This regular activity/exercise will also enable the implementing agency to periodically propose/recommend mitigation and corrective measures where and when needed.

The experience learned from the July 16, 1990 Earthquake and the June 1991 Mt. Pinatubo eruption resulted in the production by PHILVOCS of risk/hazard zonation maps which identify areas vulnerable or prone to earthquake and rain-induced landlsides. Protection debris/mudflows, flooding, and severe erosion. The factors considered in the generation of the condition made are seismicity and locality, slopes (critical from 18 to 35%), soil type (clayey), the geological character of the lithology (recent alluvium) and the proximity to the Philippine Fault System.

Two general approaches are recommended for the use of the engineers/consultants in the proper post-construction monitoring of completed project facilities. They are:

1. Locate the selected major infrastructure projects using the appropriate hazard zonation maps. Validate/confirm the plotted sites/locations of the selected major infrastructure projects through actual field reconnaissance/investigation.
2. Implement/operationalize the environmental post-construction monitoring.

GENERAL CONSIDERATIONS

The reconstruction/rehabilitation/restoration of infrastructures under the ERP and IRP include thousands of projects in Regions I, II, III, IV-A, IV-B, V, VIII, CAR and NCR. The projects consist of eight (8) project categories, namely:

1. National, provincial, municipal and barangay roads and bridges
2. Flood control facilities
3. Water supply and irrigation facilities
4. Ports and wharves and irrigation facilities
5. School/Government buildings and hospitals
6. Housing

Since most of the projects are either completed or on-going and the great majority of them are small and readily identified/assessed to be of "no environmental impact/effect", the environmental impact examination/investigation is being done on a very selective basis. Only major infrastructure facilities and those that are substantially of public importance are included in the evironmental evaluation process.

The major projects thus far for assessment and monitoring (because of their potential and actual continued environmental impacts/effects) are presented in Annex 3.

7.4 *ACTIVITIES FOR INFRASTRUCTURE DEVELOPMENT TAKING ACCOUNT OF THE GLOBAL ENVIRONMENT AND THE LIVING ENVIRONMENT*

Appropriate mitigation plan to reduce/offset assessed negative/adverse effects for infrastructure prpjects have been identified. Recommended mitigation measures include those for erosion/siltation/stagnant water, noise and vibrations, air pollution, water pollution, disturbances/displacement of human settlements, impacts on aesthetics and for socio-economic impacts.

For Erosion/Siltation/Stagnant Water

- Provision for slope and river bank stabilization measures (stone masonry, gabion, revegetation with appropriate plant species, etc.).

- o Carefully planned resurfacing and replanting of exposed areas.
- o Use of ponds and impoundments or catchment areas.
- o Provision of drainage outlets to alleviate problems from stagnant water.

For Noise and Vibrations

- o Installation of buffer zones/noise barriers and greenbelt zones.
- o Proper distancing/location of pumping stations in water supply projects.
- o Use of appropriate mufflers and sound-proofing for construction machines, engines, and equipment. Use of shock-absorbing mountings for machinery.
- o In the case of highway construction, bypass densely populated areas and archeologically, culturally and historically preserved areas. Also sites near or on faultlines, flood-prone areas and fragile local ecosystems.
- o Provision of vegetation/greenbelt areas.
- o Provision of adequate traffic signals, directional signs and traffic personnel.
- o Carefully planned traffic re-routing schemes and management.
- o Careful/rational work scheduling and timing of construction activities.
- o Proper coordination with other utilities agencies.

For Air Pollution (Toxic and hazardous substances, dusts, odors, fumes).

- o Provision of adequate and properly ventillated storage for keeping stocks of construction materials and equipment.
- o Adoption of appropriate and good construction planning and safety measures during construction and operational phases.
- o Development and/or enforcement of strict pollution control regulations for the specific areas.
- o Regular springkling of water on dust-generating piles/mounds resulting from earth moving activities.
- o Expeditious removal of excavated or dredged spoils from the construction sites.

For Water Pollution

- o Careful/rational planning for construction and post-construction phases of the project.
- o Provision of adequate drainage system and structural safeguards/protection against polluted/contaminated effluents.
- o Provision against channel diversion.
- o Well-planned monitoring program.

For Disturbances/Displacement of Human Settlements

- o Resettlement of dispalced residents to acceptable relocation sites.
- o Provison of livelihood projects and/or employment opportunities for the relocated/resettled residents.
- o Provision of appropriate and reasonable compensation packages for relocated residents.
- o Provision of transport and labor for the resettlement/relocation of the residents.

For Impacts on Aesthetics

- o Establishment of greenbelt zones around or along the perimeter of the project.
- o Provision of adequate open spaces and carefully selected recreational (e.g. picnic grounds) and parking areas.

For Socio-Economic Impacts

- o Creation of public awareness and mounting of a public information dissemination drive through:
  - Conduct of in-depth key-informant interview and informal group discussion/dialogues to determine the affected community perceptions on the project.
  - Conduct of an environmental briefing or scoping session for the proposed projects not only for the purpose of providing the affected sector with full information about the projects but also to solicit their suggestions.
  - Coordination with all concerned national/local government agencies as well as the private sector on all matters related to mitigation and/or enhancement of the proposed project impacts on the environmental millieu.

8.0 PROPOSALS FOR FURTHER DISCUSSION

1.Establishment of an ASEAN Public Works Research Institute

This is proposed to have collaborative research undretakings among ASEAN countries on common technologies related to infrastructures that can be adopted by participating countries. It will promote joint research ventures and avoid duplication of research efforts. Eventually, this will lead to the development of neighboring ASEAN countries and the Philippines. This is likewise envisaged to effect a lower overall research expenditures as well as the ability to recoup heavy research expenditures.

A Coordinating body for ASEAN and/or Inter-Asian research need to be established with the proposed institute serving the function. It is envisaged to: (a) unify objectives, policies, programs, and make them more effective; (b) coordinate the activities of various research and development and information dissemination organizations of participating countries; (c) to stimulate reforms and new initiatives in the ASEAN region; and (d) to transfer the results of scientific research undertaken under its authority.

The institute is envisaged to prepare a five-year and long range strategic program of research and development and technical information dissemination activities, particularly a set of technical assistance measures and joint research and development ventures that will encourage economic and environmentally-sound growth of the ASEAN region and Asia in general. It will also establish its appropriate information policy to answer crucial questions, such as:

a. How can the research and development activities in infrastructure and construction be coordinated among various ASEAN countries?
b. How information networks and data banks will be set up for the ASEAN region and the rest of the world linked and information shared?
c. How can the obstacles created by monopolistic patents, industrial or commercial trade secrets, and security restrictions be further reduced?
d. How can new and more advanced technology in the field of construction and engineering be assimilated by ASEAN countries considering their existing conditions and unique environments?
e. How can the necessary personnel be trained and the pursuit of substainable development, harmonious-evironment, and science-based engineering be promoted and pursued in the ASEAN Region?
f. What is the foreseeable return on completely automating this field and linking it to the recent developments in the communicatrion and information processing fields?
g. How can the impact of the Institute's activities be monitored in terms of country impact and industrial applications?

It should also address the issue for the need of standardization of technology, specifications and test parameters, guidelines, information, and reports as well as the provision of translation facilities considering the diversity of ASEAN cultures and languages.

For the long term success of the Institute, it must study and innovate upon the experience, results, and methods of the American and European countries as well as Japan in the field of research and development, design, application, and promotion.

2. Public Works and Construction Information Network Improvement Project

There is an urgent need for the DPWH to avail and integrate its research and information network with the improving world communication network and information systems which are becoming more sophiscated and advanced. A key feature of making bilateral and multilateral cooperation possible is usually the much more developed state of development and communications together with coordinating mechanisms.

The proposed project shall seek to establish two main objectives. First, establish a centralized DPWH network, say at BRS, to coordinate this effort and to establish more optimized linkages to major academic institutions, research facilities, donor institutions, engineering information agencies, etc., considering all potential and interested users, both local and foreign. Increased potentials for continuing and sustained exchange programme will be pursued.

Second, it also seeks to establish a decentralized pilot public works and construction information and promotion network similar to the BRS central network except that its operations will be on a more localized level, collecting and promoting data from regional or provincial sub-centers. This shall further be tasked at promulgating interest in the field of scientific processes and research in relation to sustainable development.

The proposed Study, in general, will establish procedures and methods nationwide that will make public works and construction related technology and information cheaper, more accessible, and easier to use.

Contacts and linkages between other countries' information agencies, research and professional organizations, and international agencies will be established, upgraded, and continuously updated. It will also seek to establish the collection of maximum intelligence from local and external sources and effect the transfer of that intelligence to its users (e.g. abstracts, periodic journals, and seminars).

The project could be a supplementary adjunct to the proposed ASEAN Public Works Research Institute's activities in the Philippines.

Republic of the Philippines
Department of Public Works and Highways
Bureau of Research and Standards

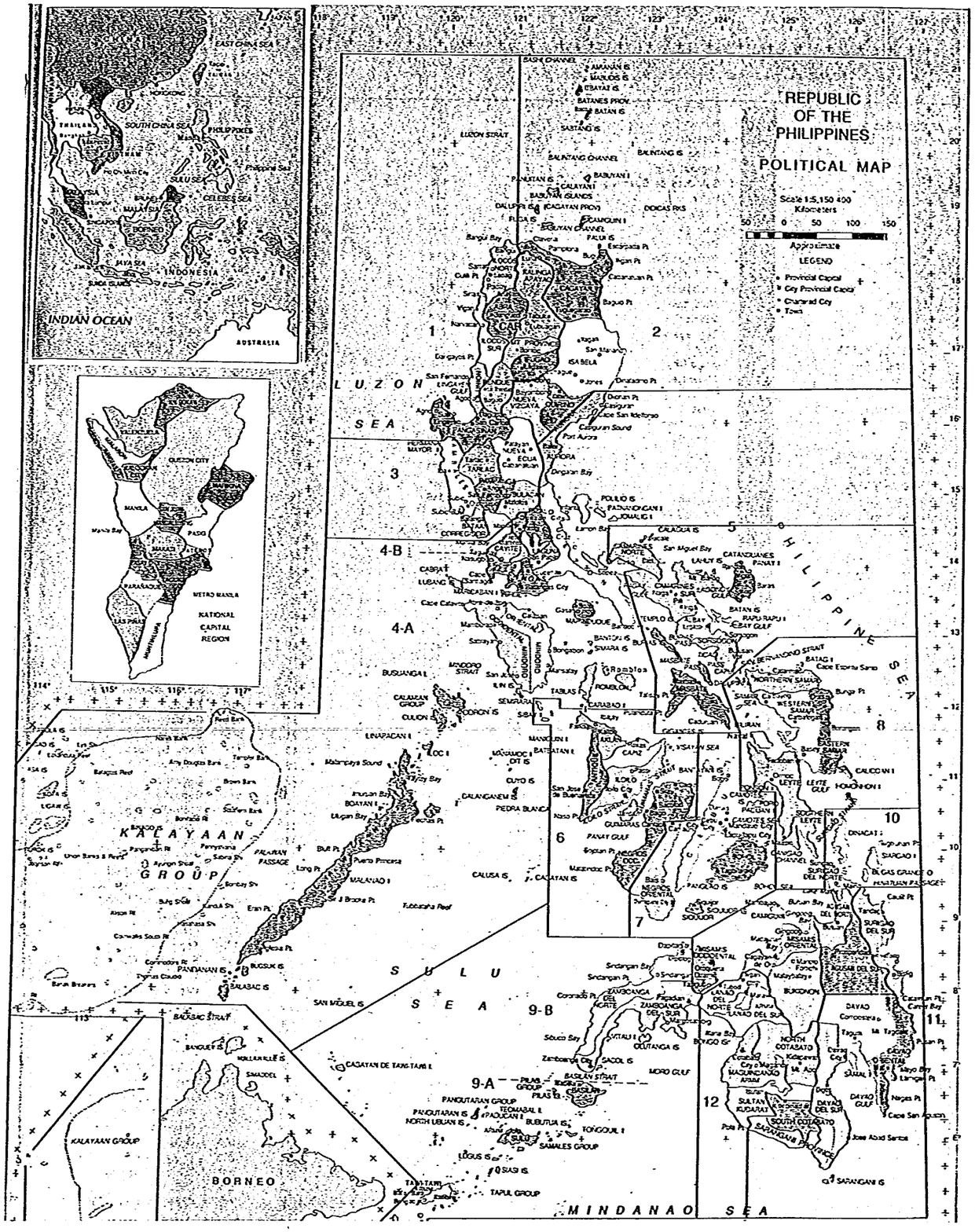
EXECUTIVE SEMINAR ON PUBLIC WORKS RESEARCH AND DEVELOPMENT COUNTRY REPORT : PHILIPPINES

Part II

by:

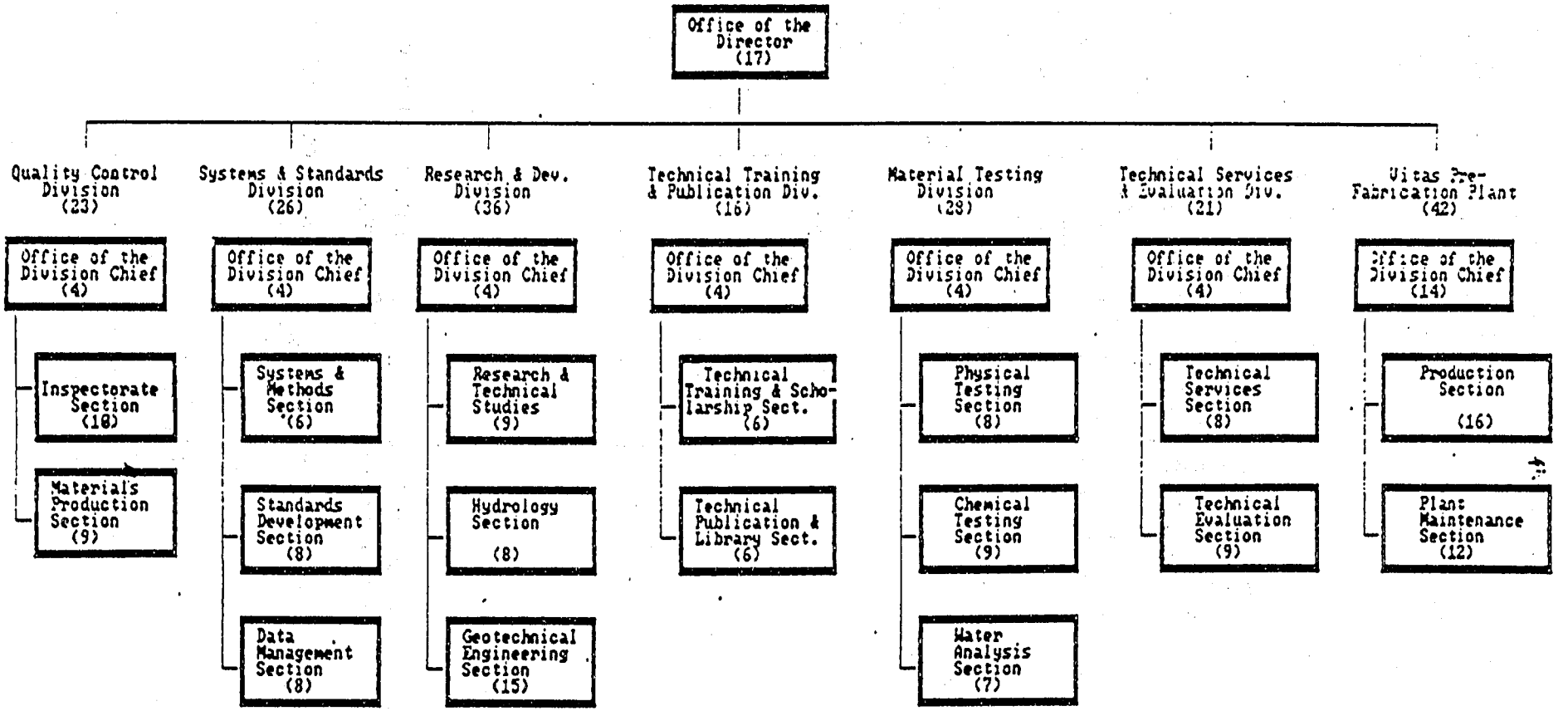
Jose H. Espiritu
Director IV

August 1993



			AREA (Sq. Km.)	POP. (1990) (000)	CITIES	MUN.	BRGY.	MAJOR DIALECTS
ABRA	CAR	Bangued	3,975.6	185	-	27	302	Ilocо
AGUSAN DEL NORTE	10	Butuan City	2,590.3	464	1	11	233	Cebuano
AGUSAN DE SUR	10	Prosperidad	8,965.5	416	-	14	304	Cebuano
AKLAN	6	Kalibo	1,817.9	331	-	17	327	Aklanon, Hiligaynon
ALBAY	5	Legazpi City	2,522.6	904	1	17	719	Bicol
ANTIQUE	6	San Jose de Buenavista	2,522.0	406	-	18	590	Hamtikan
AURORA	4	Baler	3,239.5	140	-	8	152	Tagalog
BASILAN	9	Isabela de Basilan	1,327.2	231	-	7	260	Chavacano, Cebuano
BATAAN	3	Balanga	1,373.0	426	-	12	229	Tagalog
BATANES	2	Basco	209.3	15	-	6	29	Tagalog, Ilocо
BATANGAS	4	Batangas City	3,165.8	1,476	2	32	1,076	Tagalog
BENGUET	CAR	La Trinidad	2,655.4	484	1	13	267	Ilocо, Ibaloi
BOHOL	7	Tagbilaran City	4,117.3	948	1	47	1,109	Cebuano
BUKIDNON	10	Malaybalay	8,293.8	841	-	22	457	Cebuano
BULACAN	3	Malolos	2,625.0	1,504	-	24	521	Tagalog
CAGAYAN	2	Tuguegarao	9,002.7	833	-	29	816	Ilocо, Ibanag, Itawis
CAMARINES NORTE	5	Daet	2,112.5	391	-	12	272	Bicol, Tagalog
CAMARINES SUR	5	Naga City	5,266.8	1,306	2	35	1,063	Bicol
CAMIGUIN	10	Mambajao	229.8	64	-	5	58	Cebuano, Waray
CAPIZ	6	Roxas City	2,633.2	534	1	16	473	Hiligaynon
CATANDUANES	5	Virac	1,511.5	187	-	11	314	Bicol
CAVITE	4	Trece Martires City	1,287.6	1,153	3	20	520	Tagalog
CEBU	7	Cebu City	5,088.4	2,646	5	48	1,200	Cebuano
DAVAO DEL NORTE	11	Tagum	8,129.8	1,055	-	21	419	Cebuano
DAVAO DEL SUR	11	Digos	6,237.6	1,483	1	15	500	Cebuano
DAVAO ORIENTAL	11	Mati	5,164.5	394	-	11	180	Cebuano
IFUGAO	CAR	Lagawe	2,517.8	149	-	10	161	Ifugao, Ilocо
ILOCOS NORTE	1	Laoag City	3,399.3	461	1	22	557	Ilocо
ILOCOS SUR	1	Vigan	2,579.6	520	-	34	765	Ilocо
ILOILO	6	Iloilo City	5,324.0	1,765	1	43	1,900	Hiligaynon
ISABELA	2	Ilagan	10,664.6	1,078	-	37	1,054	Ilocо, Ibanag, Yogod
KALINGA-APAYAO	CAR	Tabuk	7,047.6	214	-	15	263	Ilocо
LA UNION	1	San Fernando	1,493.1	549	-	20	575	Ilocо
LAGUNA	4	Sta. Cruz	1,759.7	1,374	1	29	671	Tagalog
LANAO DEL NORTE	12	Tubod	3,092.0	619	1	22	433	Cebuano
LANAO DEL SUR	ARMM	Marawi City	3,872.9	559	1	37	1,022	Maranao
LEYTE	8	Tacloban City	6,268.3	1,484	2	41	1,655	Cebuano, Waray
MAGUINDANAO	ARMM	Maganoy	5,474.1	753	1	17	443	Maguindanao
MARINDUQUE	4	Boac	959.2	183	-	6	218	Tagalog
MASBATE	5	Masbate	4,047.7	600	-	21	544	Bicol, Cebuano, Hiligaynon
METROPOLITAN MANILA	NCR		636.0	7,832	4	13	1,697	Tagalog
MISAMIS OCCIDENTAL	10	Oroquieta City	1,939.3	424	3	14	489	Cebuano
MISAMIS ORIENTAL	10	Cagayan de Oro City	3,570.1	865	2	24	505	Cebuano
MOUNTAIN PROVINCE	CAR	Bontoc	2,097.3	116	-	10	142	Ilocо, Bontoc
NEGROS OCCIDENTAL	6	Bacolod City	7,926.1	2,243	6	26	656	Hiligaynon
NEGROS ORIENTAL	7	Dumaguete City	5,402.3	925	3	22	556	Cebuano
NORTH COTABATO	12	Kidapawan	6,555.9	757	-	17	519	Cebuano
NUEVA ECIJA	3	Palayan City	5,284.3	1,309	3	29	808	Ilocо, Tagalog
NUEVA VISCAYA	2	Bayombong	3,903.9	301	-	15	271	Ilocо, Tagalog
OCCIDENTAL MINDORO	4	Mamburao	5,879.8	282	-	11	153	Tagalog
ORIENTAL MINDORO	4	Calapan	4,364.7	551	-	15	419	Tagalog
PALAWAN	4	Puerto Princesa City	14,896.3	528	1	21	416	Cuyonin, Tagalog
PAMPANGA	3	San Fernando	2,180.7	1,539	1	21	536	Pampango, Tagalog
PANGASINAN	1	Lingayen	5,368.2	2,018	2	45	1,348	Pangasinan, Ilocо
QUEZON	4	Lucena City	8,706.7	1,373	1	40	1,235	Tagalog
QUIRINO	2	Cabarroguis	3,057.2	114	-	6	118	Ilocо
RIZAL	4	Pasig	1,308.9	973	-	14	172	Tagalog
ROMBLON	4	Romblon	1,355.9	227	-	17	214	Hiligaynon, Tagalog
SAMAR, EASTERN	8	Borongan	4,339.6	329	-	23	597	Waray
SAMAR, NORTHERN	8	Catarman	3,498.0	383	-	24	572	Cebuano, Waray
SAMAR, WESTERN	8	Catbalogan	5,591.0	531	1	25	962	Waray
SIQUIJOR	7	Siquijor	343.5	74	-	6	134	Cebuano
SORSOGON	5	Sorsogon	2,141.4	522	-	15	541	Bicol
SOUTH COTABATO	11	Koronadal	7,468.8	1,073	1	18	307	Hiligaynon, Cebuano
SOUTHERN LEYTE	8	Maasin	1,734.8	322	-	18	503	Cebuano, Waray
SULTAN KUDARAT	12	Isulan	4,288.2	433	-	11	212	Maguindanao
SULU	ARMM	Jolo	1,600.4	466	-	18	415	Tausog, Samal, Cebuano
SURIGAO DEL NORTE	10	Surigao City	2,739.0	426	1	26	416	Cebuano, Surigaynon
SURIGAO DEL SUR	11	Tandag	4,522.2	449	-	19	303	Cebuano
TARLAC	3	Tarlac	3,053.4	851	-	17	509	Ilocо, Tagalog
TAWI-TAWI	ARMM	Bongao	1,087.4	230	-	10	203	Tausog, Cebuano, Chavacano
ZAMBALES	3	Iba	3,714.4	551	1	13	247	Zambal, Tagalog
ZAMBOANGA DEL NORTE	9	Dipolog City	6,618.1	673	2	24	645	Cebuano
ZAMBOANGA DEL SUR	9	Pagadian City	8,051.9	1,545	2	40	1,136	Cebuano, Chavacano
BURIAN	8	Naval	555.42	118,012	-	8	131	Cebuano, Waray
GUIMARAS	6	Jordan	604.65	117,990	-	3	98	Hiligaynon
SARANGANI	11	Alabel	3,723.40	257,160	-	7	87	Cebuano, Hiligaynon

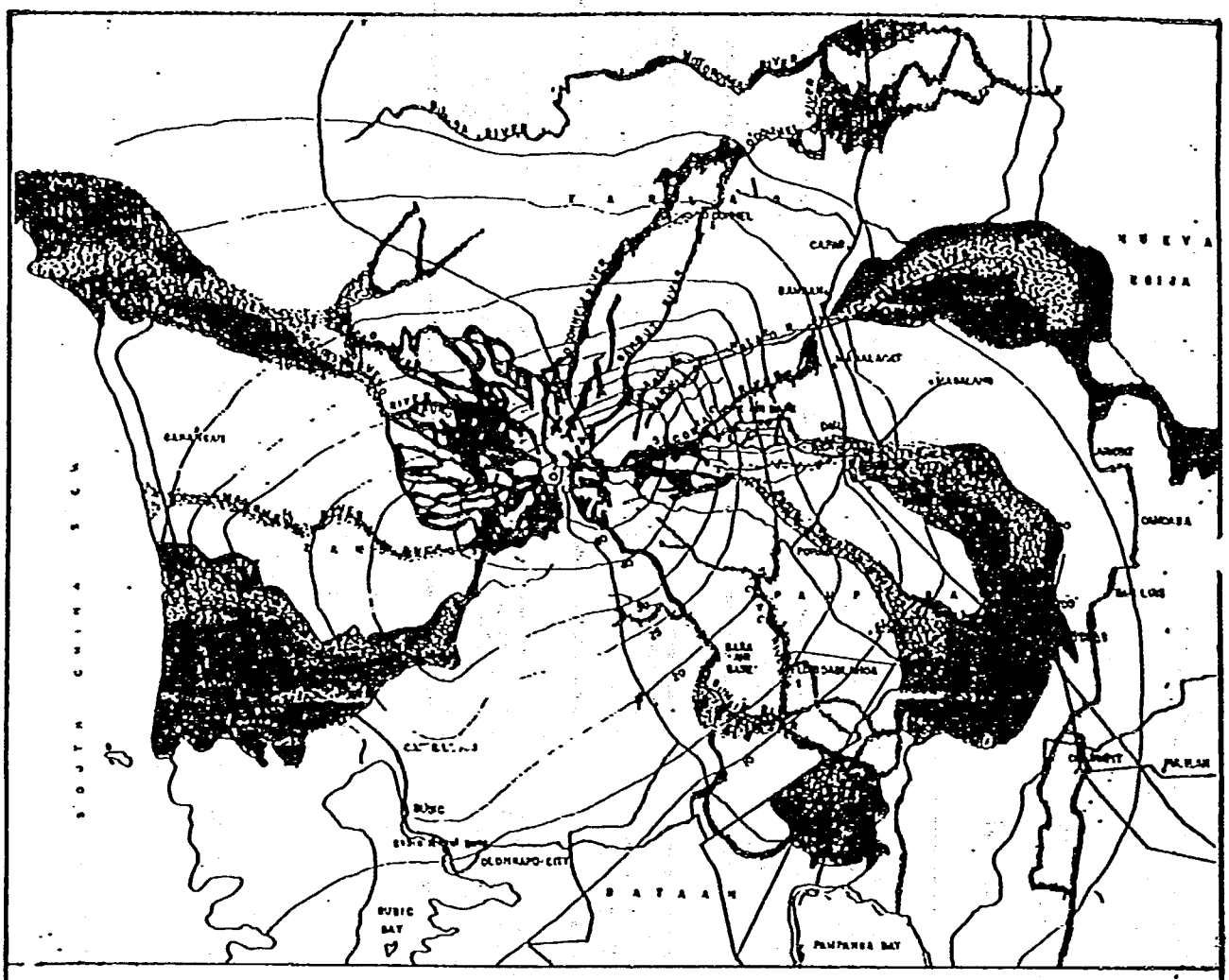
BUREAU OF RESEARCH AND STANDARDS
ORGANIZATIONAL CHART



NOTE :
At present, Vitas pre-Fabrication Plant is under the management and operation of the PMO for Special Buildings pursuant to a Department Memorandum Order

Total No. of Employees - 209

FIGURE 2



MUDFLOW HAZARD MAP

LEGEND:

15 ISOPACH LINE FOR ASHFALL DEPOSIT

PYROCLASTIC FLOW DEPOSIT

MUDFLOW PRONE AREA

MUDFLOW AFFECTED AREA

Figure 3

Table 1
1993 - 1998 MEDIUM-TERM PUBLIC INVESTMENT PROGRAM
SUMMARY ON INVESMENT, BY CATEGORY
(In Million Current Prices)

CATEGORY	1993	1994	1995	1996	1997	1998	Total 1993-1998
1. Highways	10,436.0	14,529.5	16,894.4	22,272.0	28,716.3	42,142.0	134,990.7
2. Flood Control and Drainage	1,493.7	1,685.4	2,163.4	3,371.7	5,990.6	10,633.2	25,338.0
3. Rural Water Supply	562.3	814.6	836.6	1,042.3	763.4	320.8	4,340.0
4. Urban Infrastructure	602.9	150.0	360.0	437.0	450.0	520.0	2,519.9
5. Preliminary/ Detailed Engineering [1] National Buildings	58.0	0.0	0.0	0.0	0.0	0.0	58.0
TOTAL	13,152.9[2]	17,179.5	20,254.4	27,123.0	35,920.3	53,616.0	167,246.6

1. For 1994-1998, included in the respective categories
2. Excluding P133.7 Million for Ports just to continue on-going foreign-assisted projects. Already transfered to DOTC.

Table 2
PERSONNEL COMPLEMENT OF BRS

Division/Office	No. of Personnel
Ofiice of the Director	17
Systems & Standards Division	26
Research and Development Division	36
Technical Services & Evaluation Division	21
Materials Testing Division	28
Quality Control Division	23
Technical Training & Publication Division	16
Total	167

Table 3
BRS BUDGET FOR CY 1993

Item	Budget
Personal Services	P 14,712,000
Maintenance and Other Operating Expenses (MOOE)	4,650,300
Research Fund	4,000,000
Total	P 23,362,300

STUDY OF THE MITIGATION OF LAHAR/MUDFLOWS AND REHABILITATION STRATEGIES

(SHORT - TERM)

FINAL REPORT

TECHNICAL SCIENTIFIC COMMITTEE
ON MT. PINATUBO REHABILITATION
MANILA, PHILIPPINES
APRIL 1992

EXECUTIVE SUMMARY

A. THE STUDY

The devastating effects of Mt. Pinatubo eruptions have significantly altered the ecosystem, hindered regional development and diminished economic opportunities of people in the affected areas. The extent of damages is unimaginable. Although the detrimental effects of ashfall have lessened, pyroclastic materials deposited in the upper reaches (Zone 1) of the river systems threaten to cause enormous damages whenever rainfall occurs. The emerging concern has prompted the government to create a Technical Scientific Committee (TSC) which shall conduct an in-depth study to mitigate the movement of lahar/mudflows and to formulate short, immediate and long-term plans for the rehabilitation of the heavily affected areas.

The Committee comprises the Secretary of the Department of Public Works and Highways (DPWH) as Chairman; and the Undersecretaries of the Department of Agriculture (DA), Department of Science and Technology (DOST), Department of Environment and Natural Resources (DENR); and Heads of affected Local Government Units (LGUs).

B. PROGRAMS AND RECOMMENDATIONS

B.1 INFRASTRUCTURE

At this point in time, it is advisable that the reconstruction/rehabilitation of infrastructure facilities directly affected by lahar/mudflows, specifically, roads and bridges be deferred until such time when debris control measures and river improvement works have been implemented and the rivers have settled down along their existing and/or new courses. However, economic and social imperatives may require the reconstruction and rehabilitation of infrastructure facilities such as irrigation, water supply, airport, communication and power facilities. Hence, this report contains several recommendations for the reconstruction/rehabilitation of the infrastructure facilities. Some specifics of which are the following:

- relocation of building facilities to safer sites as practicable;
- higher pitch for roofs and reduced spacing for trusses to minimize the likelihood of roof failures;
- elevation of road levels such as viaducts to cater for 25 to 50 year floods;
- provision of sufficient waterway opening for bridges with higher bridge decks and longer bridge spans;

- reduction of the effects of erosion at bridges with the use of reno mattresses and provision of pile caps below potential scour level; and,

- construction of shallow wells for irrigation as a replacement for affected surface water supply.

B.2 RIVER SYSTEM

The study recommends the following immediate measures:

River	*Recommended Measures*	*Location*
1. ABACAN	- No structural measures for 3-5 years	- At sediment production zone
	- Sabo/check dams	- Middle reaches of Sapang Bato River
	- Bank protection/ river training works	- Taug, Sapang Bato, Amsic, near Abacan and Pandan Bridges
	- Channeling/Desilting/ Diking	- Lower and middle reaches of Abacan and Taug Rivers and Sapang Balen Creek
	- Sand catch area with sand bagging	- at the outlying areas of Barangays San Juan and Cauayan
	- Sandpocket with consolidation sills	- Lower reaches of Abacan (San Patricio Area)
2. BUCAO/BALIN BAQUERO/ MARAUNOT	- No structural measures for 3-5 years	- Sediment production zone
	- Bank protection	- At Barangays Poon-Bato and Baquilan
	- Desilting/Channeling	- Middle reaches of Balin Baquero and Maraunot Rivers and Bucao Bridge to Barangay Malumboy

	- Diking	-	At Barangay Baquilan to the mouth of the river
	- Sand catch area (Sediment Basin)	-	Floodplain area at the foot of Mts, Catongohan and Munti
	- Dredging	-	From the mouth of the river to 2-3 km. upstream
3. MALOMA	- No structural measures for 3-5 years	-	At sediment production and transport zones
	- Diking/Bank protection	-	From Malcma Bridge to Barangays Yangil and Gorongoro
	- Channeling/Desilting	-	From Maloma Bridge to Barangay Yangil
	- Dredging	-	Mouth of the river to Maloma Bridge
4. O'DONNEL/ TARLAC	- No structural measures for 3-5 years	-	At sediment production zone
	- Sabo/Check Dams	-	Valleys of O'Donnel and Bangut Rivers
	- Sand catch area	-	Immediate upstream of the confluence of O'Donnel and Bangut Rivers
		-	Braiding portion of O'Donnel River at Barangay Lawy, Capas, Tarlac 5km downstream of the confluence with Bangut River
		-	Vicinity of the confluence of Moriones and O'Donnel Rivers, 5 km. upstream of the Agana Bridge

	- Dredging/Desilting	-	From the Crow Valley along O'Donnel River and from Barangay O' Donnel along Bangut River downstream to Agno River in Pangasinan
	- Bank Protection	-	Selected bends of the river from Barangay Lawy downstream to the Agana Bridge in Tarlac
	- Lahar-filled levees over-topped with sodding, sandbags, or dry boulder riprap	-	Selected low-lying areas along the middle and lower reaches of the river system
5. PASIG/ POTRERO	- No structural measures for 3-5 years	-	Sediment production zone (from the headwater to the confluence of Timbu and Papatac Rivers, specifically at the sites of the washed-out erosion dams
	- Desilting/Channeling	-	From Barangay Banaba downstream to the junction of San Fernando River
	- Diking	-	Mancatian Bridge to San Fernando River
	- Extension and raising/ reinforcement of the existing dikes	-	Upstream of Barangay Dolores down to Mancatian Bridge
	- Provision of revetment and groins	-	Before and after Mancatian Bridge
	- Sand catch area	-	At the vicinity of Barangays Mitla and Mabical

6. PORAC/GUMAIN	- No structural measures for 3-5 years	-	Sediment production zone of Gumain River
	- Check Dams	-	Headwaters of Porac River up to Barangay Dolores
	- Sand pocket with consolidation sills	-	At Barangay Pabanlag
	- Bank protection/river training	-	Town of Porac to the municipality of Floridablanca
	- Channeling/Desilting	-	Lower reaches of the river system
	- Diking with bank protection	-	Barangay Pabanlag down to the outlet of Porac and Gumain Floodway
	- Dredging	-	At the mouth of the Floodway
7. SACOBIA/ BAMBAN	- No structural measures for 3-5 years	-	Sediment production zone of Sacobia River
	- Check Dams	-	Middle reaches of Malago and Marimla and Sapang Cauayan River tributaries and at the middle reaches of Sacobia River
	- Consolidation sills	-	Upstream of Barangay Dolores and near new cut-off channel
	- Diking, Desilting/ Channeling	-	Barangay Dolores down to Rio Chico dela Pampanga River
	- Bank protection works	-	Barangay Dolores to a few kilometers upstream near the Clark Air Base boundary

	- Short cut channel with bank protection	- Near the confluence of Malago and Bamban Rivers
	- Sand catch areas with sand bagging	- South of Concepcion town and Matuladtan Swamp
8. STO. TOMAS/ MARELLA/ MAPANUEPE	- No structural measures for 3-5 years	- Sediment production zone of Marella River
	- Sabo/Check Dams	- Tributaries of Mapanuepe River
	- Sediment retaining structure	- Confluence of Marella and Mapanuepe Rivers
	- Drain channel	- Mapanuepe Lake
	- Channeling/Desilting/ Diking	- Barangay San Rafael to Maculcul Bridge
	- River training/bank protection works	- Between Barangays San Rafael and Dalanawan
	- Dredging	- Mouth of the river to Maculcul Bridge
	- Sand bagging	- Bridge embankment approach
9. PAMPANGA DELTA WATERWAYS	- Dredging/Channeling/ Diking	- Selected stretches along San Fernando/Guagua/Sasmuan/ Pasag/Dalan Bapor/ Sebitanan/Mayapap/ Malubag/Rio Chico and Pampanga Rivers.

The TSC's recommendation that no structural measures must be undertaken in the Sediment Production Zones is premised on the assumption that the river systems shall have been relatively stabilized only after three (3) to five (5) years. In lieu of this, it is vigorously recommended that desilting, diking and bank protection works must be given priority. However, recognizing our limitations relative to the availability of updated accurate data and the dynamic situation prevailing on each river system, the TSC may allow stopping the sediments at its source where enough studies on river geomorphology will justify stability and selection of areas with optimum containment.

B.3 AREAS HAZARDOUS TO SETTLEMENTS

To minimize the loss of lives and destruction of properties, the TSC also recommends that populated areas along the river banks and low lying areas which are adjacent to the eight (8) major river systems affected by the Mt. Pinatubo eruptions be temporarily restricted from settlements and/or inhabitants be properly warned of the hazards of lahar/mudflows. These areas are prone to floodings and are subject to bank overflows during days of moderate to heavy rainfalls as per Mudflow Hazard Map prepared by PHIVOLCS and NAMRIA.

Tabulated below are the river systems and the municipalities/barangays* considered hazardous to mudflows.

River System	MUDFLOW HAZARDOUS AREAS	
	Very High Risk	High Risk
3.1 Bucao/Balin-Baquero	Brgys. Porac, Maloneboy and Nagpare. Old Sugar Central.	Botolan Town and its sorrounding barangays. Brgys. Poonbato, Nacolcol, Canalig, Naguisguis and San Juan.
3.2 Sto. Tomas/Marella/ Mapanuepe	Brgys. Sabangan, Duque, Maculcul and Alusiis.	Towns of San Antonio, San Marcelino, San Narciso, San Felipe, and their surrounding barangays. Brgys. Santa Fe, San Rafael, Unaya and Paete.
3.3 Maloma	Brgys. Caragay, Yangil, and Laoag South.	Brgys. Lonboy, Tondo, Maloma, Anonang, Casabaan, Maligaya, Laoag North, Balintagac, Maguinang, Payodpod, Kakilingan, and Gorongoro.
3.4 O'Donnel/Tarlac	Brgys. Santa Lucia and Balanti. River banks of Brgy. O'Donnel and Tarlac town.	San Miguel town. Brgys. Negrito, Pingal, Bueno Carangalan, Arainia, Maniknik San Carlos, Caluring, Atioc, Pasaldacan, San Jose, Socorro, Dinginan, San Luis, Murcia, Estrada and Sapang Tagalog.

* Names obtained from NAMRIA Topographic Maps with 1:50,000 scale.

River System	MUDFLOW HAZARDOUS AREAS	
	Very High Risk	High Risk
3.5 Sacobia/Bamban	Concepcion town. River banks along Clark to Brgy. Dolores. Brgys. San Nicolas, Banaba, Lourdes, Malonzo, Sta. Rita, San Martin, Marisla, Culatingan, Capcap, Banocal, Cafe, Bangcu, Magao and Lilibangin.	Bamban town. Brgys. Arcirea, San Antonio, San Vicente, San Nicolas, San Bartolome, Panalicsican, Buluti, Malonzo, Telabangca, Luyus, Sinipit, Minane, Macabacle, San Francisco, Sto. Cristo and Alpendras.
3.6 Abacan	River banks from Brgy. Sapang Bato to Brgy. Cauayan. Brgys. San Patricio, Laput, San Juan, Concepcion, Lapug, San Agustin and Santo Rosario.	Mexico town. Brgys. Capayan, Culubasa, Malino, Santa Cruz, San Vicente, Pangatlan, San Antonio, San Nicolas, San Pablo, Matulid, San Carlos, Anao, Darabulbut, Cutud, Suclaban and Eden.
3.7 Pasig-Potrero	Bacolor town and its sorrounding barangays. Brgys.Pandan, Mancatian, Cotad, Potrero, Duat, San Antonio, Parulog, Santa Barbara, San Juan, Calaabangan,San Vicente, San Francisco, Sta. Catalina.	Towns of Santa Rita, Guagua, Sasmuan, Minalin, Santo Tomas and their sorrounding barangays.
3.9 Porac/Gumain/Caulaman	Towns of Porac and Florida Blanca. Brgys. Pabanlag, Sto. Cristo and Cabancalan. Eastern part of Basa Air Base. Barangays along river banks from Porac-Gumain Floodway.	Brgys. Carmencita, Dampe, Bodega, Cutad and Dolores.

The 12 on-going/existing settlement sites for Mt. Pinatubo affected population are considered to be at low risk from future lahar/mudflows.

It is further recommended that information campaign to disseminate the hazardous effects of mudflow in the areas identified, be organized/conducted by the DPWH, local government units (LGUs) and non-governmental organizations (NGOs) with the DSWD acting as lead agency so that inhabitants will be much prepared to cope with disaster when rainy season comes.

B.4 AGRICULTURE

In the Agriculture sector there are four (4) essential recommendations to lessen the adverse effects of volcanic ejecta on the lahar/ashfall-affected farms, namely;

1. On Planting Schedules of Irrigated Ricelands

   Planting/transplanting of rice plants must be done 2-4 weeks after the lands have been submerged by irrigation/rain water. This is to avoid potential damages from sulfide toxicity.

2. On Soil Management

   A general 50-50 ratio of ash-soil mix is recommended. For areas cultivated by farm animals, the ash depth for incorporation is about 6 cm. while for those cultivated by tractors, the ash depth is about 10 cm. In areas with more than 12 cm. ash cover; scraping is recommended if technically possible or a change in crop maybe necessary.

3. On Water Management

   Alternate irrigation and drainage is recommended to flush out toxic compounds.

4. On Fertilizer Management

   The use of phosphorous-carrying fertilizers is recommended. On lowland rice and farm with poorly drained soils, organic fertilizers, when desired, must be applied 2-4 weeks ahead of planting/transplanting to hasten the release of sulfide and to avoid the period when nutrients from the organic fertilizer is not yet available for plant use.

The Department of Agriculture has implemented a rehabilitation program for the Mt. Pinatubo affected areas called "OPLAN SAGIP-BUKID". This is done by subdividing the affected areas into four (4) zones according to the severity of sand cover and damage to agriculture. Its objective is to assist/support affected farmers and fisherfolk to regain their productivity and income.

The Program's components are as follows:

1. Crops and Soils Rehabilitation
2. Livestock Resource and Rehabilitation
3. Fishery Rehabilitation
4. Establishment of Income Generating Projects (IGPs)
5. Repair of Farm Infrastructure and DA Facilities
6. Provisions of Support Services in the Resettlement of Victims

Basket or *Bayong Farming*, an indigenous planting technique employed by farmers from Cavite, Bohol and even in Pampanga, was also introduced by the Department of Agriculture.

5. TRADE AND INDUSTRY

Adequate livelihood and employment opportunities should be provided to displaced farmers and workers. The government should likewise come up, as soon as possible with alternative uses for base lands (Clark Air Base and Subic Naval Base) to reduce massive displacement of workers in the region.

Livelihood programs should focus on agriculture and industry and special emphasis should be given to projects that maximize the use of indigenous resources and skills, and those that support other projects.

THE DPWH ORGANIZATION

The Department of Public Works and Highways (DPWH), as established under Executive Order No. 124 in 1987, functions as the engineering and construction arm of the Government tasked to continuously develop its technology for the purposes of ensuring the safety of all infrastructure facilities and securing for all public works and highways the highest efficiency and the most appropriate quality in construction. The DPWH is responsible for the planning, design, construction and maintenance of infrastructure, especially national highways, flood control and water resources development systems, and other public works in accordance with national development objectives.

The DPWH, has on the average an annual budget of about P 19 B of which the infrastructure budget component comprise about P 15 B (79 per cent) while the operation and maintenance budget component comprise about P 4 B (21 per cent). It implements an annual average of about 63,800 infrastructure projects nationwide and maintains about 160,000 kilometers of roads nationwide.

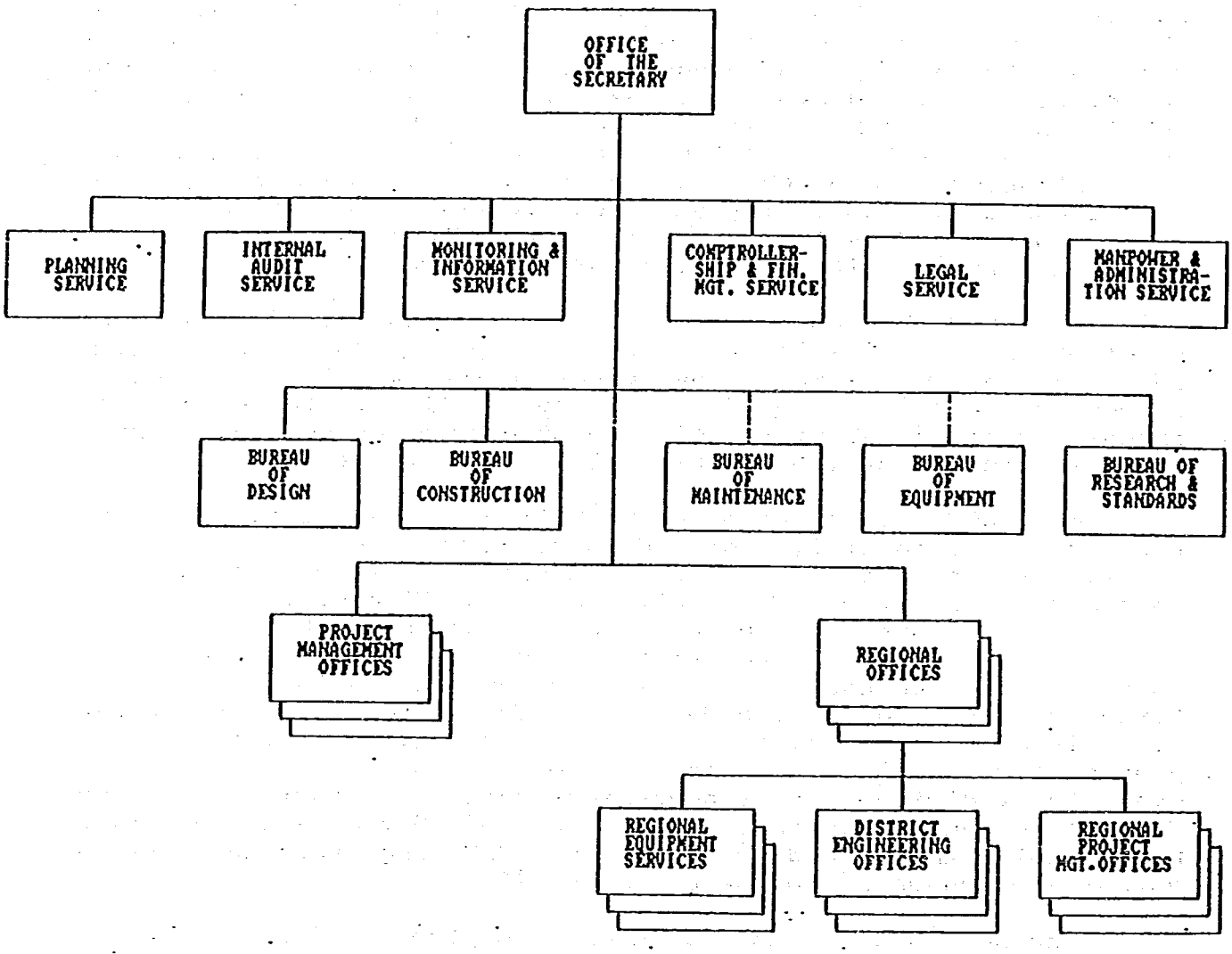
The DPWH is composed of an Office of the Secretary; six technical, financial, and administrative support services, namely: Planning Service, Internal Audit Service, Monitoring and Information Service, Comptrollership and Financial Management Service, Legal Service, and Manpower and Administration Service; five staff bureaus, namely: the Bureau of Design, Bureau of Construction, Bureau of Maintenance, Bureau of Equipment, and Bureau of Research and Standards; fifteen regional offices; about 109 district offices; and 25 project management offices. It previously had 58 city engineering offices which it has turned over to individual local government units as provided in the devolution and decentralization act of Government in 1991. Presented in the suceeding page is the DPWH organization chart as established under Executive Order No. 124.

The DPWH has a total personnel complement of about 46,786 of which 17,159 (37 percent) are permanent personnel, 5,866 (12 percent) are temporary road maintenance personnel, and 23,761 (51 percent) are casual and project-hired contractual personnel. About 13.4 percent (2,658) of its personnel is in the central office (Office of the Secretary, services, bureaus, pool of project managers, etc.); 14.6 percent (2,900) in regional offices and 44.1 percent (8,700) in district engineering offices for a total of 86.6 percent of the total DPWH staff; and the rest distributed in other offices.

The DPWH is headed by a Secretary, four Undersecretaries, four Assistant Secretaries, five staff bureau directors, 15 Regional Directors, 112 project managers and engineers, and other middle-level executives.

The personnel complement is currently being streamlined with the devolution of local infrastructure activities to local government units as well as the current Goverment thrusts for more cost-effective and efficient government operations and fiscal reforms.

DEPARTMENT OF PUBLIC WORKS & HIGHWAYS
ORGANIZATION DIAGRAM



ANNEX 3

LIST OF MAJOR PROJECTS FOR ENVIRONMENTAL ASSESSMENT AND MONITORING

Highways/Roads

1. Baguio-Bontoc Road (Halsema)
2. Manila-Tarlac-Urdaneta-San Fernando Road
3. Agoo-Baguiio Road
4. Aritao-Kayapa-Baguio Road
5. Lingayen-Dagupan-Damortis Road
6. Urdaneta-Dagupan Road
7. Bongabon-Baler Road
8. Bontoc-Banawe Road
9. Camiling-Bayambang Dagupan Road
10. Guimba-Pura-Ramos-Paniqui Road
11. Maharlika Highway from Cabanatuan to Gattaran, Cagayan
12. San Fernando-Tagudin Cervantes Road
13. Baguio-Bokod Road
14. Candon-Bangued Road
15. Marcos Highway
16. Urdaneta-Asingan Tayug Road
17. San Jose-Lupao-Umingan-Rosales Road
18. Baguio-Bacod Road
19. Gabaldon-Laur-Palayan-Cabanatuan-Rizal-San Jose Road
20. Aurora-Nueva Ecija Road
21. Baler-Casiguran Road

Bridges

1. Magsaysay Bridge, Dagupan City
2. Carmen Bridge, Rosales, Pangasinan
3. Paldakit Bridge, Dagupan City
4. Payaoas Bridge, Dagupan City
5. Palma Bridge, Pangasinan
6. Puncan Bridge, Nueva Ecija
7. Aringay Bridge, Aringay, La Union
8. Adonot Bridge, Baguio-Banaue Road, Mountain Province
9. Chico Bridge, Bontoc-Banaue Road, Mountain Province
10. Calvo Bridge, Bayambang, Nueva Vizcaya
11. Mananan Bridge, Cagayan
12. Padilla Bridge, Bugallon, Pangasinan
13. Parian-Bantay Bridge I & II, Mangatarem, Pangasinan
14. Lumban Bridge, Lumban, Laguna
15. Nalhu Bridge, San Pablo City
16. Dacanlao Bridge, Batangas
17. Jones Bridge, Manila
18. McArthur Bridge, Manila
19. Nagtahan Bridge, Manila
20. Guadalupe Bridge, Manila

21. Rosario Bridge, Manila
22. Bridges across Bucloc, Dipolo, Digdig and Talavera Rivers
23. Banila Bridge, Umingan, Pangasinan
24. Padpad Bridge, Concepcion, Tarlac
25. Plaridel-Pulilan Bridge, Bulacan
26. Don Teofilo Sison Bridge, Pangasinan

Flood Control/River Banks/Beach Protection

1. Cabangan Flood Control, Isabela
2. Cauayan Flood Control, Isabela
3. Balanoc River Slope Protection
4. Earthdikes/Revetment in Sto. Tomas, Tayug, Caranglaan, Alcala, Banila, Villasis, Bayambang, Amperez, Asingan, Urbiztondo, San Carlos, Pozzorubio, Cayanga, San Fabian, Mangaldan
5. Pogo-Lasip Grande Riverbank Protection
6. Pantal Riverside Road and Revetment Structure
7. Calmay Shore Protection
8. Chico River Flood Control, Bontoc, Mt. Province
9 Sababangan Flood Control, Mt. Province
10. Kayapa-Nueva Vizcaya Section
11. Sta. Rosa-Lingay Section
12. Camp One-Tuba Section
13. Ambuklao Upstream Section
14. Pura River Control
15. Tarlac Flood Control (left Dike)
16. Nueva Vizcaya Flood Control
17. Benguet Flood Control (14 Section)
18. Cabanatuan Flood Control
19. Amburayan River Control

Irrigation and Water Supply

1. La Union (5 irrigation projects)
2. Benguet (13 water supply projects)
3. Pangasinan (4 water supply projects)

Portworks

1. La Union (5 on-going and 1 completed)
2. Ambulong Port, Batangas

Projects of Public Interest

1. Pantabangan Dam Complex, Nueva Ecija
2. Baguio General Hospital, Baguio City
3. Don Teofilo Sison Memorial Hospital, Dagupan City
4. Central Luzon State University, Munos, Nueva Ecija
5. Benguet State University- Agriculture and Forestry
6. Nueva Vizcaya State Institute of Technology
7. Pangasinan State University, Lingayen, Pangasinan
8. Paulino Garcia Hospital, Cabanatuan City
9. Lasip-Grande & Pautal Elementary Schools

Appendix

MEASURES FOR WATER QUALITY CONTROL IN RESERVOIRS AND RIVERS

INTRODUCTION

The Philippines is endowed by nature with abundant water resources. It is an archipelagic country consisting of more than 7,000 islands with an area of 300,000 sq. km. where 65% of its towns are coastal. The population is estimated at 63 million, with an annual population growth of 2.5%. However, there is a tendency for these water resources to become scarce if not properly managed to optimize its development and its quality is not maintained or enhanced. Water resources should be made available to as many users to benefit the greatest number of people by regulating human activties. This is based on the principle that water is a finite resource and that water resources development should go side by side with water pollution control.

WATER QUALITY MANAGEMENT (WQM)

An effective measure for water quality control is a systematic WQM with the following components:

1. water classification
2. water quality criteria
3. water quality monitoring
4. pollution load assessment/inventory
5. effluent standards
6. pollution control technology, strategy and alternatives
7. management programs and policies

Water Classification

In the Philippines, classification is a very important component as there are as many sets of effluent standards as there are water classe. Effluent standards are based on the classification of the receiving body of water.

According to the Revised Water Usage and Classification (DENR AO 34), water bodies are classified into 5 classes (i.e AA, A, B, C and D) for fresh surface waters, and four (4) for marine and estuarine waters (i.e. SA, SB, SC and SD). The classes of water bodies with the corresponding beneficial usage is summarized in Table 1.

The process of water classification involves 3 stages, namely: field survey, public hearing and publication. Field survey consists of desk study, data collection and analysis of samples and reporting. Public hearing is a forum for discussion of the merits and (demerits) of the proposed classification under the context of participatory decision-making. Publication, which is the last stage, of the adopted classification is a leagl requirement.

The minimum parameters to be measured or sampled/analyzed are: Dissolved oxygen, pH, Biochemical Oxygen Demand, Total Suspended Solids and Total Coliform organisms (Coliform analysis for Class AA only). However, the type of beneficial use of that a particular water body generally dictates the WQ parameters to be analyzed aside from the minimum.

Water Quality Criteria

The numerical values for each of the important water quality indicators are set in order that the intended use of the water resource will not be impaired. The WQ criteria are numerical values/limits set at the ambient conditions or at particular waterbody for the protection of human health, aquatic life and public health and safety. These numerical limits are necessary to ensure that the prescribed use of a water body can be sustained. For example, if a particular waterbody say a river is used as a source of water supply it must not have a Fecal Coliforms count greater than 20 MPN/100mL. etc.

The water quality criteria in the Philippines as embodied in DENR Administrative Order No. 34 consists of a set of numerical limits for selected significant water quality parameters such as DO, BOD, heavy metals, etc., for each water use or classification e.g. Class AA, A, B, etc. (Example of Water Quality Criteria is shown in Table 2).

Monitoring Activities

During the period of 1972 to 1982, the National Pollution Control Commission (NPCC) established a monitoring program for some rivers and lakes. The design called for yearly ano semestral sampling of major rivers and monthly sampling of Metropolitan Manila rivers. Some water quality management projects have built-in monitoring activities notably the Pasig River Rehabilitation Projects and the Ilog Ko-Irog Ko Projects.

Monitoring activities are actually undertaken by the DENR regional Offices.

Pollution Source Inventory

Pollution source inventory is an exercise to estimate the total pollution load from various sources using "pollution factors". These factors are applied to easily obtainable data (e.g. production rate of industry) to arrive at an estimate of the wastewater generated in terms of quality and quantity.

Some useful information for the assessment of pollution load are:

- area of river basin
- population (urban, rural, transients)
- industry (type, production figures, wastes generation)
- climate (rainfall, evaporation)
- vegetation
- geology
- agriculture (area/crops/fertilizers, biocides used)
- sewage (% sewered/water supply, infiltration/discharge points/treatment efficiency/effluent quality)

Some of the pollution sources include domestic wastes, industrial wastes, agricultural wastes, naturally occuring sources (e.g. volcanic ash, pyroclastic materials, lahar, rocks & soils leaching), and other hazardous wastes (e.g. oil spills).

Pollution Prevention and Control

Pollution control or complying with set water quality standards requires engineering as well as administrative solutions. Over the years, pollution control technologies have evolved to make treatment processes more efficient and cost effective. Some basic principles have been responsible for this evolution, e.g. utilization of the assimilative capacity of streams, prevent or significantly reduce new pollution source especially in polluted water bodies and clean up/shut down/relocate existing pollution source. This component of the WQM addresses the discharge of the industries and similar point sources.

Under the concept of waste recycling is the industrial waste exchange. This has been successful in other countries and has taken a start in the Philippines under the IWEP (Industrial Water Exchange Project). As a matter of fact, other countries have a so-called "waste stock exchange" by which trading is done in terms of wastes.

There is also that shift in the use of non-polluting materials or from non-biodegradable (plastics, etc.) to bio-degradable. This would result in simpler treatment process (e.g. biological). Overall this would result to non-accumulation of these non-degradable materials in sewers, rivers and other water bodies. Another type of treatment is the use of bacteria in stabilizing the wastewater.

Waste minimization or clean technology is a new concept in pollution control which deals with improvement in the production process itself, raw materials substitution, onsite/offsite recycling, by-product recovery, reuse, etc. that would not only result in less or manageable waste but in saving to industry.

This means changes in production processes so that the amount of waste generated will be reduced or minimized. This now occupies a high priority in environemntal protection before the recycling or treatment or disposal of waste.

For toxic and hazardous wastes or sludge, the common practice is incineration but incinerators must be properly operated and maintained otherwise operating at less than the destructive temperatures will result in the dispersal of the toxic wastes to the surrounding areas.

Another strategy in pollution control is about land use and zoning. Factories could be sited in industrial zones, population centers should be located away from industries or common wastewater treatment facilities could be set up to treat small and dispersed wastewater generators.

Effluent Standards

Effluent standards are limits in terms of concentration and/or volume that any wastewater discharge coming from a point source i.e. industrial plants and municipal sewerage systems shall meet. These consist of a set of water quality parameters and their corresponding numerical limits. Each set is prescribed for each of the water classes i.e. there is one set of effluent standards for Class AA, another for Class A, etc. Effluent standards are usually a certain factor say 10 over the Water Qaulity Criteria. This idea recognizes the fact that whenever nature could complete the treatment process that whenever nature could complete the treatment process so long as there is enough assimilative capacity left. Example of Effluent standards is shown in table 3.

Management Program

1. Water Data Collection Program

Countrywide monthly discharge measurements at different gaging stations established are conducted by the Regional Offices of the Department of Public Works and Highways. Data are then submitted to the Bureau of Research and Standards for evaluation and publication. Water samples are also taken for laboratory analysis.

2. Rivers Revival Program

As the worst rivers are found in Metro Manila, two revival projects are underway : Navotas-Malabon-Tullahan-Tinajeros Rehabilitation Project (RP) or the Ilog ko-Irog ko and the Pasig River Rehabilitation Project. These two projects aimed at cleaning up or reviving these rivers.

3. Sewerage and Sanitation Program

Any river clean up program or water quality management, for that matter should side-by-side consider the issue on domestic wastewater or sewerage. Only a small part of Metro Manila is sewered. Baguio is also partly sewered, some cities belonging to the ten (10) urbanized centers such as Cebu and Zamboanga and also Gen. Santos City only have plans while the rest have nothing.

4. Solid Waste Management Plan

Reconginizng the fact that garbage contributes to about 20% of the organic pollution load in Metro Manila rivers, soild waste management (SWM) is indeed an important issue in water quality management.

5. Environmental Impact Assessment

As a preventive planning strategy, the EIA has been implemented to guide proponents of the possible environmental impacts of proposed projects and so that preventive or mitigating measures could be adopted. Practically all development activities are covered by the EIA/EIS System which at the moment is being used as a regulatory tool.

6. Industrial Pollution Control Program

This an area where DENR is quite popular with. Violators of pollution control law particularly PD 984 are apprehended, and cases filed against them and could be fined or closed down. Cases are decided by the Pollution Adjudication Board.

Regulatory efforts of DENR only focus directly on industrial sources. Domestic wastewater is not the responsibility of DENR but of local water supply and sewerage authorities.

Pertinent Policies

1. Philippine Development Plan - emphasizes the concern for the achievement of a better life for every Filipino. Also advocates an explicit policy aimed at minimizing disparities in regional development.

2. Philippine Strategy for Sustainable Development - Stresses the need to view economic growth and environmental protection as interdependent and mutually acceptable.

3. Population Policy - seeks to promote small family size on a voluntary basis and a reduced population growth rate and encourages responsible parenthood.

4. Industrial Development Policy - promotes industrial dispersal to the countryside and placing emphasis on providing incentives for a more favorable investment climate, infrastructure development, maintenance of stable investment policies and the provision of a more efficient market information system.

5. Land Use Policy - is geared towards the encouragement of a "better utilization" of land and other natural resources.

6. Philippine Action Plan for Agenda 21 - is offshoot of the Earth Summit in Rio, Brazil and as a response of the Philippine government to Agenda 21, which provides the blueprint for action in all areas relating to the sustainable development of the planet from now into the 21st century.

Specific Policies

1. The 1987 Constitution - sets the tone of environmental policies as it affirms the duty of the state "to protect and advance the right of the people to a balance and healthy ecology in accord with the rhythm and harmony of nature".

2. The 1977 Philippine Environment Code (PD 1152) - establishes specific environmental quality management policies and prescribed environmental quality standards.

3. National Pollution Control Law (PD 984 which revised Republic Act 3931) resulted in a stronger National Pollution Control Commission (NPCC now DENR) in its role as the primary agency responsible for the prevention and control of environmental pollution.

4. Executive Order No. 192 - creates the Department of Environment and Natural Resources (DENR) absorbing the powers and functions of the NPCC, National Environmental Protection Council (NEPC) and Environmental Center of the Philippines (ECP).

5. Marine Pollution Decree of 1976 (PD 979 which revised PD 600) - vests the NPCC with the primary responsibility to promulgate national rules and policies governing marine pollution while vesting the primary responsibility of enforcing the laws, rules and regulations governing the marine pollution to the Philippine Coast Guard (PCG).

6. Executive Order No. 927 - vests the exercise of major environmental functions in the Laguna de Bay area and its catchment basins to the Laguna Lake Development Authority (LLDA).

7. Presidential Decree 1586 - establishes the Environmrental Impact Assessment System.

8. Philippine Water Code (PD 1067), being implemented by the National Water Resources Board.

9. Sanitation Code of the Philippines (PD 856), implemented by the Department of Health and Local Government Units)

10. National Building Code (Revising RA 6541), implemented by the Department of Public Works and Highways and Local Government Units)

11. Republic Act No. 6969 - an act to control the importation, manufacture, processing, sale, distribution, use and disposal of toxic substances and hazardous and nuclear wastes, (implemented by DENR)

DRINKING WATER QUALITY CONTROL

Surface Water Intake and Treatment

As surface waters are, in general, subject rather easily to contamination, they are often treated and disinfected before distribution to the consumers. Two systems are most commonly used, namely: slow sand filtration; and coagulation followed by rapid sand filtration.

Slow Sand Filtration

Slow sand filtration is a convenient low-cost method of treating surface water that is not highly polluted. During the treatment process colloidal particles are retained and organic substances biodegraded. An operational limitation of slow sand filters is that the turbidity of the raw water should not exceed 15 NTU (nephelometric turbidity units). With waters of higher turbidity, plain sedimentation should be applied prior to slow sand filtration (Fig. 1).

Coagulation and Rapid Sand Filtration

Treatment plants of the coagulation and rapid sand filtration type are normally the most complicated available for small-community water supplies. They are capable of treating highly turbid surface water. The turbidity is controlled by the use of added coagulants, flocculation, sedimentation and filtration through a sandbed. A schematic representation of a typical plant is given in Fig. 2.

The coagulants are added by means of a feeder and mixer (disperser) which must be checked for correct and efficient performance. In the flocculator, large flocs are produced, which settle in the successding sedimentation tank. If this

sedimentation process is incomplete, problems of overloading will occur in the subsequent filtration. As a rule of thumb, a turbidity of not more than 10 NTU after sedimentation ensures proper filtration.

EXAMINATIONS AND QUALITY STANDARDS

Frequent bacteriological examination is required to ascertain water potability, chemical examinations are done less frequently and are utilized to detect and estimate the chemical and radioactive substances that might affect health as well as the acceptability of water for domestic use. Table 4 shows the maximum permissible level of the parameters that affect the quality of drinking water.

Initial examinations of water from newly constructe sources are required before they are opened and operated for public use. Examination of water for possible radioactive contamination should also be done initially.

Periodic examinations of water supplies shall be performed, at a minimum, annually for surface and groundwater supplies. Water from existing sources is subject to bacteriological examination as often as possible but the interval shall not be longer than six months while general systematic chemical examination shall be conducted every 12 months or oftener. Examination of water sources shall be conducted yearly for possible radioactive contamination.

Table 4 - Water Quality: Physical, Chemical and Radiological Requirements

Parameter	Maximum Permissible Level*
* Turbidity	5 units
Color	5 units (s) **
Odor	Unobjectionable
Threshold odor number	Not more than 3
Taste	Unobjectionable
* Total Solids	500 (s)
*pH	6.5-8.5
Phenolic substances	0.001

Radioactive Subs.	
Gross Alpha	3 pCi/l
Gross Beta	30 pCi/l
Trace Elements	
Arsenic	0.05
Barium	1.0
Cadium	0.01
Chromium	0.05
Copper	1.0
Cyanide	0.05
Flouride	0.6
Iron	1.0 (s)
Lead	0.05
Manganese	0.05 (s)
Mercury	0.002
Selenium	0.01
* Zinc	5.0 (s)
Organic Chemicals	
Synthetic	
Detergents (MBAS)	0.5
Oil & Grease	Nil
Persistent Pesticide	
Aldrin	0.001
DDT	0.05
Dieldrin	0.001
Chlordane	0.003
Endrin	0.0002
Heptachlor	0.0001
Lindane	0.004
Toxaphane	0.005
Methoxychlor	0.1
2,4-D	0.1
2,4,5-T	0.01
B	Nil
Other Chemicals	
Calcium	75
* Chloride	200 (s)
Magnesium	50 (s)
Nitrate (NO3)	30
Sulfate	200 (s)
Hydrogen sulfide	0.05 (s)

All units are in mg/l unless, otherwise stated.

(s) - Secondary standards; compliance with the standards and analysis are not obligatory.

Table 1. Water Usage and Classification (DENR A.O. 34)

(a) Fresh Surface Waters (rivers, lakes, reservoirs, etc.)

Classification	Beneficial Use
Class AA	Public Water Supply Class I. This class is intended primarily for waters having watersheds which are uninhabited and otherwise protected and which require only approved disinfection in order to meet the National Standards for Drinking Water (NSDW) of the Philippines.
Class A	Public Water Supply Class II. Fo sources of water supply that will require complete treatment (coagulation, sedimentation, filtration and disinfection) in order to meet the NSDW.
Class B	Recreational Water Class I. For primary contact recreation such as bathing, swimming, skin diving, etc. (particularly those designated for tourism purposes).
Class C	1) Fishery Water for the propagation and growth of fish and other aquatic resources; 2) Recreational Water Class II (Boating, etc.) 3) Industrial Water Supply Class I (For manufacturing processes after treatment).
Class D	1) For agriculture, irrigation, livestock watering, etc. 2) Industrial Water Supply Class II (e.g. cooling, etc.); 3) Other inland waters, by their quality, belong to this classification.

(b) Coastal and Marine Waters

Classification	Beneficial Use
Class SA	1) Waters suitable for the propagation, survival and harvesting of shellfish for commercial purposes;
	2) Tourist zones and national marine parks and reserves established under Presidential Proclamation No. 1801; existing laws and/or declared as such by appropriate government agency.
	3) Coral reef parks and reserves designated by law and concerned authorities.
Class SB	1) Recreational Water Class I (Areas regularly used by the public for bathing, swimming, skin diving, etc.);
	2) Fishery Water Class I (Spawning areas for Chanos chanos or "Bangus" and similar species.
Class SC	1) Recreational Water Class II (e.g. boating, etc.);
	2) Fishery Water Class II (Commercial and sustenance fishing);
	3) Marshy and/or mangrove areas declared as fish and wildlife sanctuaries;
Class SD	1) Industrial Water Supply Class II (e.g. cooling, etc.)
	2) Other coastal and marine waters, by their quality, belong to this classification.

(c) General Provisions on Water Classification

1. Classification of water body according to a particular designated use or uses does not preclude use of the water for other purposes that are lower in classification provided that such use does not prejudice the quality required for such waters.

2. Water classification are arranged in the order of the degree of protection required, with Class AA and SA having generally the most stringent water quality, respectively, for fresh surface waters and marine/coastal waters; and Class D and SD waters have the least stringent water quality for fresh surface waters and marine waters, respectively.

3. The main objective of the water quality criteria is to maintain the minimum conditions necessary to assure th suitability of water for its designated use or classification.

4. Any person regulated under the rules or having a substantial interest in this chapter may seek reclassification of waters by filing a petition with the DENR giving all neceesary information to support the petition.

5. All reclassification of water shall be adopted, only after public notice and hearing and upon affirmative findings by the DENR Regional Office concerned that:

   i) The proposed reclassification will establish the present and future most beneficial use of the waters;

   ii) Such a reclassifications is clearly in the public interest, and,

   iii) The proposed designated use is attainable, upon consideration of environmental, technological, social, economic and institutional factors.

6. For purposes if classification or reclassification the following minimum water quality parameters are to be considered:

   i) Dissolved Oxygen (DO)
   ii) pH
   iii) Biochemical Oxygen Demand (BOD)
   iv) Total Coliform Organisms

Water Quality Criteria

(a) Minimmum Criteria for Surface Waters. All surface waters of the country shall be free from:

1. Domestic, industrial, agricultural, or other man-induced non-thermal components of discharges which, alone or in combination with other substances or in combination with other components of discharges (whether thermal or non-thermal):

   i) That settle to from putrescent deposits or otherwise create a nuisance; or

   ii) That float as debris, scum, oil, or other matter in such amounts as to form nuisances; or

   iii) That produce color, odor, taste, turbidity, or other conditions in such degree as to create a nuisance; or

   iv) That are acutely toxic; or

   v) That are present in concentrations which are carcinogenic, mutagenic, teratogenic to human beings or to significant, locally occurring, wildlife or aquatic species; or

   vi) The pose a serious danger to the public health, safety, or welfare.

2 Thermal components of discharges which alone, or in combination with other discharges or component of discharges (whether thermal or non-thermal):

   i) That produce conditions so as to create nuisance; or

   ii) That increase the temperature of the receiving body of water (RBW) so as to cause substantial damage or harm to the aquatic life or vegetation therein or interfere with the beneficial uses assigned to the RBW.

(b) Water Quality Criteria for Fresh Waters

1. Conventional and Other Pollutants Affecting Aesthetics and Oxygen Demand. - Please refer to Table 2 for the parameters and limits or specifications according to classification and use of the receiving body of water (RBW).

Table 2 WATER QUALITY CRITERIA, a) FOR CONVENTIONAL AND OTHER POLLUTANTS CONTRIBUTING TO AESTHETICS AND OXYGEN DEMAND FOR FRESH WATERS

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

Note:

(c) - No abnormal discoloration from unnatural causes

(f) - Not more than 30% increase

(g) - Not more than 30 mg/L increase

(h) - Not more than 60 mg/L

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

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

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

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

(m) - These values refer to the geometric mean of the most probable number of coliform organism during a 3-month period and that the limit indicated shall not be exceeded in 20 percent of the samples taken during the same period.

(o) - Limit is in terms of dissolved copper

nil - Extremely low concentration and not detectable by existing equipment.

- - Means the standard of these substances are not considered necessary for the present time, considering the stage of the counry's development and DENR capabilities, equipment and resources

nr - Means No Recommendations made

Table 3 EFFLUENT STANDARDS : TOXIC AND OTHER DELETERIOUS SUBSTANCES

(Maximum Limits for the Protection of Public)

Parameter	Unit	Protected Waters Category I (Class AA & SA)		Protected Waters Category II (Class A,B, & SB)		Inland Waters Class C		Marine Waters Class SC		Marine Waters Class SD	
		OEI	MPI	OEI	MPI	OEI	MPI	OEI	MPI	OEI	MPI
Arsenic	mg/L	(a)	(a)	0.2	0.1	0.5	0.2	1.0	0.5	1.0	0.5
Cadium	mg/L	(a)	(a)	0.05	0.02	0.1	0.05	0.2	0.1	0.5	0.2
Chromium (hexavalent)	mg/L	(a)	(a)	0.1	0.05	0.2	0.1	0.5	0.2	1.0	0.5
Cyanide	mg/L	(a)	(a)	0.2	0.1	0.3	0.2	0.5	0.2	-	-
Lead	mg/L	(a)	(a)	0.2	0.1	0.5	0.3	0.1	0.5	-	-
Mercury (Tot.)	mg/L	(a)	(a)	.005	.005	.005	.005	.005	.005	0.05	0.01
PCS	mg/L	(a)	(a)	.003	.003	.003	0.003	.003	.003	-	-
Formaldehyde	mg/L	(a)	(a)	2.0	1.0	2.0	1.0	2.0	1.0	-	-

NOTE:

(a) Discharge of sewage and/or trade effluents are prohibited or not allowed.

Fig 1. Schenatic representation of slow sand filtration plant

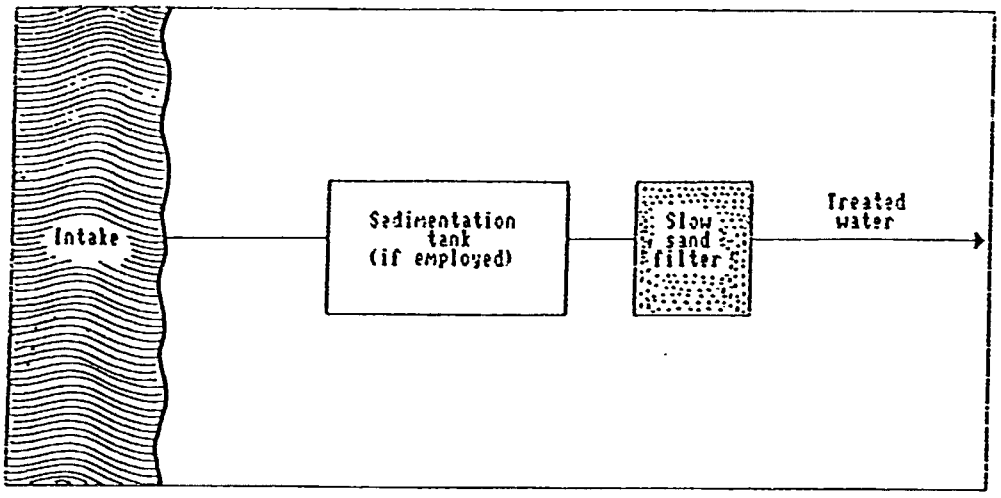
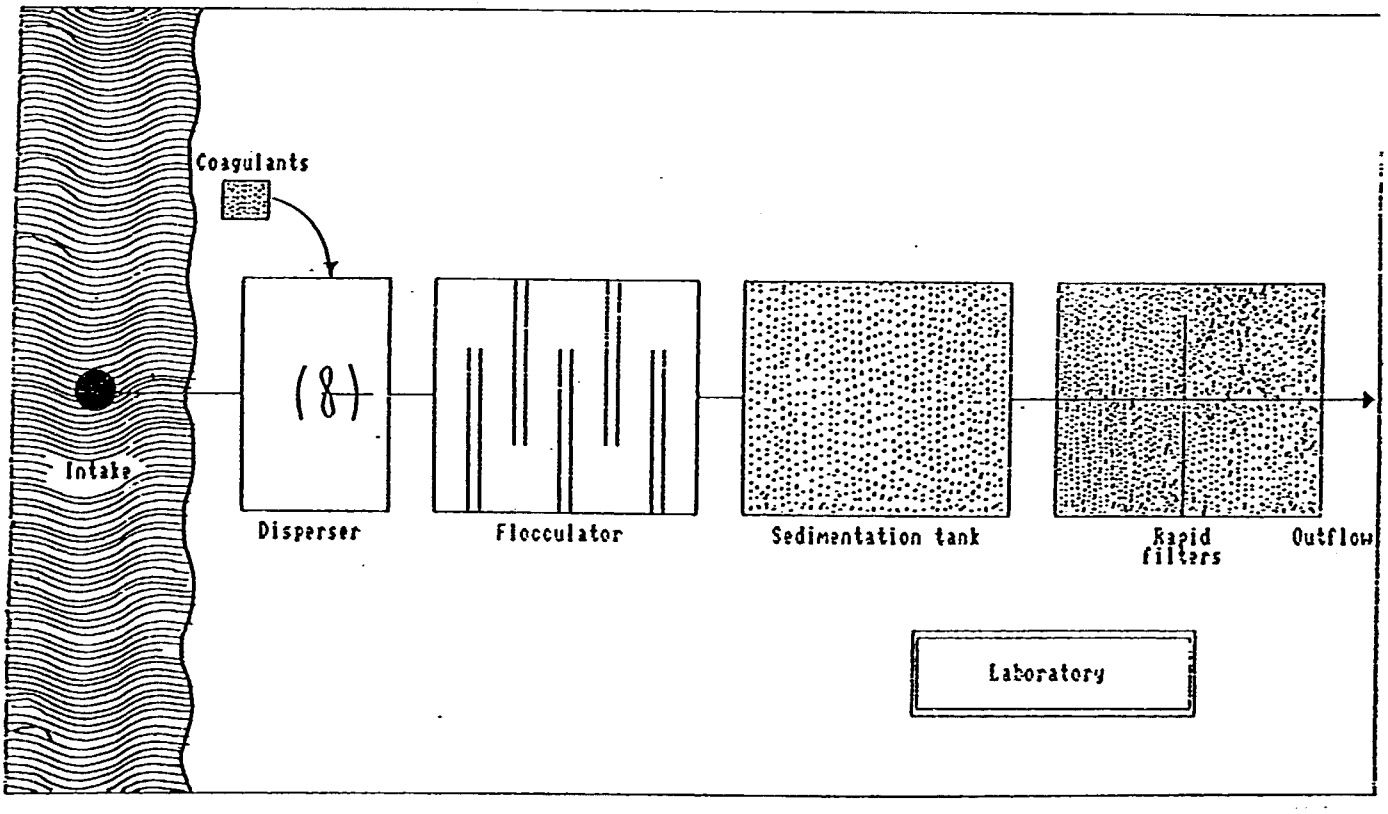


Fig. 2. Schenatic representation of a coagulation and rapid sand filtration plant



VI. Republic of Singapore

Mr. Khor Poh Hwa, Chief Civil Engineer,
Public Works Department, Ministry of National Development

Country Report for

EXECUTIVE SEMINAR ON PUBLIC WORKS RESEARCH AND DEVELOPMENT

NOV 1993

Organised by The Japan International Cooperation Agency

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COUNTRY REPORT FOR THE EXECUTIVE SEMINAR ON PUBLIC WORKS RESEARCH AND DEVELOPMENT

1 The Outline of Singapore

1.1 Description of the country

Singapore is located in South East Asia (Fig 1). It consists of the island of Singapore and some 58 islets within its territorial waters. The main island is about 42 km in length and 23 km in breadth. Including the offshore islets, the total land area of Singapore is about 633 sq km.

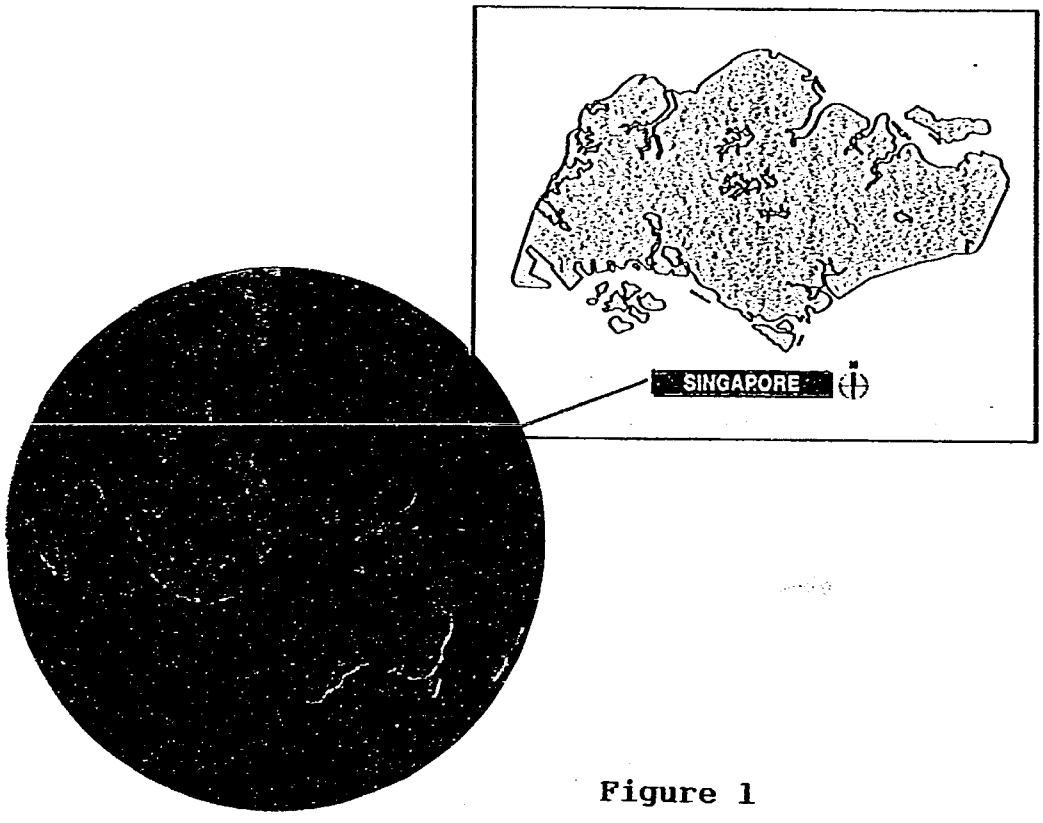


Figure 1

The main island of Singapore can roughly be divided into three regions: the central hilly region of igneous rock formation; the western region of sedimentary rocks, which form a succession of northwest-trending hills and valleys; and relatively flat eastern region of sand gravel depots. The highest peak is the Bukit Timah Hill which measures 176m situated roughly in the centre of the main Singapore island.

The land utilization is summarised in the following table.

Table I

	Area in sq km
Total land area (main island and offshore islets)	633.0
Built-up areas (including new industrial sites)	311.6
Farm holding areas (of licensed farms, excluding land occupied by pure rubber and coconut plantations)	10.8
Forest	28.6
Marsh and tidal waste	15.7
Others (inland waters, open spaces, public gardens, cemeteries, non-built-up areas in military establishments, quarries, rubber and coconut plantations, and unused land)	266.4

1.2 Climate

The main features of Singapore climate are relatively uniform temperature, high humidity and abundant rainfall due to the maritime exposure of the island and its close proximity to the Equator.

The climatological statistics are shown in Table II.

Table II Climatological Statistics

Mean daily temperature	26.7^{0}C
Mean daily maximum temperature	30.8^{0}C
Mean daily minimum temperature	23.8^{0}C
Highest maximum temperature	35.8^{0}C
Lowest minimum temperature	19.4^{0}C

Mean daily relative humidity	84.5%
Mean daily maximum relative humidity	96.3%
Mean daily minimum relative humidity	64.2%
Mean annual rainfall	2,362.8mm
Highest annual rainfall	3,452.4mm
Lowest annual rainfall	1,483.9mm
Highest rainfall in 24 hours	512.4mm

1.3 Demographics

The total population living in Singapore on Census Day, Jun 90, was 3,002,800. Of this total population, Singapore residents (citizens and permanent residents) comprised 89.6% and numbered 2,690,100. The resident population grew by an average annual rate of 1.7% during 1980-1990. The foreign population, which numbered 312,700, included foreigners who were working, studying or living in Singapore but excluded foreign tourists residing in hotels and ships' crew and passengers in Singapore waters.

The resident population comprised 2,089,400 Chinese, 388,600 Malays, 191,000 Indians and 29,200 persons of other ethnic groups. The Chinese constituted 77.7% of the population and Malays 14.1%, the Indians 7.1% and others the remaining 1.1%.

1.4 Economy and Society

From an entrepot depending on trading, the Singapore's economy has been transformed into a broad based one with Manufacturing, Financial & Business Services, Commerce and Transport & Communication forming the major sectors.

Today, the economic development strategy of Singapore has been broadened, so that promotional emphasis is placed on both manufacturing and services as the twin engines of growth. In addition, local enterprises are encourage to diversify their operations into regional growth areas, upgrade their skills and develop into strong export-orientated companies.

The 1990s will see the Asian-Pacific region grow in strategic importance to global business. Singapore aims to build on its capabilities and continue to provide a pro-business and competitive environment. The emphasis will be on partnership with international business to develop and implement global and regional strategies.

Since the starting of the industrialization programme in the 1960s, Singapore has been experiencing high growth for its economy. The Growth Domestic Product (GDP) grew at an average rate of 9.45% from 1969 to 1984. However, in 1985 the economy plunged into negative growth due largely to recession in the world economy to which the Singapore economy is closely linked.

Swift recovery was made in subsequent years due in part to the various cost cutting measures introduced by the Government and recovery in the world economy. Presently, the annual GDP is growing at a rate of about 6%. The projected growth rate for the rest of the decade is 4% - 6%.

2 Public Works System in Singapore

2.1 Master Plan for National Development

In the 1960s, the task that confronted Singapore was one of immediate urban renewal - clearing slums and revitalising the city centre so that it could support and encourage economic growth. The urgency then was on improving the living environment and to meet the housing demands of a booming post-war population. The Master Plan drawn up to chart the physical growth was modelled on traditional British planning concepts. It was not geared to the rapid development and expansion that Singapore put into effect.

A new and more flexible plan was designed in 1971 leading to the formulation of the Concept Plan. It was a long range land use and transportation plan devised to guide our new development. It did so by forming a "Ring Plan" to structure high density residential areas, industries and urban centres in a ring formation around the central catchment, linked together by a high capacity and efficient transportation network.

"Corridors" of urbanised areas stretched along the southern portion of the island with the Central Area (which encompasses the Central Business District) as the focus. With development over time, two additional corridors were added - to Tampines and to Hougang.

The existing New Towns, the airport, expressways, main roads and the MRT were shaped by the 1971 Concept Plan. However, there have been many significant social and economic changes since the formulation of the Concept Plan. From 1967 to 1988, the population had increased by 1/3. The resident population is expected to increase to about 3.7 millions by the Year 2030. Singapore economy has been steadily growing over the years. The projected rate of growth is from 4% to 6% up to the year 2000. Sufficient land and resources must be allocated to cater for such growth and new industries such as those in the high-tech and information-based fields. With economic growth, there has also been a significant growth in the per capita income of Singaporeans from S$1,600 to S$19,500 in the last 25 years.

With increasing population, affluence and continuing economic growth, there was a need to review the Concept Plan to meet the changing needs and to bring about a better quality of life to Singaporeans. A revised Concept Plan was drawn up recently taking into consideration our land supply, our ultimate holding capacity and the needs of different sectors of the community. The broad objective of the revised Concept Plan is to plan for the physical development of Singapore into a Tropical City of Excellence, an exotic island and an international hub. It will meet the objective by:

i) Safeguarding and providing land for development to meet all future needs.

ii) Encouraging sustained economic growth and co-ordinating infrastructure development.

iii) improving the quality of living and working environments.

iv) enhancing the quality of life.

v) projecting our Asian city and tropical island image.

To realise these goals, the Concept Plan will be implemented in phases to take Singapore to Year X, the year the population will reach an ultimate level of 4 million. Staging the development will enable Singapore to adapt to changing circumstances as planning is a dynamic process, ever subject to change. The Concept Plans for year 2000, year 2010 and year X are shown in Figures 2, 3 and 4 respectively.

2.2 PWD Budget for investment in construction

The Public Works Department (PWD) is responsible for developing and managing public works infrastructure such as roads, schools, airport, hospitals, polyclinics, public libraries, government office buildings, arts centre etc. The annual Budget is broadly divided into two groups: one for roads programme and the other for building programme. Based on past records, the annual development expenditures for roads programme and building programme handled by the PWD averages about S$200 million and $300 million respectively. In the next few years, the project expenditures in these two programmes are expected to rise due to several major road infrastructure and public building projects that are being planned. The projected expenditures are shown in the Figure 5.

2.3 Organisations concerned with public works

There are a number of public agencies involved with the implementation of infrastructure projects in Singapore. These agencies and their functions are listed below:

Agency	Ministry	Functions
Parks & Recreation Department	Ministry of National Development	Develop and manage public parks and open spaces
Drainage Department	Ministry of Environment	Develop and manage public drainage works; control of private drainage works
Sewerage Department	Ministry of Environment	Development and manage public sewerage projects

Port of Singapore Authority	Ministry of Communication	Develop and manage port including control of sea navigation
Mass Rapid Transit Corporation	Ministry of Communication	Develop and manage mass rapid transit system
Telecommunication Authority of Singapore	Ministry of Communication	Develop and manage telecommunication system
Public Utilities Board	Ministry of Trade and Industry	Develop and manage public utilities ie electricity, water and gas
Jurong Town Corporation	Ministry of Trade and Industry	Develop and manage industrial estates and provide related industrial facilities and infrastructure
Sentosa Development Corporation	Ministry of Trade and Industry	Develop, market and manage Sentosa as a holiday resort and manage 11 other offshore islands

2.4 History, progress and problems of the development of major infrastructure

In the following paragraphs, the roads development programme will be described.

The development of roads infrastructure forms the main stay of the work carried out by PWD. The planning and construction of roads was undertaken by PWD since colonial days when Singapore was under the rule of the British. Many roads and bridges in the city which were constructed during the colonial era are still being used now, although these roads had been improved and bridges restored.

Major roads construction programmes were undertaken by the PWD after independence to serve the new housing estates that were developed to provide cheap public housing for the growing population, and industrial

estates developed to spearhead the Republic's industrialization programme. These included the construction of new road as well as upgrading of existing roads. Many city roads were upgraded and converted to one-way streets to improve traffic flow. Road radiating from the city were widened to a minimum 3 lanes each direction and upgrading of some of the existing roads to form an inner and an outer ring road to bypass the city area was affected. In addition, flyovers and grade separated intersections were erected at critical junctions to relieve congestion.

The most important road project implemented from the late 60s onwards was the expressway network, which saw many tree-lined highways with impressive flyovers and interchanges dramatically altering Singapore's landscape and radically changing the whole concept of motor traffic. The expressway network (Figure 6) measuring 141km in length to be completed before the end of this decade, links the city, the satellite towns and industrial estates to each other with tributaries leading vehicles on and off the main expressway network. The first expressway, namely the Pan-Island Expressway (PIE) which was completed over a 13 years period (from 1969-1981) has attracted so much traffic that it is fast reaching its saturation point especially during the peak hours. Widening of the PIE is now being carried out to increase its capacity and to relieve traffic congestion. Elsewhere, upgrading of some interchanges at the intersection of these expressways is being undertaken to improve traffic flow.

The main problems encountered in road and expressway construction pertain to shortage of land, resettlement of affected people and poor soil conditions. Being a small, land scarce, densely populated and highly urbanised city state, major roads development and improvement programmes in Singapore cannot help but affect many people whose lands have to be acquired to make way for roads development. Little time is generally available for site preparation and soil improvement. This is aggravated by the fact that about 30% of Singapore's land surface is covered by soft soils which are highly compressible. As a result, roads constructed on reclaimed land and areas with poor subsoils were often faced with settlement problems during and after construction. The problem was most acute at the approaches to bridges/flyovers where the unsuspended at grade roads meet the pile supported bridges or flyovers. The PWD has carried out soil

improvement at critical sections of the roads during construction wherever time permits. Unfortunately, settlement could not be totally eliminated during the construction stage. Some residual settlement persists affecting the road riding quality and necessitating repair and resurfacing during the operation of the roads.

The shortage of land means that construction of new roads and widening of existing roads will often lead to traffic noise problem when the roads pass through or by residential estates. Current planning guidelines require a noise buffer zone of 30m to be provided between residential development and expressway. However, for existing residential estates, this requirement could not be easily met. PWD has carried out noise surveys to study the problems of traffic noise. Several solutions are available. However, it is doubtful whether these solutions are practicable and effective in Singapore context.

Currently, about 10% of the Singapore land area is taken up by road space. There is a limit to the amount of land that can be used for further expansion of road network. Underground road is being considered as the solution to the shortage of land for road construction.

2.5 Major projects in progress

As the public works authority in Singapore, the PWD is responsible for the planning and implementation of major public infrastructure projects. It has been projected that the PWD will be spending about S$5 billion on roads development projects and s$7.5 billion on building development projects within this decade. In addition, the annual expenditure on maintenance activities for road and building is estimated to increase from the current value of about S$65 million to more than S$100 million within the next five years.

Current major building programmes under implementation and in the pipeline include the following:

Project	Estimated Cost (S$ mil)
Secondary school building programme involving building 34 new secondary schools and upgrade 17 existing sec schools	873

Redevelopment of K K Hospital	277
Central Ministries Building	138
New Immigration Building	121
Institute of Health & National Dental Centre Building	168
New Parliament Complex	100
Changi Airport Terminal I Refurbishment	170
Changi Airport Terminal II Extension	300
Changi Airport Phase III	1000
Singapore Arts Centre	780
New National Library	80
New Ministry of Education HQ	180
Redevelopment of Changi Prison	645
Redevelopment of Tan Tock Seng Hospital	323
Eastern General Hospital	248
Temasek Polytechnic	340
New Woodlands Checkpoint	155
Hill Street Police Station	63

The road construction programme will not lag behind the building construction programme. The construction of the expressway network in Singapore was started in the late 60s. Presently, about 83% of the expressway network has been completed including 2.4km of underground road tunnel forming part of the Central Expressway. The whole expressway network is planned to be completed before the end of this century.

Besides the expressway construction programme, the PWD is now planning another massive road development programme involving the construction of about 90 lane-km of underground road. The Singapore Underground Road System (SURS) will be planned as a ring road system to follow the inner ring road of Singapore and cross the

water from Marina South to Marina East (see Figure 7 for the proposed alignment). It will increase the total road capacity in the Central Business District (CBD) and immediate surrounding area by about 40% as compared with the capacity of the existing main roads and it will help to relieve traffic congestion along the major road corridors and traffic intersections. The SURS will cater for traffic demands in the CBD up to the year 2030. The estimated cost of the SURS is $4 billion. It will be implemented in phases and is planned to be completed within the next 10-15 years. The feasibility study has been completed and engineering design has begun. Construction is expected to start in 1994.

In addition to the underground road system, there is also a long term plan to upgrade the present arterial roads and construct new roads to form a semi-expressway system to cater for the traffic demands in the whole island in the next century.

While new roads development programmes will further enhance Singapore's road capacity, the PWD is also actively looking into ways and means to optimise road capacity by improving the efficiency of our traffic management system. The Area Licensing Scheme (ALS) is one of the most unique and well-known measures that PWD has introduced in 1975 to control congestion in the CBD. Under the scheme, motorists will be required to pay to enter, during the morning and evening peak hours, the Restricted Zone (RZ) which covers an area of 725 hectares in the CBD. In a sense, the ALS is a form of road pricing and is operated manually. In the next few years, the ALS scheme will give way to an Electronic Road Pricing (ERP) system. The ERP is the new technology which PWD will introduce to replace the existing ALS and Weekend Car Registration Scheme. When implemented in the next few years, Singapore will have one of the most sophisticated electronic traffic management systems in the world. Eventually, the ERP will be extended to the outlying area and future regional centres. Besides ALS, the PWD has also introduced another traffic measure called the Green Link Determining System (GLIDE). The GLIDE is a computerised traffic light control system which allows for the traffic light timings to be centrally monitored and continuously adjusted to suit changing traffic conditions. The system maximises the use of the existing road capacity and ensures smooth traffic flow. The GLIDE was introduced for the CBD in 1988 and is being extended to other parts of the island.

3 Research & Development in Public Works Department

3.1 History of Public Works Department, Singapore

The history of Public Works Department (PWD) dates back to 1833 when the first Superintendent of Public Works was appointed for the island. During that time, the Straits Settlements (to which Singapore belongs) came under the control of the colonial administration of British-ruled India.

With progress and pressure from local commercial community, the British decided to create a Crown Colony in 1867 to transfer the control of the Straits Settlements directly under the Colonial Office in London. With further development, the first Public Works Department, Straits Settlements was formed in 1872. By the ends of 1930s, the PWD had grown to a size of 45 staff headed by the Director of Public Works. The headquarters was housed in Singapore.

After the Second World War, Singapore gained self-government from the British and the Public Works Department, Singapore finally came into being. The 1950s saw the PWD working had to establish the essential amenities for a growing population and thriving city.

In 1954 a new Assembly House (now the Parliament House) was renovated. The next year, Paya Lebar Airport was completed and so was a new ward built at Tan Tock Seng Hospital in 1956. It was also the year the Merdeka (Malay for 'Freedom and Independence') Bridge was completed. Independence came in May 1959, when the People's Action Party was swept into power and a new era began for PWD. With full internal self-government, the new leaders abolished local authorities like Municipality and appointed the first local Director of Public Works in November that year.

The task of nation building began in earnest and the PWD played an important role in it. The 1960s were a decade of many 'firsts'. The first library, the National Library was completed in 1960. The year of 1964 saw the first multi-storey car park, the first pedestrian overhead bridge and first pedestrian under-pass. In 1966, the first permanent television studio was completed. The first junior college came in 1968.

By the time Singapore moved into the 1970s, the political situation had stabilised. The children of baby-boomers were reaching the school age and the first school building programme was launched in 1973. The year also saw the National Stadium completed in time for the Southeast Asia Peninsular Games.

The 1970s were also years of change within the PWD. In 1972, building control function was transferred to PWD. The drainage and sewerage functions were transferred to the Ministry of Environment and the Parks and Recreation function was taken out to form a separate Department. By that time, important foundation has already been laid to make Singapore a garden city.

Cruising into 1980s, the PWD went into high gear and the fast lane to keep up with an affluent car-loving population. Although more roads were built and existing ones expanded, the 1980s were really the decade of the Expressway, with the Pan-Island Expressway, the East Coast Parkway and Benjamin Sheares Bridge ready in 1981. In 1985, the Bukit Timah Expressway joined the network, followed by the Ayer Rajah Expressway in 1988. The Central Expressway (CTE) tunnel system was opened in Sep 1991, taking Singaporeans into a new era of road travel.

1980s also saw the completion and opening of Phase I of Changi Airport in 1981. The second runway was completed in 1984 and by 1991, the Changi Airport Terminal 2 went operational only ten years after Terminal I.

In the coming decades, the PWD will embark on more challenging undertakings and build Singapore into a tropical city of excellence.

3.2 Organisation chart

The PWD is headed by the Director-General of Public Works assisted by a Deputy Director-General. The Department is made up of five divisions, each of which is headed by a director. The five divisions and their function are as follows:

i) Corporate Service Division - provide financial, personnel, administration, public relation and computerisation services for the Department.

ii) Building Control Division - Regulate private

building works to ensure building safety; ensure private buildings are well-maintained by their owners; safeguard the interest of private house buyers.

iii) Specialist Services Division - Planning, design and supervision of construction of government buildings including schools, junior colleges, fire stations, prisons, office buildings etc.

iv) Development & Management Services Division - consultancy business development which includes project development services, project management services, property estate management services.

v) Roads & Transportation Division - Planning, Design, construction and maintenance of public roads, flyovers, bridges and pedestrian walkways; maximising the use of road network and implementation of road safety measures. administration of car parking policies.

The organisation chart of the PWD is shown in Figure 8. The PWD has a staff strength of about 1500 officers of which 20% are professional staff.

3.3 Budget

As a government department, the budget for the operation of PWD is fully provided by the Government. The annual budget is divided mainly into two components ie current expenditure and development expenditure. The current expenditure consists mainly of the manpower cost and other operating expenditure such as utilities, office stationery, travel expenses, office equipment purchase & maintenance, maintenance of government buildings and roads etc. The development expenditure comprises of annual development budgets for roads construction and building construction.

In Financial Year 93 (from 1 Apr 93 to 31 Mar 94), PWD's annual budgets for various items of expenditure are as follows:

Item	Annual Expenditure (S$ million)
Manpower Cost	70

Item	Annual Expenditure (S$ million)
Other operating expenditure (including maintenance of government buildings and roads)	117
Roads development	384

3.4 Major research facilities

Because of shortage of manpower, no full-time research unit is set up in PWD to carry out research work. Traditionally in PWD, the PWD Engineering Laboratory has been playing a leading role in conducting research & development work in PWD. The PWD Engineering Laboratory also provides day-to-day quality control testing for construction materials such as soil, concrete, steel, road pavement materials etc. It is the oldest and also one of the largest civil engineering material testing laboratory in Singapore. In more recent years the various specialist offices in the Specialist Services Division of PWD have undertaken more and more applied R&D projects to enhance their skills and knowledge in their own specialised areas.

A number of organisation in Singapore are involved in R&D activities. The two universities in Singapore namely, the National University of Singapore (NUS) and the Nanyang Technological University (NTU) possess good laboratory facilities and qualified staff to carry out building and civil engineering related R&D work. The PWD has been collaborating with both the NUS and NTU in jointly conducting R&D projects. These joint R&D collaboration not only provide opportunities for PWD to tap the good research facilities in the universities but also enable PWD's engineer to share their practical experience and problems with the academics from the universities. Through these tertiary institutions, the PWD has recently extended its research collaboration with foreign institutions such as Tokyo Institute of Technology and others.

4 Major research and development project in PWD

4.1 Names of research & development projects

Recently completed R&D projects included the following:

i) Study on the feasibilities of creating underground caverns in the Bukit Timah Granite Rock for various uses

This was a joint study between PWD and the Nanyang Technological University (NTU) aimed at investigating the feasibility and potential of constructing underground spaces in the Bukit Timah Granite Rock body for various uses. Due to shortage of land in Singapore, there is a need to make use of underground spaces. The project was commissioned to explore the potential of Bukit Timah Granite Rock in central and northern Singapore for this purpose.

This project is funded by the government with a budget of S$1.5 million. The project commenced in Jan 89 and completed in 1993.

ii) Community noise study of Singapore with specific reference to the preparation of planning and design guides

This was a joint project between PWD and National University of Singapore (NUS). The aim was to survey the noise problems in various building types so as to evaluate the response of Singaporeans to acoustical environment and determine the noise criteria for the various building types. The study covered buildings like schools, hospitals, office buildings, hotels & libraries and places of public resort.

The project commenced on Oct 89 and was completed in 1993 at a cost of S$310,000/-.

iii) A scientific study of building defects

This was another joint study between the PWD and NUS. The project aimed at a comprehensive survey and development of a knowledge base for building defects and the study of factors causing cracking and deterioration of reinforced concrete in Singapore.

The project commenced on Jun 92 and was also completed in 1993. The cost was S$410,000/-.

iv) Survey on Traffic Loadings in Singapore

This was a joint study undertaken by PWD and NUS

Centre for Transportation Research. The aim was to study the characteristics of traffic loadings on Singapore roads. Hitherto, road design in Singapore is based on design criteria established in foreign countries, notably U.K. The project would provide information on the levels of traffic loading which are useful for road planning and design.

The project started in Dec 91 and was completed in 1993. Its total budget was S$915,000/-.

4.2 Research and Development in progress

Currently PWD is conducting a number of R&D projects. These are highlighted as follows:

i) Sumatran Earthquake Effect on Singapore Buildings with special reference to High Rise Buildings

This is a joint research project with NTU.

The known active fault zone nearest to Singapore is the Sumatra Fault located approximately 400 km away. In the Mexican earthquake disaster (Magnitude 8.1, 19 September 1985) the greatest concentration of structural damages occurred in the clay deposits of the lakebed region in Mexico City which was located approximately 400 km from the epicentre. This demonstrates the damaging effect of locally amplified ground motions resulting from a distant network.

In Singapore about 30% of land area is covered by soft soil and it is possible that these thick soft soil deposits could likewise amplify bedrock motions generated by distant earthquakes to a degree which could be damaging to our buildings.

The joint research would evaluate the effects of seismic wave originating from a design Sumatran earthquake on Singapore buildings with special reference to high-rise buildings. The project includes earthquake data acquisition for analysis and establishing the design earthquake for structural evaluation of 2 commercial buildings and 2 residential apartment blocks.

The research project will be carried out over a

period of 3 years at an estimated cost of S$820,000/-.

ii) Interaction of Excavation and Support System with nearby structures

The project is a joint research with NUS which commenced in January 1993 and is expected to be completed in January 1995. The estimated cost is S$200,000/-.

The PWD has in recent years carried out the design and construction of many deep basement projects. Many more are in the pipe line. One of the major considerations in basement works is the support system for excavation which should resist damage to surrounding buildings and premises. There are presently no design guidelines on this aspect of civil engineering works. The objective of this project is therefore to develop a correctly calibrated numerical code and design guide using an appropriate constitutive model based on local soils. The code will assist the engineers to accurately determine the displacement and deformation in adjacent ground of deep excavation work and arrive at the most economical design. The methodology involved the use of centrifuge tests and finite element modelling technique. Recently Tokyo Institute of Technology became a partner in this research collaboration.

iii) Study on blast pressure through accessways louvres and expansion chambers; and shock analysis and design requirement for shelters

The project started in July 1991 and is expected to be completed in June 1994. The project as its title suggests is related to the design of the Civil Defence Shelters and is carried out to resolve technical issues and aims at achieving the following objectives:

i) to establish a methodology for predicting the blast pressure propagation along accessways for the design of the passageway and the blast doors

ii) to determine the effectiveness of various arrangements of blast louvres and expansion chambers, and

iii) to formulate design requirements for the protection of people and vital equipment in Civil Defence Shelters.

The work is focused on the development of software that would improve analysis and design in the respective areas. The cost of the research is S$461,000/-.

4.3 Problems in promoting research and development

The following problems have been encountered in the promotion of R&D activities in building & civil engineering in Singapore.

i) Lack of manpower

There is a general lack of personnel trained in conducting R&D work in building and civil engineering. This is especially so in a tight labour market situation currently experienced in Singapore due to the booming construction industry. Most of the building & civil engineering professionals in Singapore are engaged in planning, design and construction of new projects and maintenance of existing building infrastructure. There are difficulties in attracting good personnel to conduct R&D work in building & civil engineering. This explains the high turn over in research staff for several joint research projects undertaken by PWD and local universities.

ii) Lack of research facilities

Singapore is a small country with a modest local construction market. This constraint places a limit on the size of local construction companies. Most local construction companies, except a few larger ones, do not have the technical capability and financial capacity to carry out R&D work. The cyclical boom and bust nature of the construction industry also does not encourage local construction companies to make long term planning and commitment on research & development. As a result, R&D work in building & civil engineering is mainly carried out by large state organisations and the academic institutions.

iii) Presently, most of the R&D activities supported by the Government are channelled through the National Science and Technology Board (NSTB) which was a statutory body set up by the Government to promote R&D work in Singapore. Up to now, the emphasis of the NSTB is on promoting R&D activities which will increase the competitiveness of the high-tech, manufacturing and service industries. The construction industry is lower down in priority because of its limited export potential and smaller contribution to the economy. There is therefore greater difficulty in securing government funding support for building and civil engineering related R&D activities as compared with other industries.

5 Internation research programmes

5.1 Present situation

The PWD has been involved in a few international research exchange programmes in the last few years. These are:

i) Japan-Asean Cooperation Programme on Materials Science and Technology

The Singapore project under this programme was on the prevention of corrosion in structures. The direct participation organisations in this Singapore project were JICA, Ministry of Construction of Japan, Ministry of Transport of Japan, Singapore Science Council, Housing Development Board, Port of Singapore Authority, National University of Singapore and Singapore Institute of Standards and Industrial Research. The PWD was not directly involved in the project. However, PWD has been involved in discussions and seminars organised for the project.

The Singapore project was started in Aug 87. It covered the study of corrosion prevention in drinking water storage tanks and corrosion prevention in concrete structures at port and harbour. The project was completed in 1190 and a seminar was held in Sep 90 at Singapore to present the results of various joint Japan-Asean R&D projects carried out. For the Singapore

project on the study of Prevention of Corrosion in Port and Harbour Structures, it was decided that the technical cooperation be extended for another two years (from Sep 90) to continue the research activities and finalise the manuals for corrosion prevention.

iii) Coordinating Committee on Offshore Propecting (CCOP) programme

Singapore is a member of CCOP. It was previously represented by PWD. However, for administrative reason, the representation was transferred to the Economic Development Board (EDB). Although, Singapore is now represented by EDB in the CCOP, the PWD continues to play an active role in CCOP activities in advising EDB and participating in the training programmes and activities organised by the CCOP. Between 23 Jul and 4 Aug 90, CCOP organised a workshop on "Introductory Training on Land and Marine Engineering and Environmental Geophysical Techniques" in Singapore and the workshop was hosted by PWD. PWD's officers had also participated in workshops organised by CCOP in Hawaii and China in 1991. Presently, PWD provided some limestone core samples retrieved in one of the deep borehole sunk in western part of Singapore for petrological and palaeotological analyses by experts from the CCOP.

iii) International Atomic Energy Agency (IAEA)

The PWD has also participated in some discussions and training programmes organised by the IAEA. Singapore was represented by the Singapore Science Council (now National Science and Technology Board) in the IAEA activities. So far, PWD has not been directly involved in any project on the application of radioactivity in civil engineering. However, PWD has together with the Singapore Science Council discussed with Japanese experts from IAEA on the possibility of applying radioactive techniques in civil engineering construction. PWD's officers had also participated in workshop on "Non-Metallic Materials" organised by UNDP/IAEA/RCA in Japan.

5.2 Problems in Promotion

The shortage of manpower is a constraint not only to

promotion of R&D within the PWD but also to the promotion of international R&D research exchange programmes. The current exchange programmes are concentrated more on training and development. For instance, PWD regularly sends its professionals to overseas for academic courses, practical training and study visits through various programmes such as the JICA Group Training Scheme, Colombo Plan Scholarship, Commonwealth Scholarship etc. In return, PWD is also providing training schemes for applicants from its counterparts in ASEAN under the Colombo Plan Training Scheme.

The are a number of agencies in Singapore conducting building & civil engineering related R&D work. Overseas organisations intending to collaborate with Singapore on R&D work may encounter some difficulties in approaching and choosing the right agency.

6 Activities concerning "Disasters and Disaster Prevention"

6.1 Present situation and problems in Singapore

Natural disasters that have wreaked havoc and brought destruction to civilization include earthquakes, floods, cyclones, drought, landslides etc. Singapore lies at the fringe of one of the most active seismic belts in the world. The nearest distance from Singapore to the Sumatran Fault Zone is about 400 km. Although at this distance the earthquake effects are generally negligible, there had been unique cases in the past where major damages had been inflicted on other cities situated at about 400 km from the epicentre of major earthquakes. The most recent example is the magnitude 8.1 Mexican earthquake which occurred on 19 Sep 85 at an epicentre about 400 km west-southwest of the Mexico City. The earthquake caused extensive damage in the centre of the city area, primarily to modern buildings 6 to 20 storeys high. The destructive effects of the earthquake were due mainly to the long period effect and soil amplification.

So far, Singapore has not been struck by any major tremor in memory. However, minor tremors had been felt time and again in Singapore. These minor tremors were mainly due to long period waves generated by distant earthquakes. Because of the long distance, the intensity of the seismic waves reaching Singapore is usually

very low. However, these low intensity waves could still be amplified by the soft foundation soils and building structures through resonance effect. Resonance effects are most pronounced on tall buildings and these effects are generally called long-period effects.

Other natural hazards faced by Singapore include floods and landslides. The incidence of drought and cyclone in Singapore is rare or practically nil. Flooding problems in Singapore have diminished with the completion of major drainage schemes in recent years although minor and localised flooding still occur during the Northeast Monsoon period. Singapore drainage system is still being further improved.

Landslides in Singapore are often induced by heavy rain. They normally occur in steep cut or filled slopes and natural hill slopes. However, as Singapore is generally low lying and less hilly as compared to other countries such as Malaysia, Hong Kong, Japan etc, the scale of landslide problems in Singapore is considered to be minor when compared with other countries. Nonetheless, fairly large landslides had occurred in the past. However, the risk caused by landslide is considered low and no casualty due to landslides has been reported so far.

6.2 Activities concerned with prevention of natural disasters

As described in para 6.1, Singapore is fortunate to be spared of major natural disasters that have brought untold damages and casualties to other disaster prone countries. Nevertheless, the authorities in Singapore are not complacent of Singapore's fortunate position.

Although Singapore has not been affected by major earthquakes, the Building Authority is concerned about the possible damages caused by long period effects especially if magnitude 8 and above earthquakes occur along the Sumatran Fault in the future. The PWD is proposing to carry out a study on earthquake effects on high rise buildings in collaboration with the Nanyang Technological University.

The Government is also devoting more funds for the improvement of country's drainage system to further minimise the flooding problems.

The Government has also formulated and implemented an emergency plan to deal with both natural and man-made disasters. Training and exercise are being conducted to prepare the people against disasters.

6.3 Technical tasks required for disaster prevention

As mentioned earlier, the PWD & NTU are contemplating to investigate into earthquake risk in Singapore with particular reference to long period effects on tall buildings. The aim is to determine possible earthquake risk and the resistance of existing buildings against earthquake forces and to recommend design criteria against earthquake.

PWD is also considering introducing more stringent building control measures to minimise the risk and occurrence of landslides.

7 Activities concerning "Harmony between Environment and improvement of Infrastructure"

7.1 Summary

Singapore has developed a Green Plan in 1992 which charts the strategic directions that Singapore will adopt to achieve the principle of balancing development and environment. The thrust of the Green Plan is to cultivate an environmentally conscious population, promote conservation and clean technology and increase the efforts in protecting the local and global environment. Based on the charted strategic directions, action programmes have been generated and are being implemented.

The action programmes cover solid waste management, waste water management, drainage schemes and waterbodies, environmental management and protection, nature conservation, hazardous substances management, environmental education, environmental technology etc.

The long term goal of the Green Plan is to develop Singapore into a model Green City within the context of a sustainable social and economic development.

7.2 Present situation and problems in Singapore

For the past 30 years Singapore has developed a comprehensive and efficient infrastructure to manage

and protect the environment. The need for environmental protection has never been overlooked despite other pressing demands for national funds. There are however issues to be tackled:

a) solid waste management

The present level of refuse collection is about 2.2 million tonnes a year. The per capita domestic waste generated is about 1.1 kg per day.

The daily refuse collection service is reliable but it is still largely a manual collection system which is very low-skilled and labour intensive.

Due to the limited size of Singapore, and the great competitive demand for land for other purpose, there is limited land available for sanitary landfill and disposal of non-incinerable wastes and incineration ash. By 1997 the present landfill sites will be exhausted.

b) waste water management

All waste water is treated before discharge into sea or at river mouths. The volume of sewage treated has increased from 250 million cubic metres in 1985 to about 350 million in 1992 and is expected to reach 475 million in year 2000.

At present a S$2 billion sewerage reticulation system comprising about 2250 km of sewers and 6 sewage treatment works are in place. The 6 sewage treatment works are of open designs and the treatment units are laid out over large areas of land. While concentrated sources of odour have been contained, fugitive emissions still present odour problems.

c) industrial sources of air pollution

Emissions from industries and power generation plants are major sources of air pollution. These installations are equipped with flue gas cleaning equipment to comply with emission standards. Today all levels of pollutants in our ambient air are within World Health Organisation and US Environmental Protection Agency standards. With continued growth in the industrial and economic sectors the amount of fuel used will be increased

correspondingly. Emissions of sulphur dioxide, nitrogen oxides, carbon dioxide and particulate will also increase.

d) environmental impact for reclamation

Singapore has reclaimed about 6,500 hectares of land from coastal areas in the past. Reclamation of some 2,100 hectares of land will be carried out by year 2000 and another 5,300 hectares after that. For reclamation projects that have been undertaken previously, environment impact assessments have been conducted in one form or another, but these are confined mainly to hydraulic model studies and assessment of changes in water quality. There is a need for more vigorous assessment of other impacts on coral reefs, mangrove areas and marine lives.

7.3 Activities on environmental improvement

Some of the activities are summarised as follows:

i) study of offshore landfill site for disposal of non-incinerable wastes and incineration ash

ii) all sewage treatment works will be upgraded with compact and covered designs in phases over a 40 year period form 1993 so that odorous gases will be contained

iii) solid waste generated to be reduced from the current 1.1 kg per capita per day to 0.9 kg by year 2010 by having a less wasteful society and encouraging waste minimisation through reduction, reuse and recycling

iv) open drains and canals will be modified and upgraded to aesthetically pleasing waterways to allow for recreational activities in some of the larger streams.

v) Pollution monitoring will be automated and updated and by 1995 allometry systems for air monitoring will be in place.

vi) secondary treated effluent will not be discharged into coastal areas by year 2010.

7.4 Activities for infrastructure development taking account of the global environment and the living environment

i) Unleaded petrol was introduced in January 1991. In February 1991, a financial incentive was introduced which made unleaded petrol cheaper than regular petrol. By March 1991 50% of motorists whose vehicle can use unleaded petrol switched to unleaded petrol. The percentage is increasing. From July 1991 all new cars imported must be able to run on unleaded petrol.

ii) Controlled CFC aid Halons used in fire extinguishers, fire-fighting equipment and refrigerators will be phased out by 1998. To reduce CFC consumption, the import and manufacture of non-pharmaceutical aerosols and polystyrene sheets/products containing CFCs have been banned since February 1991.

iii) At present, some 2,000 hectares or about 3% of land are set aside for nature reserves. In the longer term, 5% of the land, after reclamation to the full, will be set aside for nature conservation to promote appreciation of nature and interest in the country's natural resources.

8 Proposals for further discussion

As PWD will be embarking on a massive construction of an underground road system within the highly developed urban city area, the Department is particularly concerned with the impact of road tunnel construction on adjoining properties. The impact will include noise and vibration generated during the construction, ground movement caused by the excavation works, noise and air pollution at tunnel portals during the operation of the tunnels.

About 7,600 hectares of land will be reclaimed from the sea. We are also proposing to create an offshore landfill site for disposal of non-incinerable wastes and incineration ash. In these reclamation projects and development of the offshore site for waste disposal, we are concerned with the environment impacts and want to ensure that due consideration will be given and all necessary engineering measures taken to protect the ecosystem and the environment.

Because of shortage of land, Singapore will have to

seriously look into the possibility of making more use of the underground space. Besides the utilization of underground space in the city area which is generally underlain by soft soils, the sound granite rock in the Bukit Timah area also shows a high potential for the creation of underground space for a variety of uses.

With the above background, I wish to propose the following topics for further discussions with the relevant Japanese experts.

i) Construction of road tunnels using cut and cover methods as well as bored tunnelling methods.

ii) Effects of construction for road tunnels in soft ground on adjoining structures such as MRT tunnels, building foundations, services etc and their prediction.

iii) Underpinning of structures affected by adjoining deep excavation work in soft ground.

iv) Environment impact assessment of land reclamation from coastal areas in particular to marine life and plant life.

v) Underground space development technology and policy.

Year 2000 Plan.

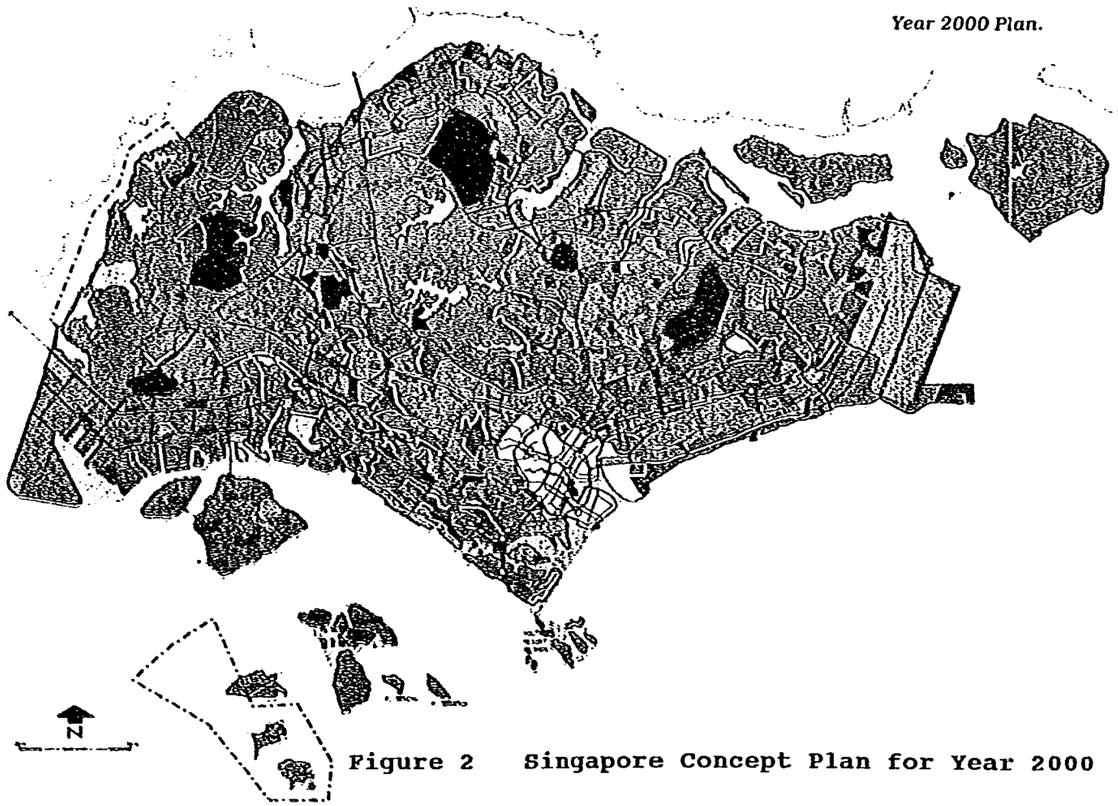


Figure 2 Singapore Concept Plan for Year 2000

Year 2010 Plan.

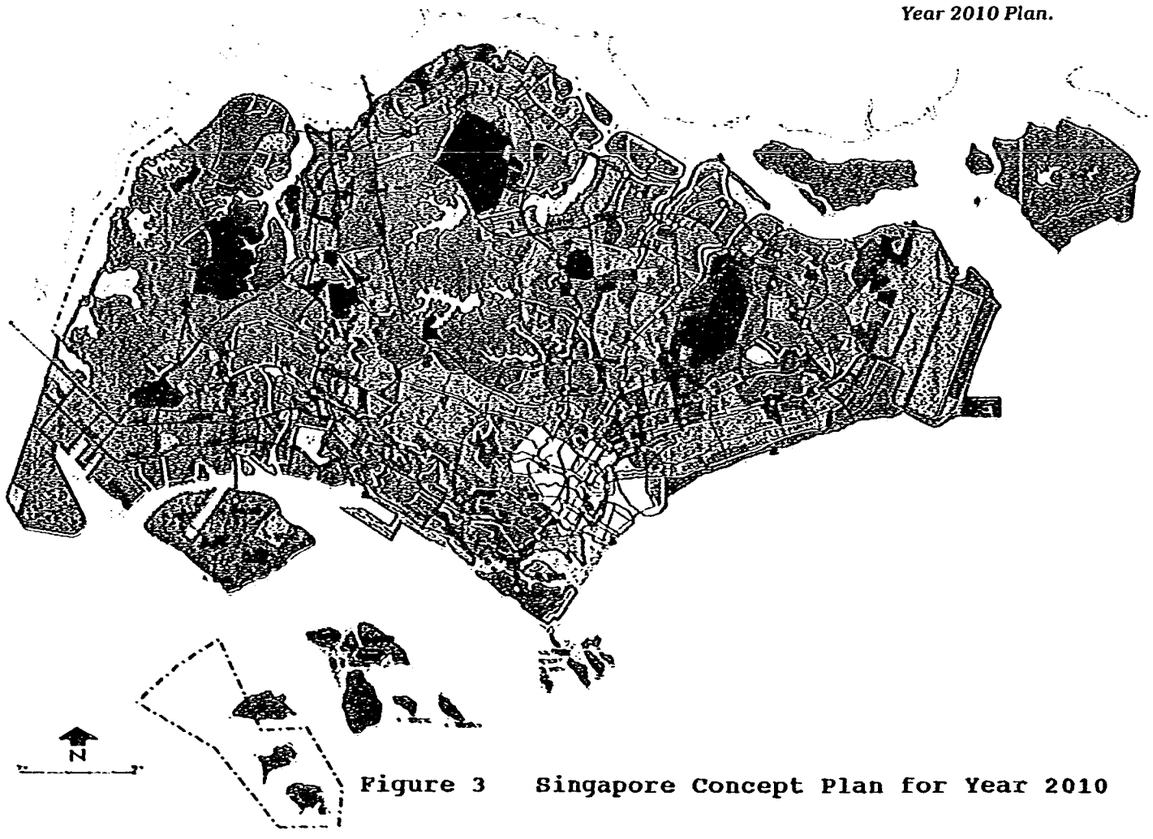


Figure 3 Singapore Concept Plan for Year 2010

LEGEND

- HIGH DENSITY HOUSING
- LOW / MEDIUM DENSITY HOUSING
- COMMERCIAL
- INDUSTRY
- BUSINESS PARK
- AGRICULTURE
- OPEN SPACE / RECREATION
- INFRASTRUCTURE
- INSTITUTION
- SPECIAL USE
- LIVE FIRING AREA
- CENTRAL AREA
- MRT
- LRT
- SPECIAL PEOPLE MOVER
- MRT / LRT STATION
- FERRY LANDING POINT (LOCAL SERVICE)
- FERRY LANDING POINT (INTERNATIONAL SERVICE)

These plans are part of the vision of Singapore's future. But the timing of developments depends on demand.

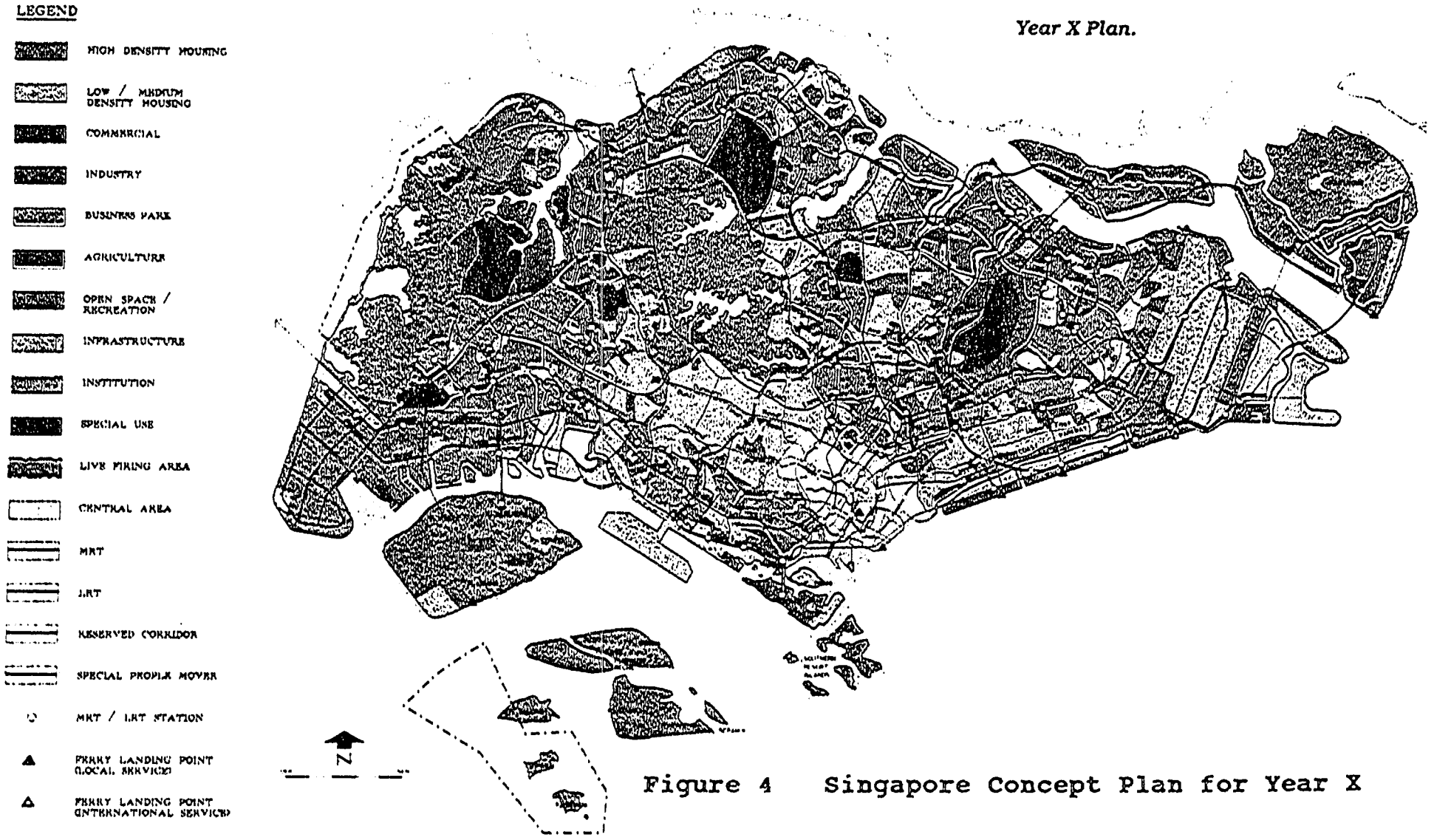
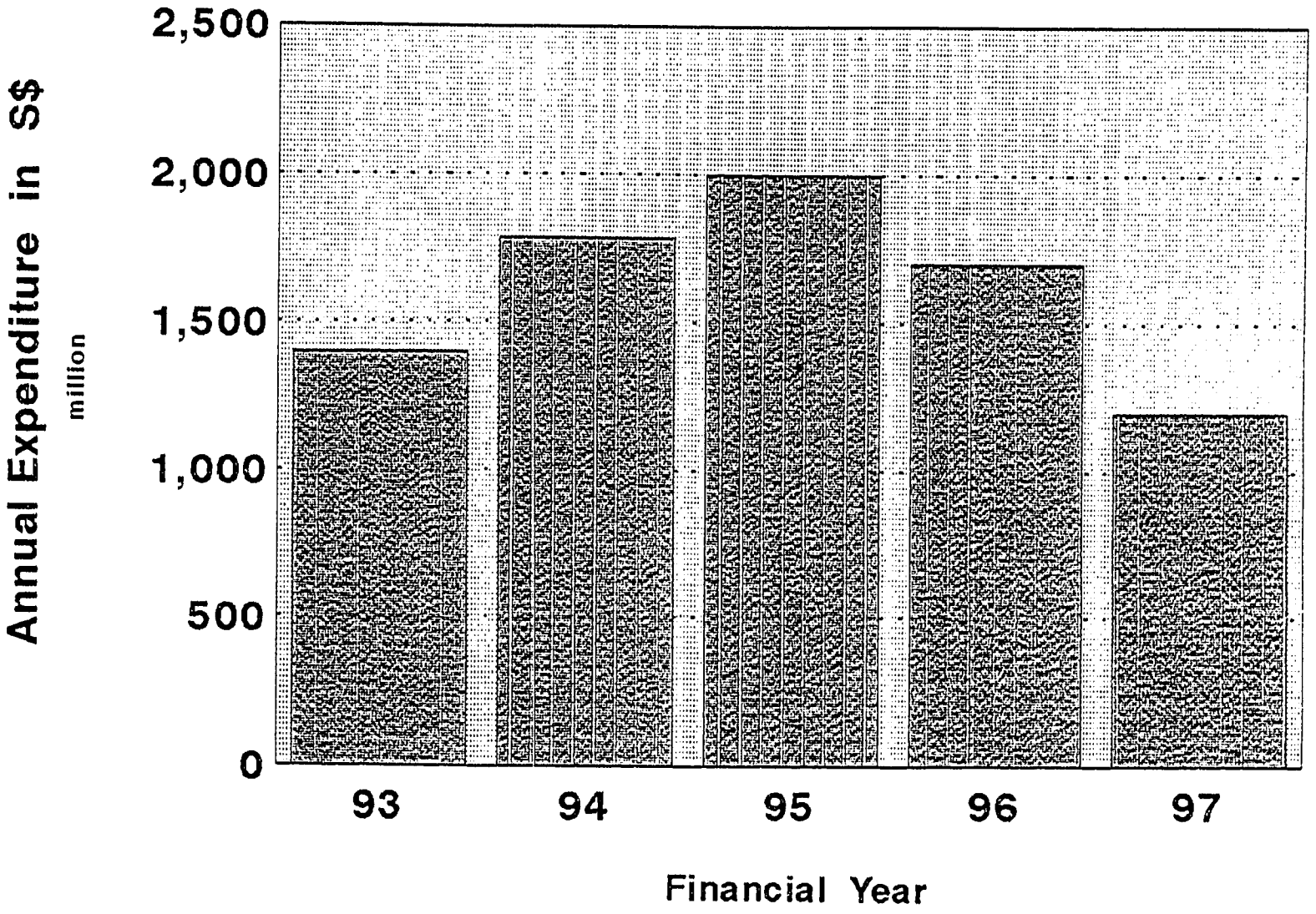


Figure 4 Singapore Concept Plan for Year X

Figure 5 Projected Total Budget



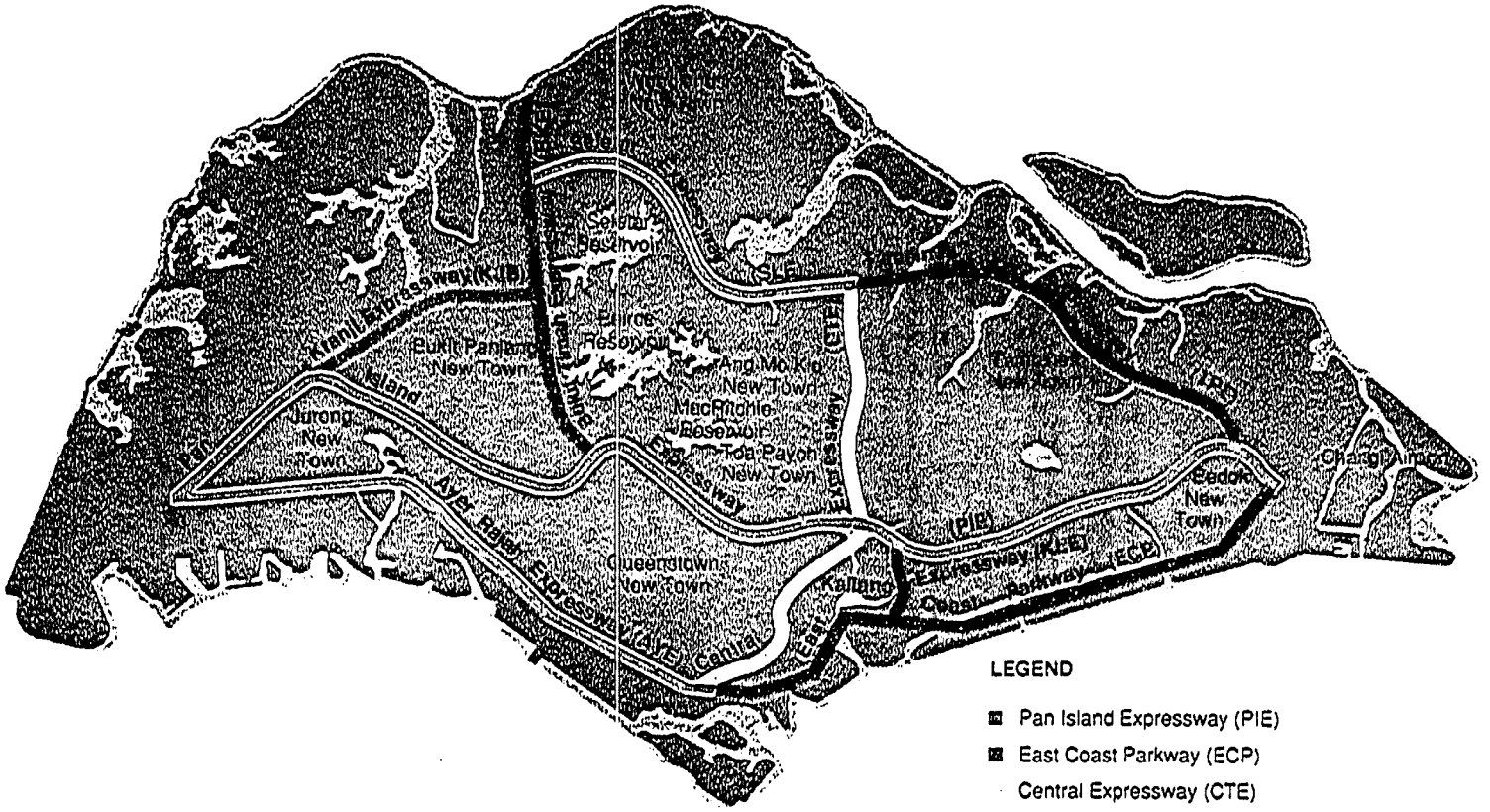


Figure 6 Singapore Expressway Network

By the end of the 1990s nine expressways will cross the island

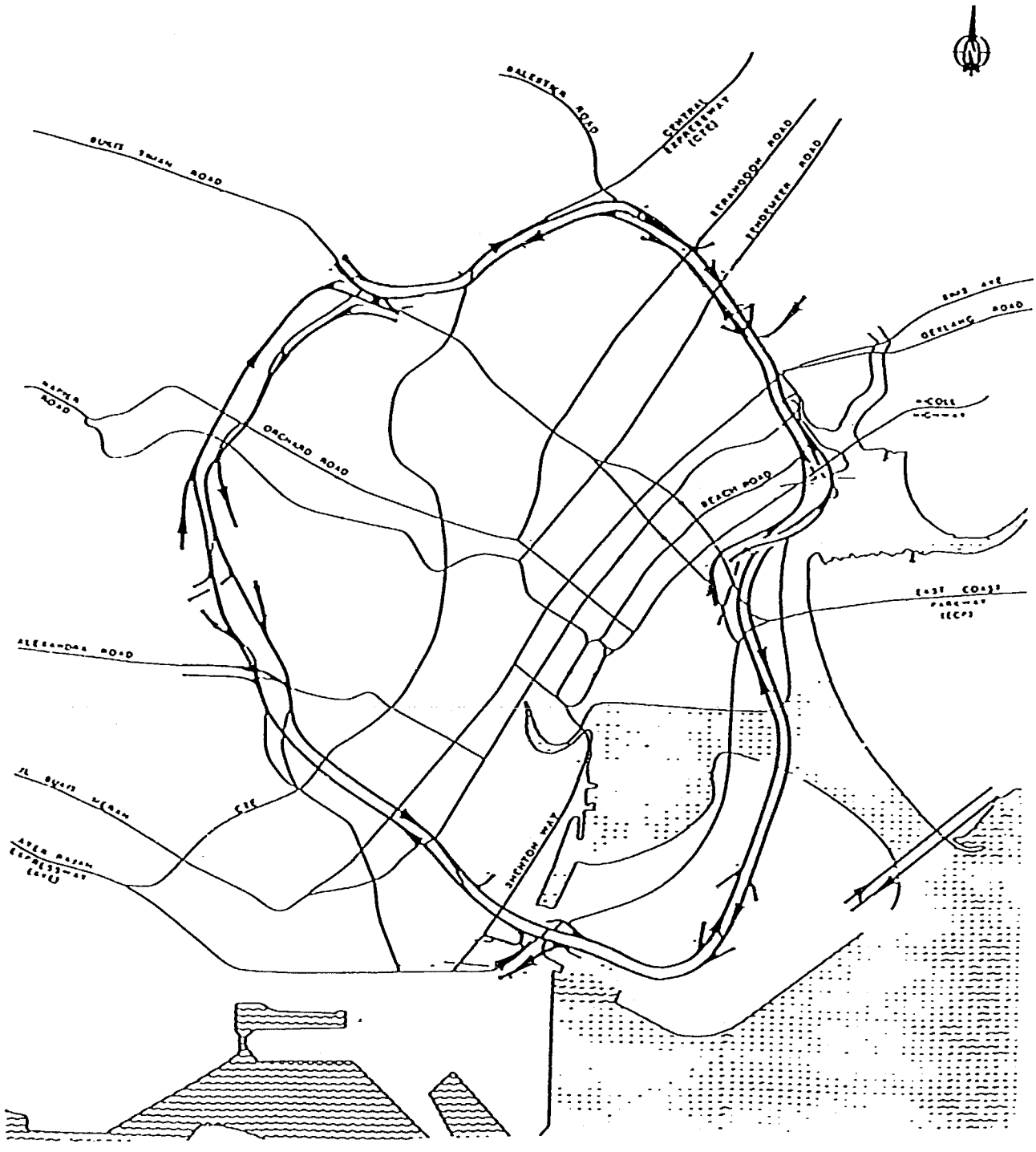


Figure 7 Proposed Singapore Underground Road System (SURS)

ORGANISATION STRUCTURE OF THE PUBLIC WORKS DEPARTMENT

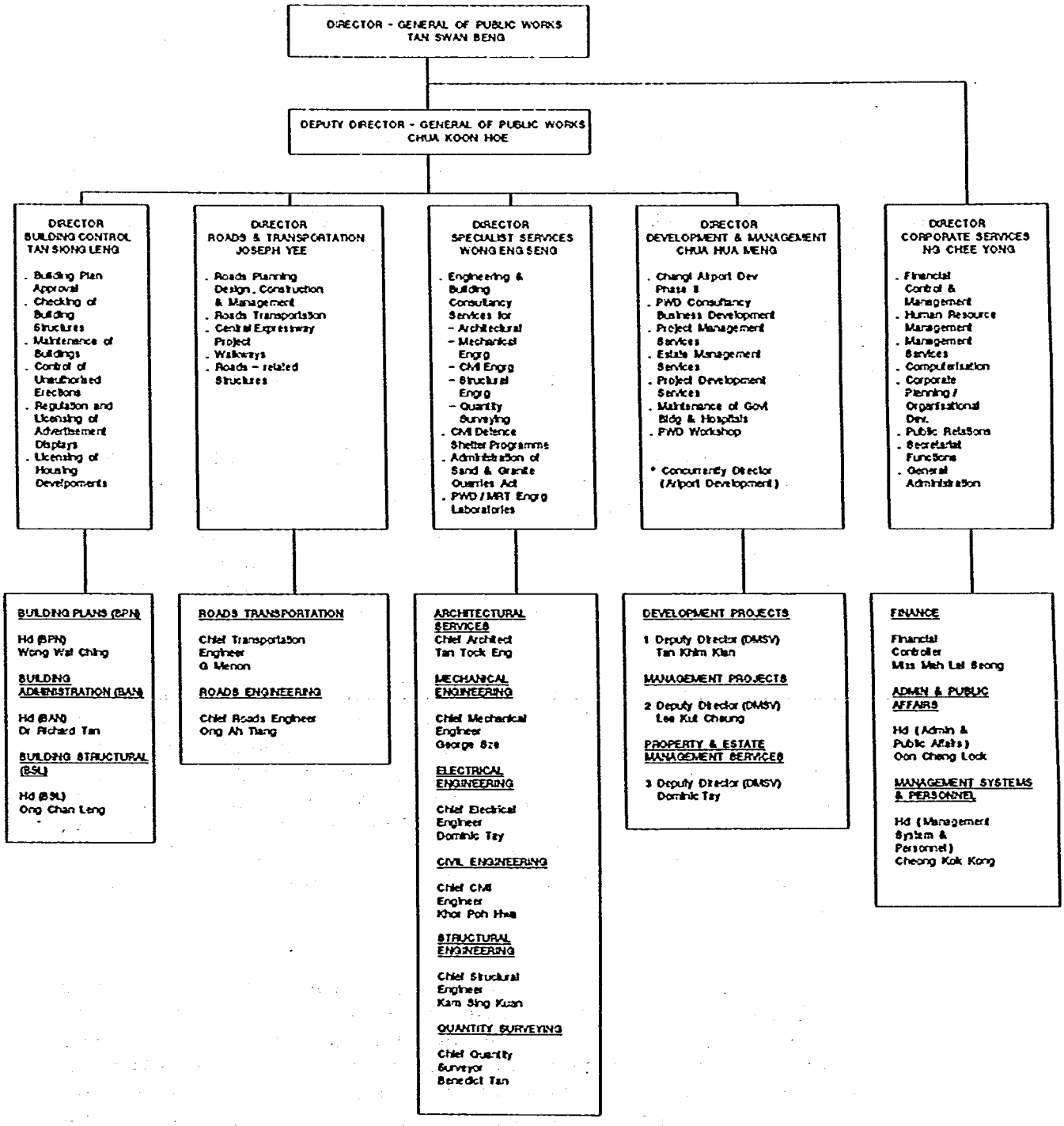


Figure 8 Organisation Chart of Public Works Department, Singapore

Appendix

Countermeasures against Air Pollution and Noise caused by Road Traffic in Singapore

1 Introduction

Adverse effects of road traffic in terms of air pollution and noise are ameliorated in many ways in Singapore. The measures range from controls at the sources, urban planning and development control and building designs to low noise road surfaces, noise barriers and road tunnels.

2 Air pollution

Vehicular emission is a major source of air pollution.

2.1 Emission standards of vehicles, including oxides of nitrogen, hydrocarbon, carbon monoxide and smoke shall be tightened to be within advanced countries' standard such as that of Japan and EC. Vehicles will be subject to more stringent emission inspections to ensure that they are maintained properly and that they comply with emission standards.

2.2 Unleaded petrol was introduced in Singapore in January 1991. In February 1991, a financial incentive was introduced which made unleaded petrol cheaper than regular petrol. From July 1991 all new cars imported into Singapore must be able to run on unleaded petrol. The availability of unleaded petrol paves the way for stricter emission standards which can be complied with through the use of catalytic converter.

2.3 Transport Policy encourages the use of more efficient transport system such as MRT and buses to reduce the overall emissions of vitiated air. Tunnels are constructed to contain air pollution while at the same time provide capacity to cater for increased traffic demand. The MRT system will be extended to serve a greater population. Light Rail Systems are being considered for implementa-tion. Cycling tracks to link MRT and bus stations and neighbouring centres to nearby residential areas are being planned. As soon as the technology is commercially available, electric cars will be encouraged as they are clean, quiet and do not consume energy at idling.

3 Traffic noise

Traffic noise is mitigated in Singapore by the following methods:

3.1 Control at the source

This refers to the control of the emission of noise from individual vehicles. This is regarded as the best solution against noise problem. Singapore's present standards are way off from those adopted in countries like EC, and the standards would be reviewed.

3.2 Urban planning and development control

This refers to locating noise-tolerant uses such as play fields and parks, car parks, light industry, warehousing etc adjacent to main roads and expressways. Residential buildings are set-back from the main roads and expressways. This method of noise control is mainly suitable for new or re-developed urban areas.

3.3 Low noise road surfaces

Porous asphalt is being tried out in Singapore and found to be quite effective in reducing noise. The other main objective of using porous asphalt in Singapore is to provide drainage of water away from the road surface to improve further the safety of road users during wet weather. Fig 1 shows the effects of porous asphalt.

3.4 Noise barriers

Noise barriers are used only in special situations in Singapore because they are considered as ugly and ineffective in a high rise environment.

3.5 Tunnels or depressed roads

Tunnels or depressed roads are being used increasingly in urban areas in Singapore as one of

its main advantages is the reduction of noise. The increase in noise level at the portals can be adequately treated by means of planting barriers.

3.6 judicious transportation improvement to, planning, design and management of roads such as

3.6.1 speed limit of 80 kph along expressways is maintained compared to other countries with speed limit of 110 kph; this speed limits is consistently capped despite pressures to relax it;

3.6.2 area licensing scheme in Central Business District Area which accounts for almost half of the "day-time" hours;

3.6.3 restrictions of heavy goods vehicles in city and residential areas;

3.6.4 traffic calming measures eg use of road humps and cul-de-sac;

3.6.5 small schemes in discouraging car usage eg provision of bicycle parks, park-and-ride etc;

3.6.6 design elements such as road gradients, critical grade length, ramp locations and gradient, compact interchange layouts;

3.6.7 effective proper and regular maintenance of roads with proper finished pavements which are free from joints and other surface irregularities.

Summary

Singapore aims to be a tropical city of excellence. In pursuing this aim, one of the tasks is to reduce air pollution and noise caused by road traffic. Many measures have been implemented but more efforts will be taken.

Prepared by Public Works Department Singapore Nov 93

VII. Kingdom of Thailand

Mr. Anusornant Mahavinichaimontri,
Director of Materials and Research Division,
Department of Public Works, Ministry of Interior

1. THE OUTLINE OF COUNTRY

1.1 DESCRIPTION OF THE LAND

THAILAND is situated in the heart of the Southeast Asian mainland (figure 1.1,1.2) and covering an area of 513,115 sq.km., from N.5° 30" to N.21° and from E.97° 30" to E.105° 30", Thailand borders the Democratic People's Republic of Loas and the Socialist Republic of the Union of Burma to the north, Democratic Kampuochea and the Gulf of Thailand to the east, the Socialist Republic of the Union of Burma and the India Ocean to the West, and Malaysia to the South. Thailand has maximum dimensions of about 2,500 km. north to south and 1,250 km. east to west, with a coastline of approximately 1,840 km. on the Gult of Thailand and 865 km. along the India Ocean.

Thailand is divided into four natrual regions (1) the North (2) the Central Plain or Chao Praya River Basin, (3) the Northeast, or the Korat Plateau , and (4) the South, or Southem Peninsula.

The North is a mountainous regiou comprising natural forests, ridges and deep, marrow, alluvial valleys.

Central Thailand, is a lush, fertile valley. It is the richest and most extensive rice-producing area in the country.

The Northeast region is an arid region characterized by a rolling surface and undulating hills.

The Southern region is hilly to mountains, with thick virgin forests and deposits of minerals and ores. This region is the center for the production of rubber and the cultivation of the other tropical crops.

1.2 CLIMATE

Thailandis a warm and rather humid tropical country. The climate is monsoonal, marked by a pronounced rainy season lasting from about May to September and a relatively dry season for the remainder of the year. Temperatures are highest in March and April and lowest in

December and January. The average temperature is 23.7° c. to 32.5° c.

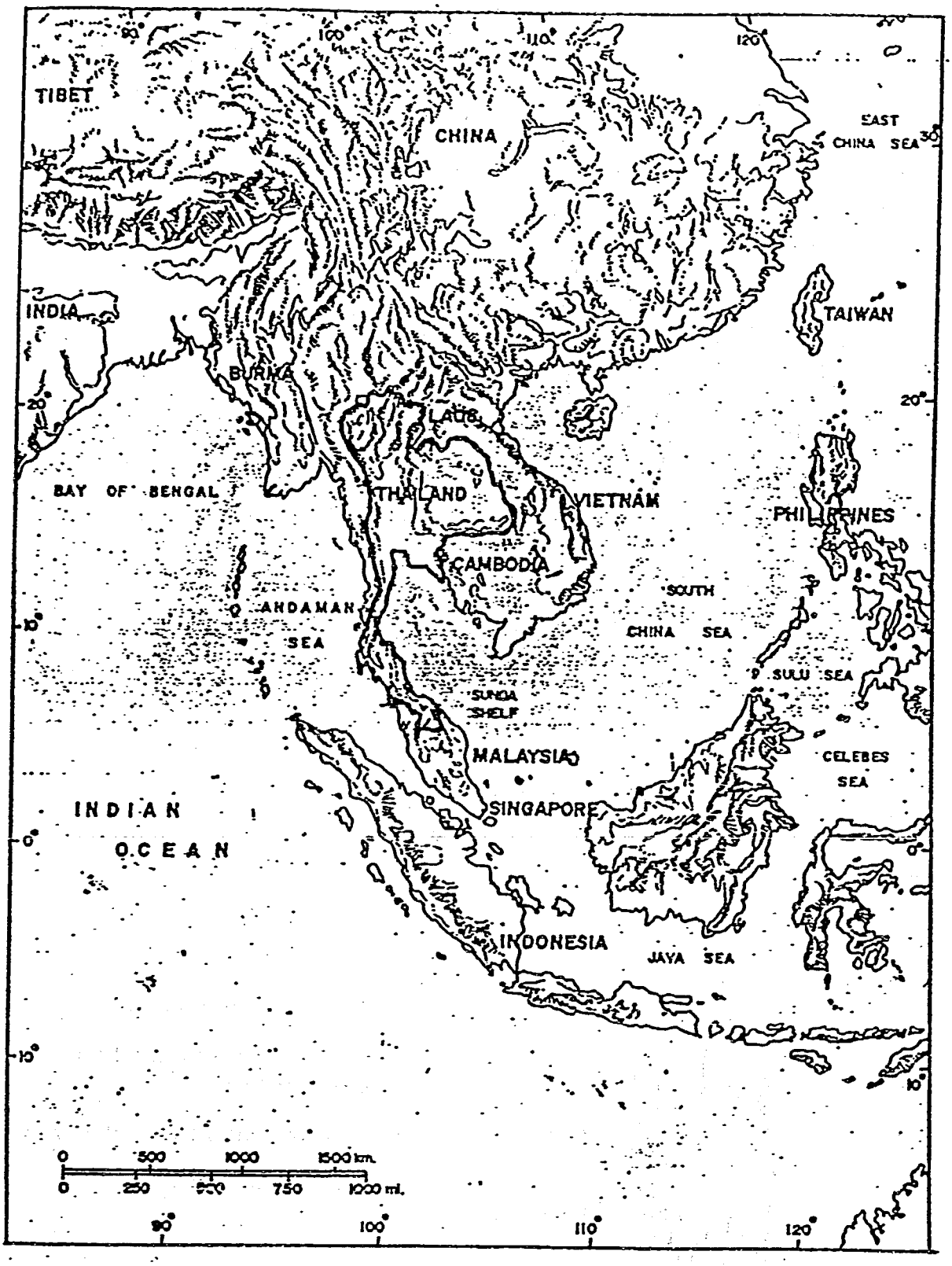
1.3 Demographies

There are conflieting opinions as to the origins of the Thais. Three decades ago it could be said with persumed certainty that the Thais originated in Northwestern Szechuan in China about 4,500 years ago and later migrated down to their present homeland. However, this theory has been altered by thediscovery of remarkable prehistoric artifacts in the village of Ban Chiang in the Nong Han, District of Udon Thani Province in the northeast. It now appears that thais might have originated here in Thailand and later scatlered to various parts of Asia, including some parts of China.

The population of Thailand is approximately 57,788,965 with an annual growth rate of approximately 1.3 percent. The most important ethic minority are Chinese. Other minority groups include Malays, Kampucheans, non-Thai hill tribes, and Vietnamese. The urban population is about 5,562,141.

1.4 ECONOMY AND SOCIETY

GNP (1993) is approximately US $ 2,072. Total exports for 1992 amounted to approximately US $ 24,000 million and imports were approximtately US $ 30,000 million.



Physiographic map of East Asia, Southeast Asia showing position of Thailand in relation to the surrounding areas.

FIGURE 1.1

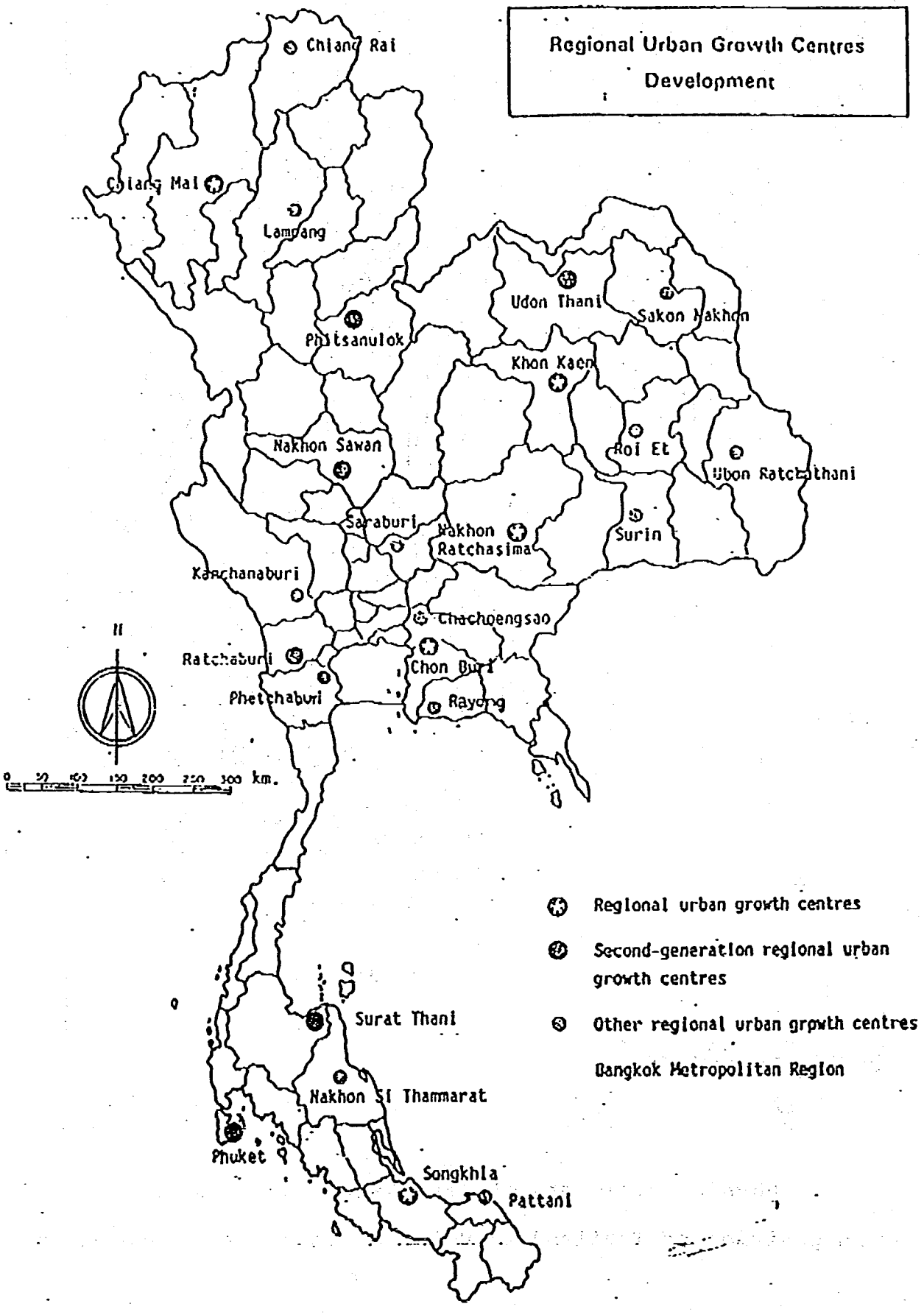


FIGURE 1.2

Office of the National Economic and Social Development Board

2. DESCRIPTION OF THE PUBLIC WORKS

2.1 MASTER PLAN OF NATIONAL LAND DEVELOPMENT

The southern Seaboard is one of the national land development project. The project has undertaken on January, 1992 and its schedude covered a 21-year span, of which the first ten constitute the action plan, (Figure 2.1). The activities shown beyond the action plan period include the anticipated expansion of facilities proposed under the plan, and illustrate a possible evolution of the project. Utilities are not included in the schedule, but they must be available by the completion dates of the facilities served.

The Southern Seaboard is part of Southern Penisular Thailand, (Figure 2.2) and consists of the five provinces with 32,254 square kilometers and 2.8 million people. The ideology of project is to study the potential to become and international hub with global transportative and trade links. The main objectives of this project are to establis a new economic region, creating the 230,000 direct jobs over a 10-year period and also promoting the tourism. The proposed 10-year action plan carries an overall cost for infrastructure of 72,170 million baht (Figure 2.3)

2.2 BUDGET FOR INVESTMENT IN CONSTRUCTION

The budget for investment in construction may be divided into 2 classification as follows

2.2.1 Program classification

(in million baht)

Fiscal year / Sector	1993		1994	
	Amount	%	Amount	%
Transportation and Communication	46,933.2	8.4	53,450.9	8.6

2.2.2 Functional and Economic Classification

(in million baht)

Function \ Fiscal year	1993		1994	
	Amount	%	Amount	%
- Community and Social Service				
1. Housing and comunity Amenity Affairs and Services	22,301.5	4.0	30,135.4	4.8
- Economic Services				
1. Mining and Mineral Resource Affairs and Services, Munufac turing Affairs and Services; and Construction Affairs and Services	3,408.4	0.6	3,106.1	0.5
2. Transportation and Commurica- tion Affairs and Services	61,482.4	11.0	69,557.3	11.2

2.3 ORGANIZATIONS CONCERNED WITH PUBLIC WORKS

2.3.1 Public Works Department

Responsible for all utilities & Facilities and building services and infrasturctures aspects all over the country, except ortherwise indicated to be lawfully undertaken by other Authorities.

2.3.2 Local Government Services (Engineering Department)

Responsible for all building services and infrastructures in the municipal and sanitary administrations areas.

2.3.3 Office of Accelerated Rural Development

Carring out of all infrastructures outside the areas specified to Public Works Department and Local Government Services.

2.3.4 State Enterprises

Concerning with transportations, electricity and water works.

2.4 HISTORY, PROGRESS AND PROBLEMS OF MAJOR INFRASTRUCTURES

Road Improvement

Rama VII Bridge is one of the major road improvement. It is the twin 3-span prestressed concrete bridge crossing the Chao Phraya river to connect Charansanitwong Road on Thonburi side to Wong Sawang and Phibul Songkram roads on Bangkok side. The objectives of the project is to diversify the traffic cengestion cause by the dead ends of the roads an each side of the river by joining them together to help improve the road capacity to its full scale. The bridge is 934 meters long, including approaches on both sides of the river, and stand 5.5 meters clear of the river's highest water level, also including a new railway bridge 70 meters in length. The project took 32 months and has ceremoniously opened on 23 September 1992. The construction project cost 1,008 million baht. During the construction, there was only techhnical problem, regarding the long span railway bridge, 7o meters, in length to cope the problem, the lateral sliding method being introduced.

2.5 MAJOR PROJECT IN PROGRESS OR IN PLANNING

Wat Nakorn-In bridge and road construction project is the construction of the 6-pane trafffic parvement bridge crossing the Chao Phraya river at Wat Nakorn-In on Thonburi side with the 30.55 kilometers main road connecting Thivanon, Petchkasem and Rattanathibet roads. The estimate construction cost is 12,370 million baht, The total time frame is 9 years period and the construction will be comencing in 1996.

SUMMARY SCHEDULE

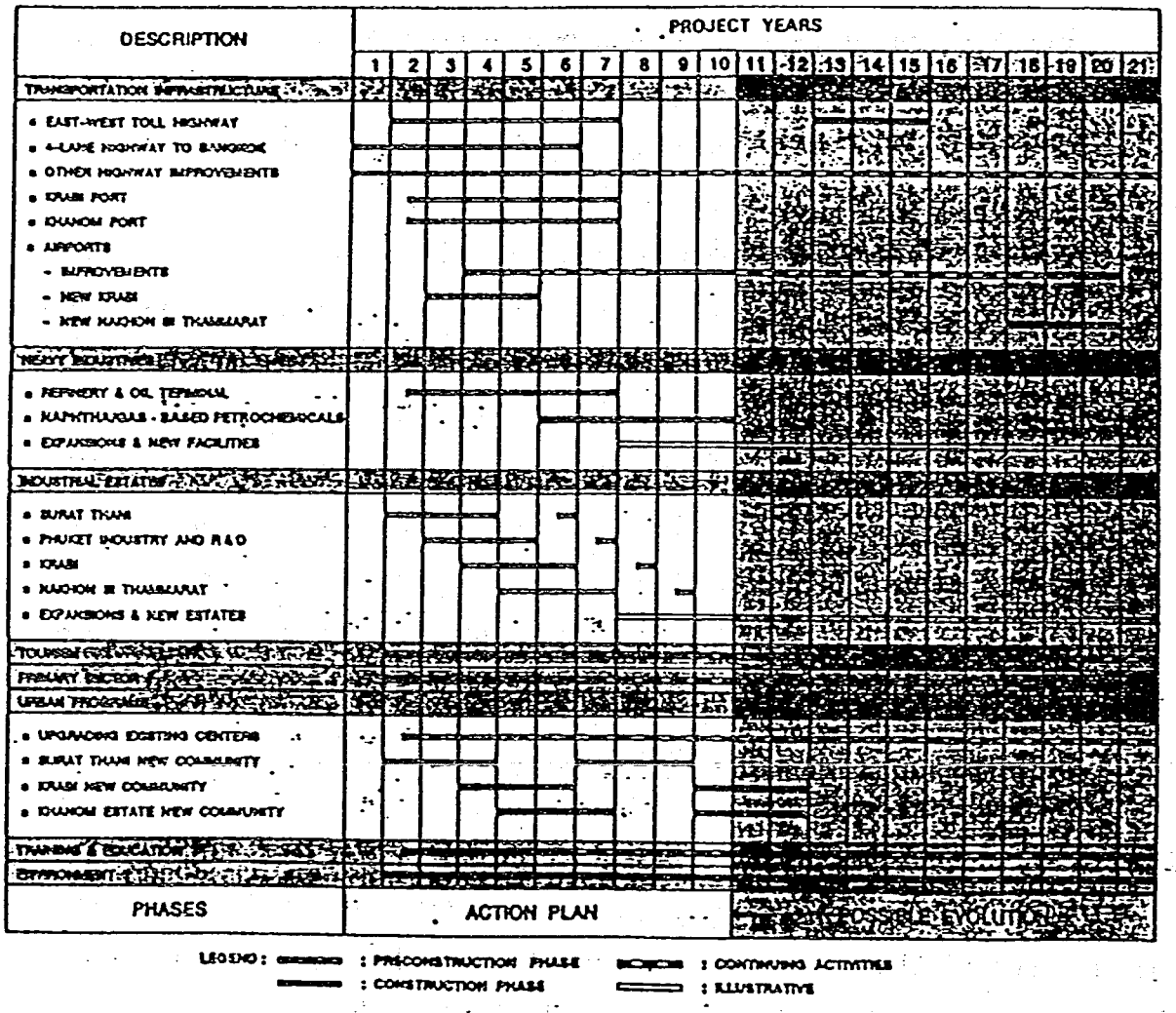


FIGURE 2.1

PROJECT AREA AND EXISTING INFRASTRUCTURE

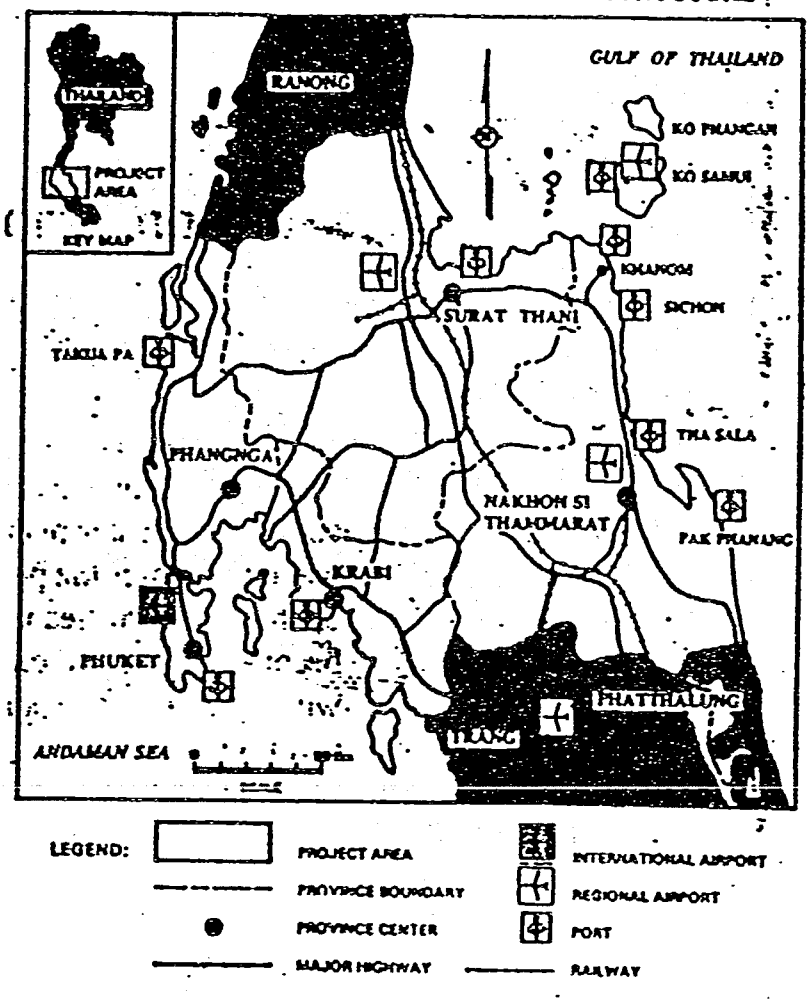


FIGURE 2.2

COST ESTIMATE AND PUBLIC/PRIVATE SPLIT

Unit: Million 1991 Baht

PROJECT COMPONENTS	TOTAL COST	LOW PUBLIC SHARE		HIGH PUBLIC SHARE		REMARKS AND PUBLIC COST RECOVERY MEASURES
		PUBLIC	PRIVATE	PUBLIC	PRIVATE	
Krabi and Khanom General Cargo Ports	4,420	3,680	740	3,930	490	Public share could be reduced by participation of the hydrocarbon industry in its share of the cost of the Khanom port. Partial cost recovery through fees and charges.
New East-West Highway	4,160	170	3,990	1,250	2,910	First stage only. Partial recovery through tolls. Second stage is estimated at 2,830 million baht
Highway Improvements	14,700	14,700	-	14,700	-	No recovery as tolls are not practical on local roads
Airport Upgrading and Construction	1,660	1,660	-	1,660	-	Cost could be recovered through airport tax, landing fees, rents, leases and/or concessions
Hydrocarbon Complex and New Community-Dedicated Infrastructure and Utilities	7,150	5,360	1,790	7,150	-	Site preparation excluded. Private sector share to be determined by negotiations (assumed to be 25% in Low Public case). Partial cost recovery possible through charges, user's fees, leases and/or land sales
Other Industrial Estates and New Communities	4,100	1,560	2,540	2,150	1,950	Infrastructure only. Public share could be recovered through user's fees, leases, rents, and/or land sales
Urban Upgrading (Excluding Utilities)	7,520	4,710	2,810	4,710	2,810	Public share could be recovered in part through municipal and property taxes, special assessments, leases, etc.
Tourism Infrastructure	9,250	9,250	-	9,250	-	Cost could be fully recovered through leases, rents, and/or special tourist tax
Primary Sector Programs	690	690	-	690	-	Cost could be recovered through special assessment on agricultural land and/or special tax on products
Utilities	17,380	3,530	13,850	6,780	10,600	Public share could be recovered through fees and/or charges
Training Programs	970	-	970	485	485	Public share could be recovered through a training tax
Environmental Studies and Monitoring	170	170	-	170	-	Cost could be recovered through an environmental protection tax
TOTALS	72,170	45,480	26,690	52,925	19,245	

FIGURE 2.3

3. RESEARCH AND DEVELOPMENT OF THE PUBLIC WORKS DEPARTMENT

The Public Works Department was established in 1898, now affiliated to the Ministry of Interior. The Department is responsible for public utilities and development works in rutal areas, cities and some specific areas through out the country.

It both supervises and implements construction, according to building and safety codes. The Department has recieved a mandate for implementing construotion projects according to the development plan. This is very impotant work and directly concerns the life, property and well being of the people. It concerns also, with Bangkok and subsurbs as partly, to resolve the traffic problem, such as by the establishing bridges across Chao Phraya River in Bangkok area. And in addition, it also gives technical a advice in improving and expanding the transport system as a basic need to rural areas througout the country. Another activities are in connection with river bank protection against erosion which affects villages, assisting in solving problem of lack of water for public service and consumption in some large cities, including established a waste water purification system in densely populated areas.

In dealing technical services, it concerns establishing construction standards, code of practice and some research in connection with appropriate technology, latest achievements is application to low cost construction materials used in rural areas i. e. light weight hay cemented pannel, latcritic cenrent brick, etc.

And, as to support, now in establishing Thai Building Code in connection with Earthquake, the Public Works Department, in cooperation with Chulalongkorn University, conducts a research work, entitled "The Study of Site Amplification and Dynamic Response of Structure" to derive approxincately parameters concerned.

The total number of permanent stuff member of the Public Works Department is about 4,000 and its budget for management and

development is 12,223 million bahts in 1993 and 13,219 million bahts will be proposed for 1994.

The Organization chart of Public Works Department is as follow:-

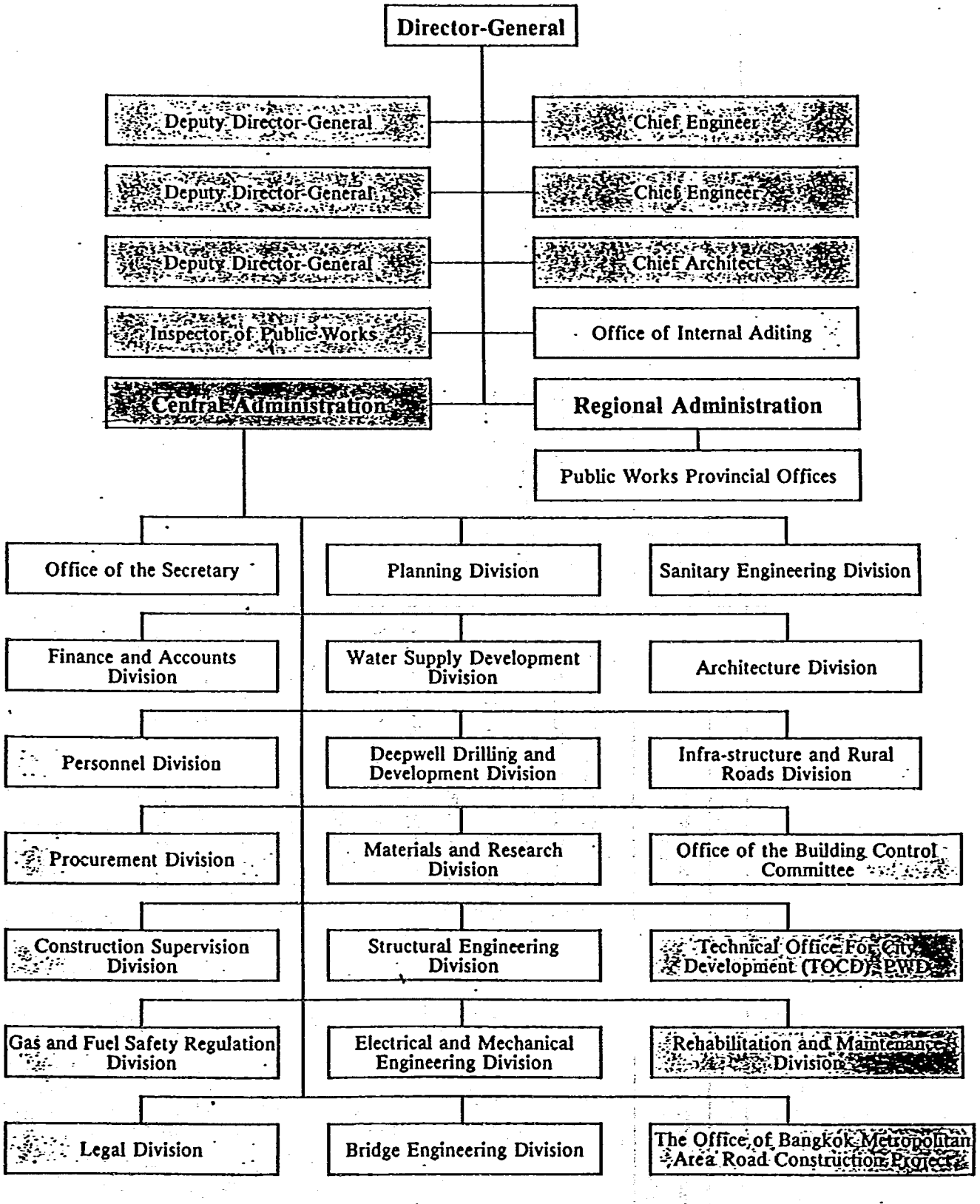


FIGURE 3.1

Organization Chart of Materials and Research Division

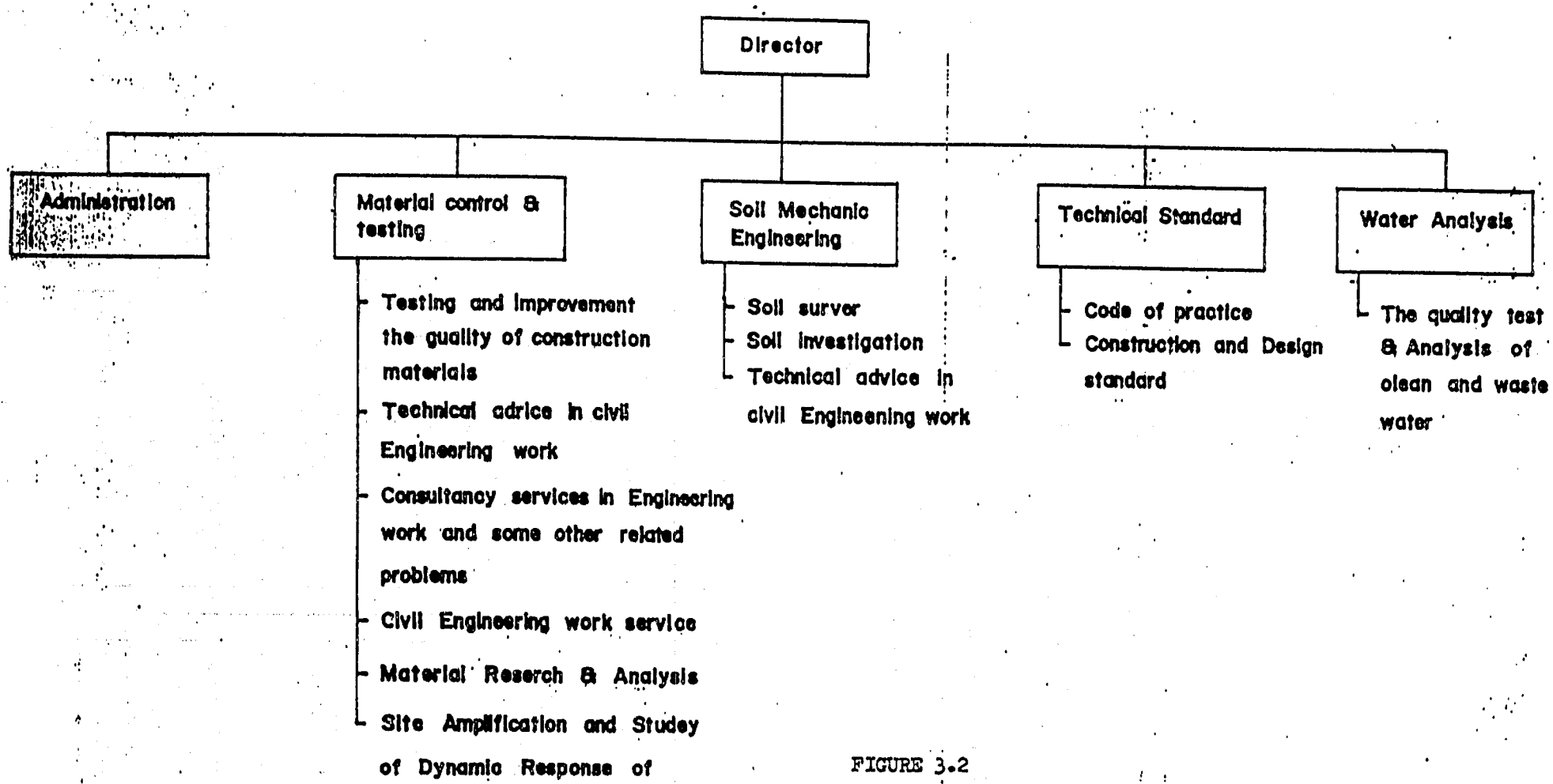


FIGURE 3.2

4. MAJOR RESEARCH AND DEVELOPMENT PROJECTS OF THE PUBLIC WORKS DEPARTMENT

Formerly, the Public Works Department performed research and development projects, aimed, to help people in labour intensive areas, to produce, themselves, low cost construction materials in building their houses.

Such research works were lateritic cement brick, hay cemented pannel etc. Result of the researchs were, widely spread, utilized in rural areas, where raw materials were easily available.

As, referring to wide variety in connection with public utilities and securities, the Public Works Department has major researchs in;

- Evaluation of waste water disposal systems in Thailand
- Study of Site Amplification and Dynamic Response of Structure
- Study of light weight portable house

In 1994, the Public Works Department, in cooperation with some consultant Engineering Company, will shedule to perfom research work on "Mae khong River Bank Protection Against Erosion", the research will cover utilizing the modulation technique and the computer program analysis.

And, also, in the future, The Public Works Department needs, if possible, as partially applied to research works, some big scale testings and more proper computer programe analysis.

However, the achievement for those requirements will depend upon government policy and budget to support and also, the cooperation or contribution from other agency, JICA is for example.

STUDY OF SITE AMPLIFICATION AND DYNAMIC RESPONSE OF STRUCTURE

1. Background:

There was an earthquake in Thailand on April,22,1983 which 5.9 Richter scale was registered. The quake create panic sensing for people living in medium to high-rise buildings in Bangkok.

Upto the present, there is no Building Code in connection with Earthquake applied appropriately in Thailand. In establishing local regulation to prevent the hazard resulting from earthquake, it is neccessary to deriver sufficient informations in connection with building formations and earthquake force. So, the research has been carrying out.

2. The Purpose of the Project

2.1 To study site magnification and site response spectum.

2.2 To analyse the total seismic force applied on a structure. And to improve ministerial regulations and seismic design or the code for buildings in Thailand.

3. Organizations Responsible

3.1 Materials and Research Division, Public Works Department

3.2 Chulalongkorn University, Bangkok

4. Budgetary (for phase I)

Years	1991	1992	1993	1994
Million Baths	5.941	0.320	1.320	0.302

5. Location for observation and data correction

43 Storeys Building in Bangkok

6. Processing

By the computer program

7. Results

After Earthquake equipments installation in 1992, there were only 2 events, informations were not sufficient. So the length of the project should be prolonged. The satisfied results, should depend on sufficient informations derivered from events. The Earthquake monitoring system attached.

EARTHQUAKE MONITORING SYSTEM

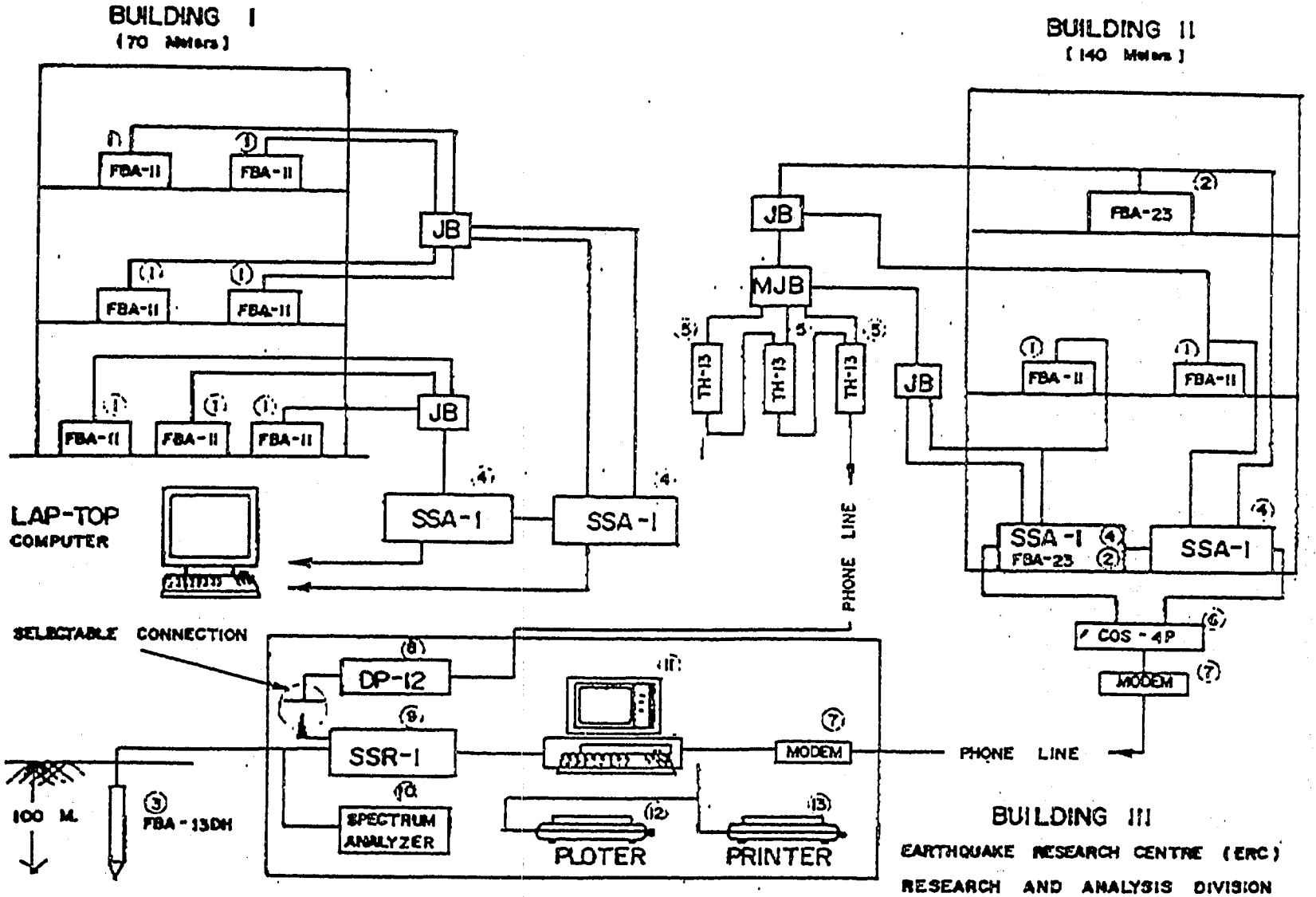


FIGURE 4.1

5. INTERNATIONAL RESEARCH EXCHANGE PROGRAM OF THE PUBLIC WORKS DEPARTMENT

There were no international research exchanges because of our researchs, as a matter a fact, not major or prominent researchs. And, also no activities concerned. However, the international research exchange program should become an urgently need for upgrading research works.

Formerly, the government allowed very low budget for research works. Lickily for the present situation, Thai Government looking forward to being a New Industrialized Country, which of course, update technologies should be transferred. One thing is update research works should be programmed to modify technologies for industrialization or upgrading construction methods. So, the government allows more budget in national researchs.

Thailand needs the contribution from donor country, Japan for example to transfer of technologies, including update research works before having the exchange program among countries.

6. ACTIVITIES CONCERNING "DISASTER AND DISASTER PREVENTION"

6.1 SUMMARY

Flood is one of the natural diaster, causing damages in both ecomomics and lives. Samut Prakan Province is located mostly in the swamp area and river and never avoidable from floodings. Floods controlled and protection are the most comprehensive countermeasure to mitigate the disaster. Samut Prakan East is a relatively flat land and having ground elevation close to the mean sea level, and covers the whole area of Samut Prakan Province on the east bank of the Chao Phraya river. Majority of the 512,000 population of Samut Prakan East lives in about 220 square kilometers area on the west of the King's flood protection dike (figure 6.1). Samut Prakan plays a significant role in economics, especially in industry and trading. In 1986 taxes revenue from Samut Prakan was 4,400 million baht per annum, which was the second highest of the country, and inferior only to Bangkok.

In the past 4-5 years, Samut Prakan areas adjacent to the Gulf of Thailand have been faced with increasing flood problems. These include floods caused by heavy rainfall similar to Bangkok which is located just to the north, and frequent floodings at high tides even during periods with no rain. The tidal flooding are relatively predictable, and have occured during a period from October through January. The frequency of floodings average about 7 days per month, and lost about 4 hours per day. These frequent floodings which constantly cause repeated losses and inconveniences to the area definitely deserve immediate attention. After the 1983 record flood in Bangkok and its vicinity area much efforts have been spent in investigations and implementation aiming to mitigate the damaging flood problems. In the eastern suburban area of bangkok a master plan using the polder type system was odopted. According to such plan, it is necessary to drain flood water from about 240 square kilometers

area, known as flood "retarding area" through Samut Prakan East for subsequent drainage in the Chao Phraya river. Therefove, a properly planned drainage and flood protection system in Samut Prakan East area is needed to enable coordinated drainage on the east bank. The Public Works Department has therefore, carried out the flood protection and drainage project for Samut Prakan East, commencing on 25 September 1986.

6.2 PRESENT SITUATION AND PROBLEMS IN THE COUNTRY

During the past serveral years, Thailand has enjoyed one of the highest rate of economic growth in the world. Not only, Thailand's outstauding business growth has been achieved, but also has contributed to a number of fundamental problems facing the nation. The first problem is that the high rate of growth has been accompanied by increasing destruction of country's rich natural resources and rapid deterioration of the environment massive degradation of forests, agricultural land and mangroves, which disturbing the access to natural waterways. The second problem is the deforesting which decreasing capabilities of land to help retain the surface water runoff caused by the heavy rain. The immense amount of water rushes rapidly from the highland to the central plain and submersing the land.

Samut Prakan Province is located in the central plain area or Chao Phrya River Basin, next to Bangkok in the east it has been being suffered for long time. Floodings in this area may be categoried into 2 types. One type of floodings is due to rising tides and corresponding high stages of Chao Phraya river, causing overflows of nearby lowlands. This is characterized by frequent floodings in a period from October to January for about 7 days per month, and about 4 hours in each day with this type of floodings. Another type of floodings is a result of heay rain and inadequate drainage facilities. The frequent floodings have caused economic lossess, detrimental to economic development in the area for long time. In addition to the

opportunity loss in area development to its full potential, the floodings have adversely affected the local residents in Their daily livings due to the degraded living environment caused by decomposition of the long standing flood water. The maximum annual flood losses was estimated at 778 million baht, while the expected value of annul flood losses was estimated at about 384 million baht.

6.3 ACTIVITIES IN THE ORGANIZATION

Public Works Department has been assigned as the main responsible agency by the Goverment to carry out the flood protection and drainage project for Samut Prakan East, commencing on 25 September 1986. After a master plan preparation in the first 12 months, a feasibility study of the flood protective and drainage project as proposal for the master plan area has been scheduled for another 8 months period. The estimated construction time is 7 years which would have been beginning in 1990. PWD, also has been assigned to supervise, coordinate and follow-up the project.

6.4 COMPREHENSIVE COUNTERMEASURE AGAINST FLOODS

6.4.1 Existing Drainage Pattern

Drainage in the project area is through the system of canals as shown in Figure 6.2. There are 3 east-west canal systems, including (1) Klong Samrong: (2) Klong Muang-Praek Sa-Pak Nam : and (3) Klong Chonprathan (Chai-ta-le) along Sukhumvit road. There are also 2 main north-south canal systems: Klong Bang Ping and Klong Kut Mai aalong the King's dike.

In the plain north of Bang Na-Trad Hwy, a portion of water drains into Klong Phra Kanong in the north, while some drains through the highway to the south to Klong Samrong. The drainages into both canals are dependent on the relative water levels in the two intercepting canals. The drainage into Klong Samrong can be through

Klong Palat Priang and Klong Bang Kaeo Yai which are directly connected to it. The drainage is also via Klong Salut-Klong Chuat Lak Khao-Klong Lat Krabang, then to Klong Samrong at a location east of the King's dike.

The plain between Bang Na-Trad Hwy and Sukhumvit road locating on the west of the King's dike is drained by Klong Samrong, Klong Praek Sa, and Klong Chai-ta-le. Water in Klong Praek Sa and Klong Cha-ta-le can drain into Klong Samrong through Klong Bang Ping and a number of connecting canals. Drainage directly into the Gulf is also possible through Bang Tamru gate and gated culverts at Bang Pu and Hua Lamphu, and by direct pumping. At present drainages directly into the Gulf are obstructed at the tidal reaches of the canals south of Sukhumvit road.

Water drained into Klong Samrong is released through gates and pumped into the Chao Phraya river at Samrong gate and pumping station locating between Sukhumvit and Na Grom road. Drainage from Klong Samrong into the Chao Phraya river can also be through Klong Maha Wong through its gate and pumping station location close to the river.

Samut Prakan municipal area bounded by Sukhumvit and Sai Luad roads and the Chao Phraya river is presently flood protected by the two roads and a flood wall along the river. Drainage in this polder is through Klong Pak Nam, which drains into the river at Pak Nam gate and pumping station.

For the area on the west of Sukhumvit road, the portion to the north of Poo Chao Saming Prai road drains into Klong Samrong. Klong Bang Nang Greng is the main drain canal for south portion. Although the area along the rim of the river bank is relatively higher than the inner area, these are many canals traversing the high bank to join Klong Bang Nang Greng and the Chao Phraya river. As a result low spots in the area are flooded daily during high tides period in the

Chao Phraya river. In its existing condition these tidal floodings is from September through December, for about 4 hours per day and about 7 days per month.

6.4.2 Implemented Flood Protection Measures

The flocd protection and drainage in the area of Samut Prakan East has been carried out continuously for some time, and accelerating a great deal after the record flood in 1983. Projects and various improvements undertaken by the Flood Protection Committee for Bangkok and Vicinity as well as by the local sdministrations , which can be concisely summarized as follows.

6.4.2.1 King's Dike

The King's Dike was constructed as a part of the project for eastern plain drainage according to the king's recommendation. Its main objective aims to protect the eastern area of Bangkok and its vicinity from flood that flows from the eastern plain and from the overflow of the Bang Pakong river. Such a flood used to cause a lot of damage in a wide area during the flood events of 1980 and 1983. For Samut Prakan area, this flood protection dike has a total length of about 24 km (Figure 6.3). The first section of the dike from Soi On Nuch (Sukhumvit 77 road) to Teparak road of 14 km is an earth embankment with the crest width of 1.0 metre and the top elevation at 1.9-2.1 metres (MSL). Another section from Teparak road to Sukhumvit road in the coastal area near Bang Tamru gate is about 10 km long. It is an embankment of laterite road surface of about 6-10 metres wide with the top elevation at 1.5-2.3 metres above the mean sea level.

In addition to the flood protection dike, there are control gates and gated culverts at 18 locations, starting from Prawet gate to Bang Tamru gate. These hydraulic structures are provided to protect the enclosed area from the water flowing from the eastern plain during flood period and use as water regulator and drainage facilities for comsumption and agraicutrue during normal period.

The King's Dike as well as gates and culverts have been constructed since the end of 1983, and start partially functioning since 1983 until completion and fully in operation in 1985.

6.4.2.2 Short Term Flood Protection Project for Muang Samut Prakan

The project was initiated to expeditously mitigate flood problems in the zone of densely populated community and local administration center of Muang Samut Prakan Municipality. The protective area is about 2.6 square kilometres. The municipal area of Muang Samut Prakuan is generally rather flat, with the ground elevation ranging between 0.40-1.00 m. above the mean sea level, whereas the daily highest water level in the Chao Phaya river throughout the year ranges from 1.2 to 2.0 metres above the mean sea level. Therefore, without the protection from this short term project this area would subject to almost daily tidal flooding from the Chao Phraya river.

The implemented flood barriers include a reinforced concrete flood barrier along the riverside from the mouth of Klong Maha Wong to the mouth of Klong Pak Nam with a total length of 1700 m, whose top elevation at present is about +2.0 to +2.2 m (MSL) : roads improvement by raising their traffic surface elevations for use as enclosure dikes for the protected area, as shown in Figure 6.4. Internal drainage system in the area was also improved by dredging and improvement of klongs and drain conduits, coupled with the installation of pumps and control gates for draining flood water out of the polder (Figure 6.4). The combined pumping capacity is 3.87 cms.

In addition to the improvement works for the 2.6 square kilometres polder area, drainage improvements were also carried out at the mouth of Klong Maha Wong by constructing a drainage gate with 2 openings, each equiped with 3 m wide gate leaf. Also 2 electric motor

driver pumps each with 3.0 cms capacity were installed for facilitating drainage from Klong Maha Wong area.

6.4.2.3 Other Flood Protection and Mitigation pProjects

Other flood protection and drainage projects in Samut Prakan East are

(a) Klong dredging and drainage improvement within the area protected by the King's Dike.

(b) Flood protection projects of various agencies.

(c) Drainage project for the eastern plain of the King's Dike.

Klong dredging and the improvement of drainage efficiency for the flood protected area of Samut Prakan East have been carried out since 1984, consisting of the dredging of 20 main and submain canals with a total length of 76.6 kilometres and the improvement of Klong Samrong gate to have 3 openings of 6 metres wide each as well as the increase of pumping capacity with 25 electric pumps of 3 cms each. In the south improvements were made on Hua Lamphu gated culverts, Bang Pu gated culverts and Bang Tamru gate.

Other flood protection projects under the responsibilities of local administrations such as the municipality of Muang Samut Prakan, sanitary districts, and various agencies consisted of both temporary remedial works and permanent works. The permanent works involved only individual construction of small polder systems.

The drainage project for the eastern plain of the King's Dike had an objective to improve the drainage efficiency in the plain by controlling the flow towards the sea during heavy rain, and to mitigate the flood damage on the agricultural areas. The projects involved the klong dredging, construction of gates and installation of pumps at canal locations along the coast.

6.4.3 Summary of the Prevailing Flood Problems

The various measures which have already been implemented for

mitigating flood problems in the project area have thus for contributed to significant alleviation of the problems, especially for the area east of Sukhumvit road and the 2.6 square kilometres area in the densely populated ceentre of the municipal area. Although for protection level cannot be considered as adequate. There are many areas still in need of immediate attention, including the riverside area west of Sukhumvit road and the area along the gulf coast south of Sukhumvit road (Figure 6.5). These areas are presently not yet protected from high tides and high river stages, thus subjected to floodings even during fair weather.

The area having the most severe flood problem is the industrial area along Poo Chao Saming Prai road which is to the west of Na Grom and Sukhumvit roads, and extending from Klong Wat Yothin Pradit on the north to the Naval Academy and Klong Maha Wong on the south, particularly the areas along Klong Samrong and the south reach of Klong Gang Nang Greng (Figure 6.5). The coastal area south of Sukhumvit road is not severely damaged at present because of the existing self-flood protectiom systems employed by individual factories.

6.4.4 MASTER PLAN FOR FLOOD PROTECTION AND DRAINAGE

Flood protection and drainage system proposed in the master plan (Figure 6.6), which would be adequate for future land use in the year 2001, consists of the followings:

Flood barrier	53.4	km
Gates	28	gates
Pumping station	13 stations with 133 cms capacity	
Main drain canals and pipes		
a. New drain canals	29.1	km
b. Canal improvement	60.4	km
c. Main drain	73.8	km
Sub-total canals and pipes	163.3	km
Flood retention storages	126	rai

The proposed flood protection system includes flood barrier

of various designs and equipped with necessary appurtenant structures. The system is intended to prevent overflow from outside the flood protection area, and also from one polder to the others. With the exception of about 41 km flood barrier along the Chao Phraya river and along the Gulf, most of the proposed flood barrier will be existing roads and other existing structures which can be used with very minimum improvement cost. Different designs suitable to the existing land use are adopted for the flood barrier along the river and the Gulf, with only about 5.75 km being the relatively high cost structure (master pile with panel and anchorage).

The proposed main drainage system consists of main drain canals, main drain pipes, pumping stations, and flood retention storages. The system has been sesigned to be adequate for 5 year short duration rainfall (72 mm/hour for 60 minute duration) for most of the area. For the area served by main drain pipes a 2 year short duration rainfall was adopted (59 mm/hour for 60 minute duration). Drainage in the master plan area has been designed as 3 independent polders (Figure 6.6) including Klong Samrong polder, Pak Nam polder, and Klong Bang Nang Greng Polder. Each polder would be drained by its main drainage system for discharging into the Chao Phraya river through its pumps and gates.

Along Sri Nakharin road which serves as the inner flood barrier (Figure 6.6) control gates have been planned for all canal crossings. During flood season water from the retarding area in Bangkok and from the flood relief area are planned to be drained to the south through a system of improved canals, for emptying into the Gulf mainly through the new gate planned at the flood barrier near the river moutn (Figure 6.6). During high tides when the gate has to be closed water has to be temporarily stored in the improved canal network and low areas in the flood relief area. The stored water in drained throught the gate as soon as the tide recedes to an elevation lower than the water level just upstream of the gate. Hydraulic

analyses by nathematical models indicate that the proposed drainage system can adequately drain 2 year rainfall in the flood relief area.

Two significant drainage modification in the proposed master plan should be noted:

(A) Flood Water from the retarding area of the Eastern Suburban Bangkok as well as from the flood relief area of Samut Prakan East is to be drained southwards directly to the Gulf. This is to avoid conveying a large quantity of flood water through high valued community areas via Klong Samrong to the Chao Phraya river.

(B) Samrong gate and pumping station is to be relocated to a new site closer to the river, so that more industrial area in Poo Chao Saming Prai road area can be provided with flood protection, thus minimizing conflicts with residents living further downstream from the pumping station during flood drainage.

6.4.5 SUPPLEMENTARY MEASURE IN FLOOD PROTECTION

Flood is a natural phenomenon which is regarded in hydrology as extreme event following a stochastic process. Its long term variation can not be reliably predicted. Thus, flood loss reduction can be categorized into:

(a) Protective measure : This approach is characterized by the provision of adeuate flood protective structures such as the construction of flood barriers and adequate drainage system.

(b) Flood liability control measure : This approach employs planning and management to reduce the amount of properties liable to flood losses such as planning and control of land use in the flood prone area.

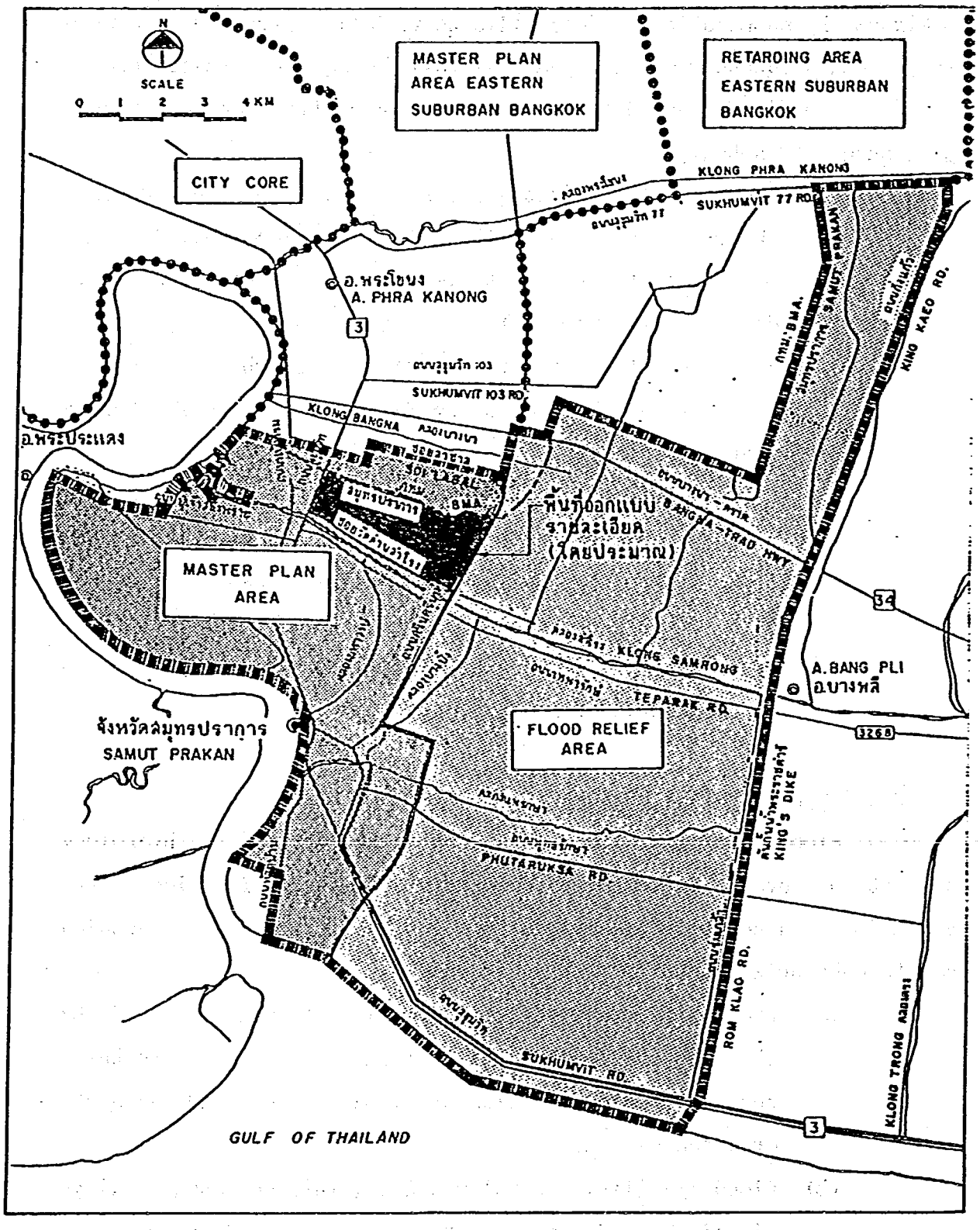


FIGURE 6.1
PROJECT AREA

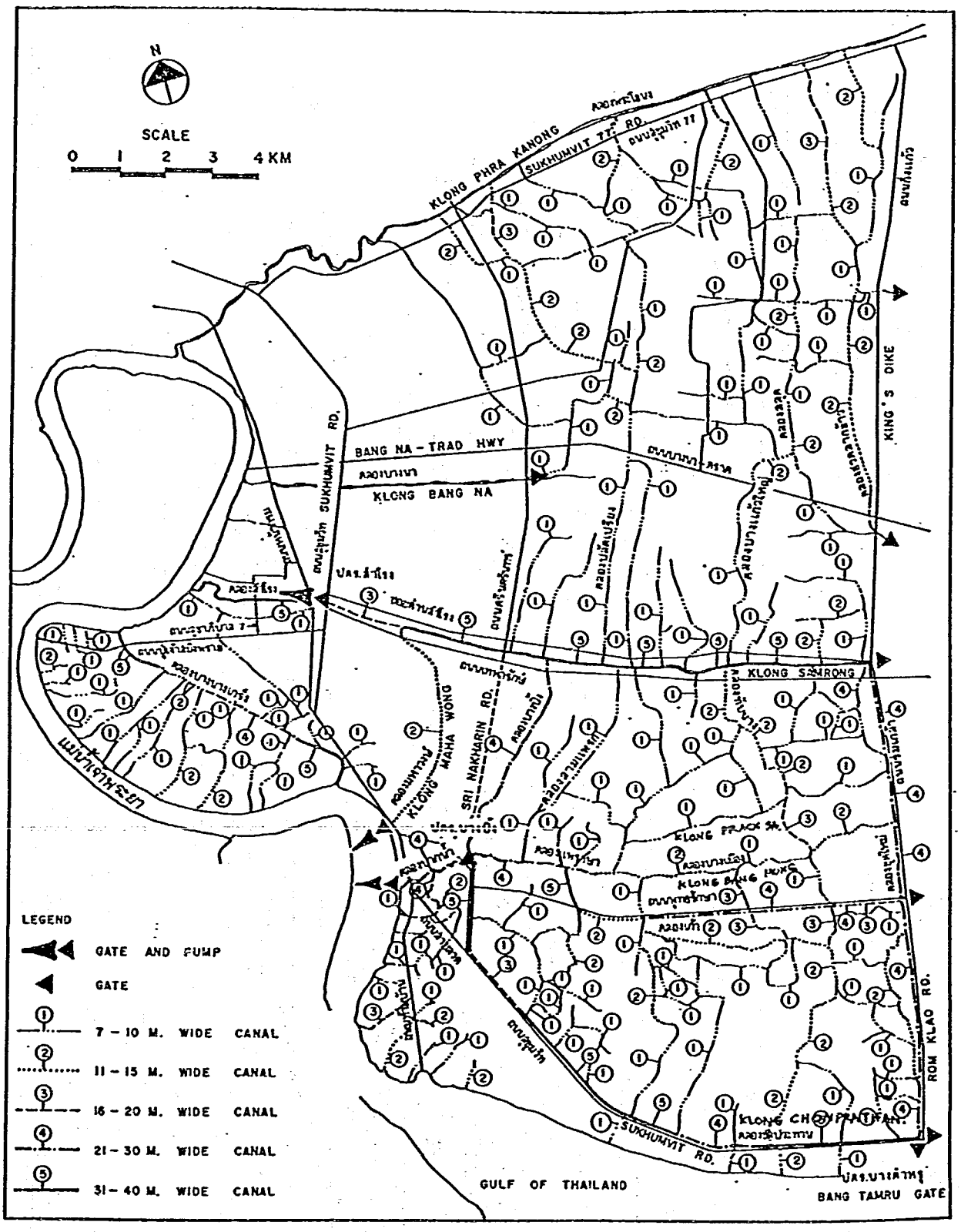
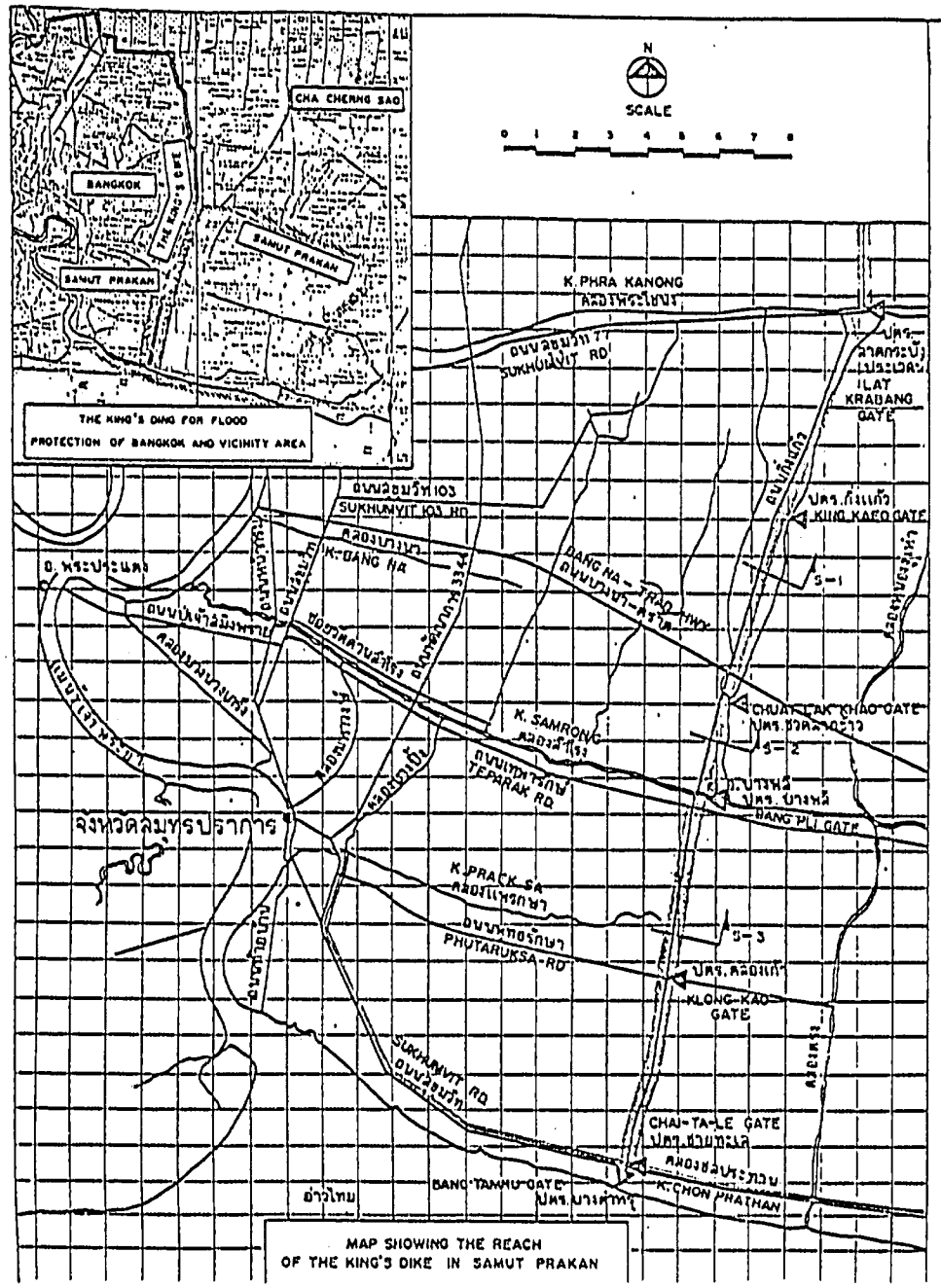
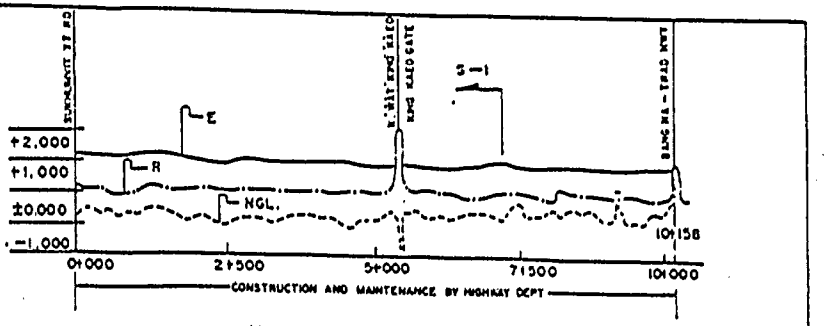


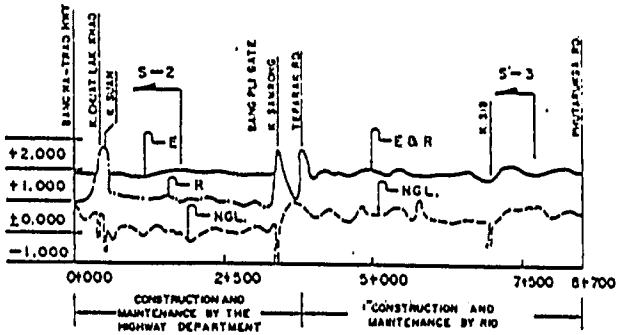
FIGURE 6.2

EXISTING CANALS

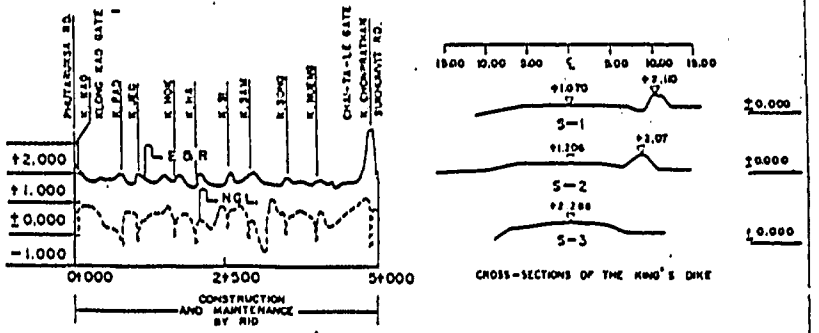




LONGITUDINAL PROFILE OF THE KING'S DIKE BETWEEN SUKHUMVIT 77 RD TO BANG NA-TRAD HIGHWAY



LONGITUDINAL PROFILE OF THE KING'S DIKE BETWEEN BANG NA-TRAD HWY. TO PHUTARUKSA RD.



LONGITUDINAL PROFILE OF THE KING'S DIKE BETWEEN PHUTARUKSA RD. TO SUKHUMVIT RD.

LEGEND
- DIKE ALIGNMENT
- GATE
- E EMBANKMENT
- E Q R ROAD FUNCTIONS AS FLOOD BARRIER
- NGL NATURAL GROUND LEVEL

FIGURE 6.3
THE KING'S FLOOD PROTECTION DIKE

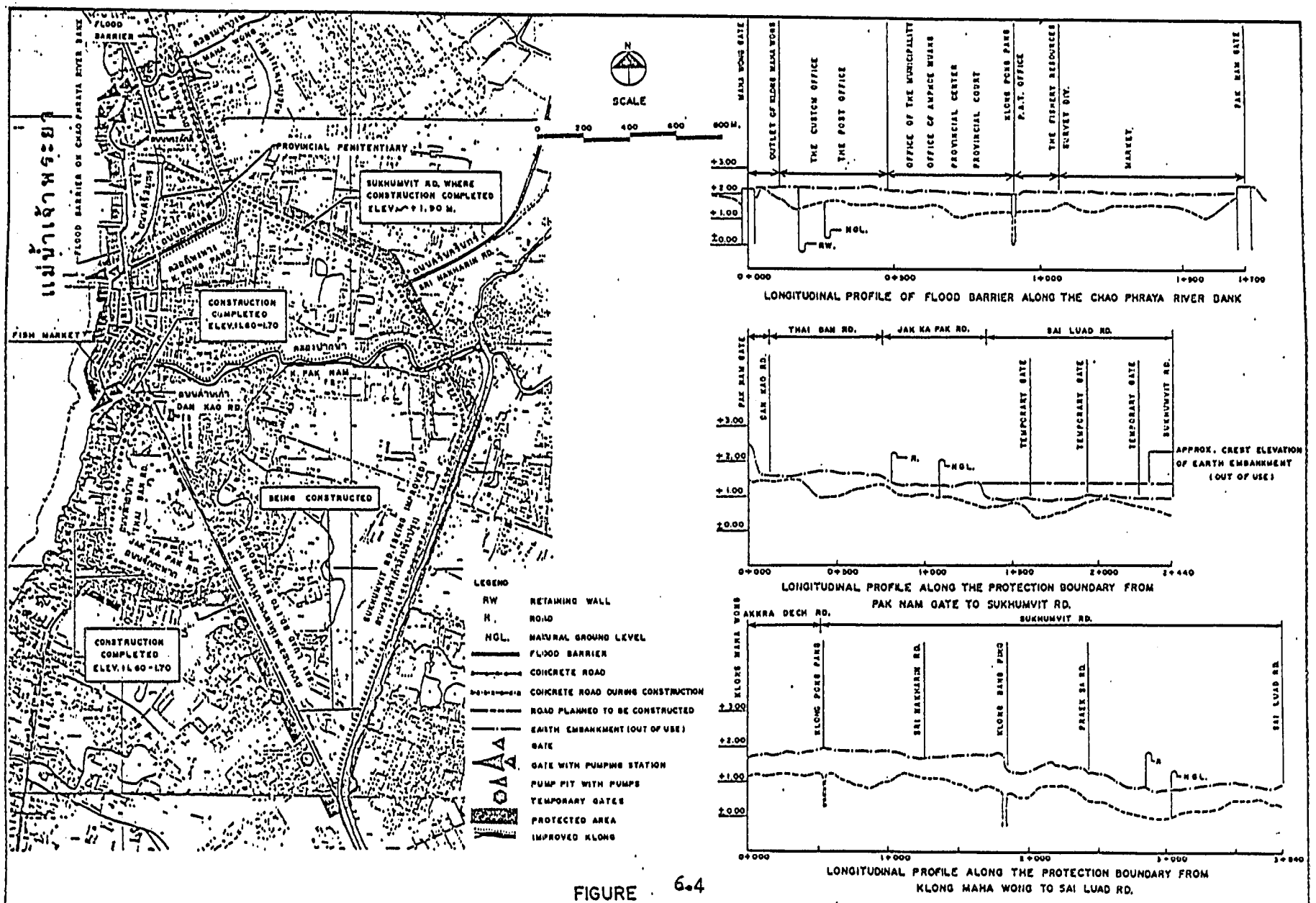


FIGURE 6.4

SHORT—TERM MITIGATION AND PROTECTION OF FLOOD PROBLEMS IN THE TOWN OF SAMUT PRAKAN

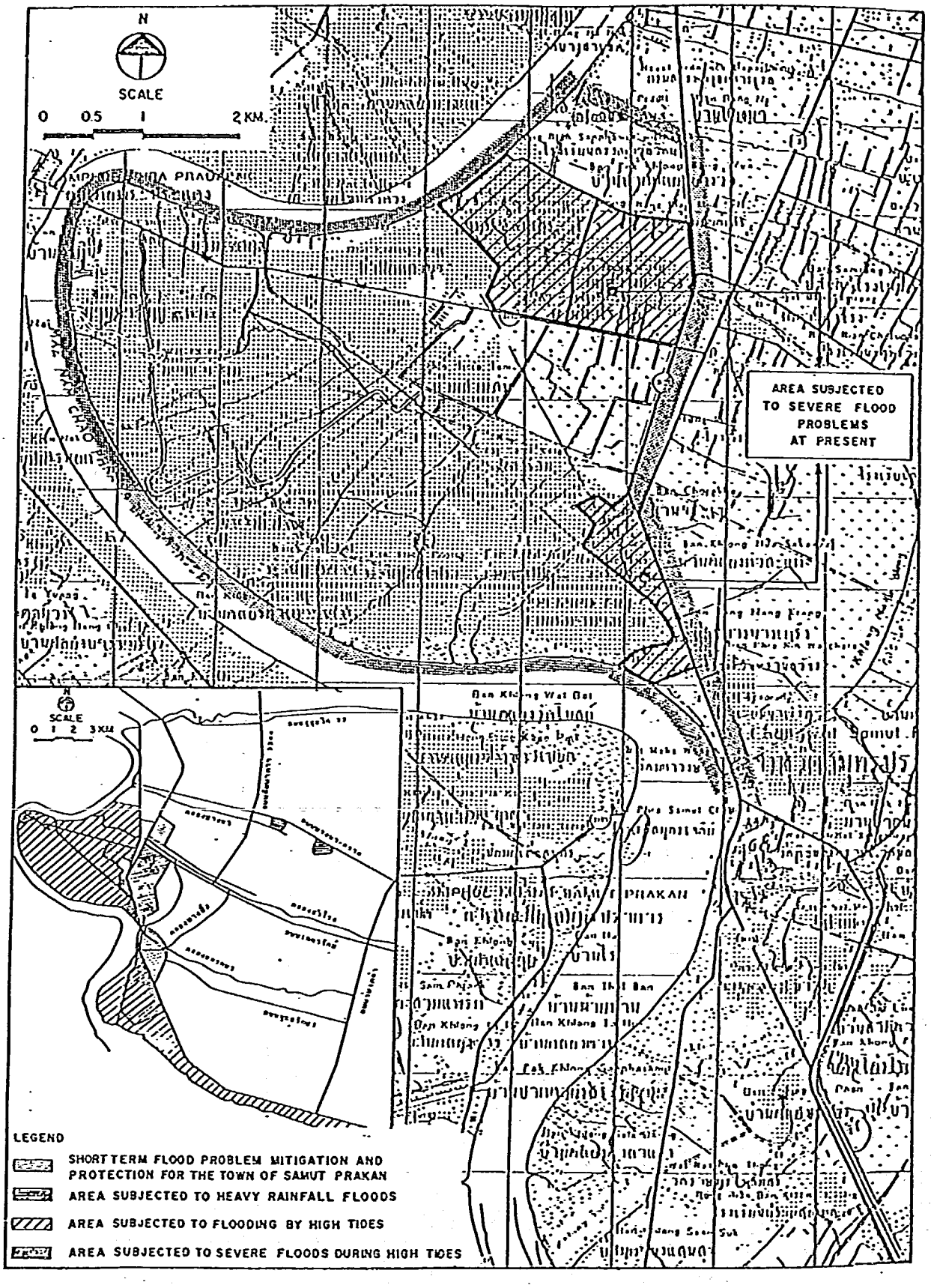


FIGURE 6.5

AREA NEEDING URGENT FLOOD PROTECTION MEASURES

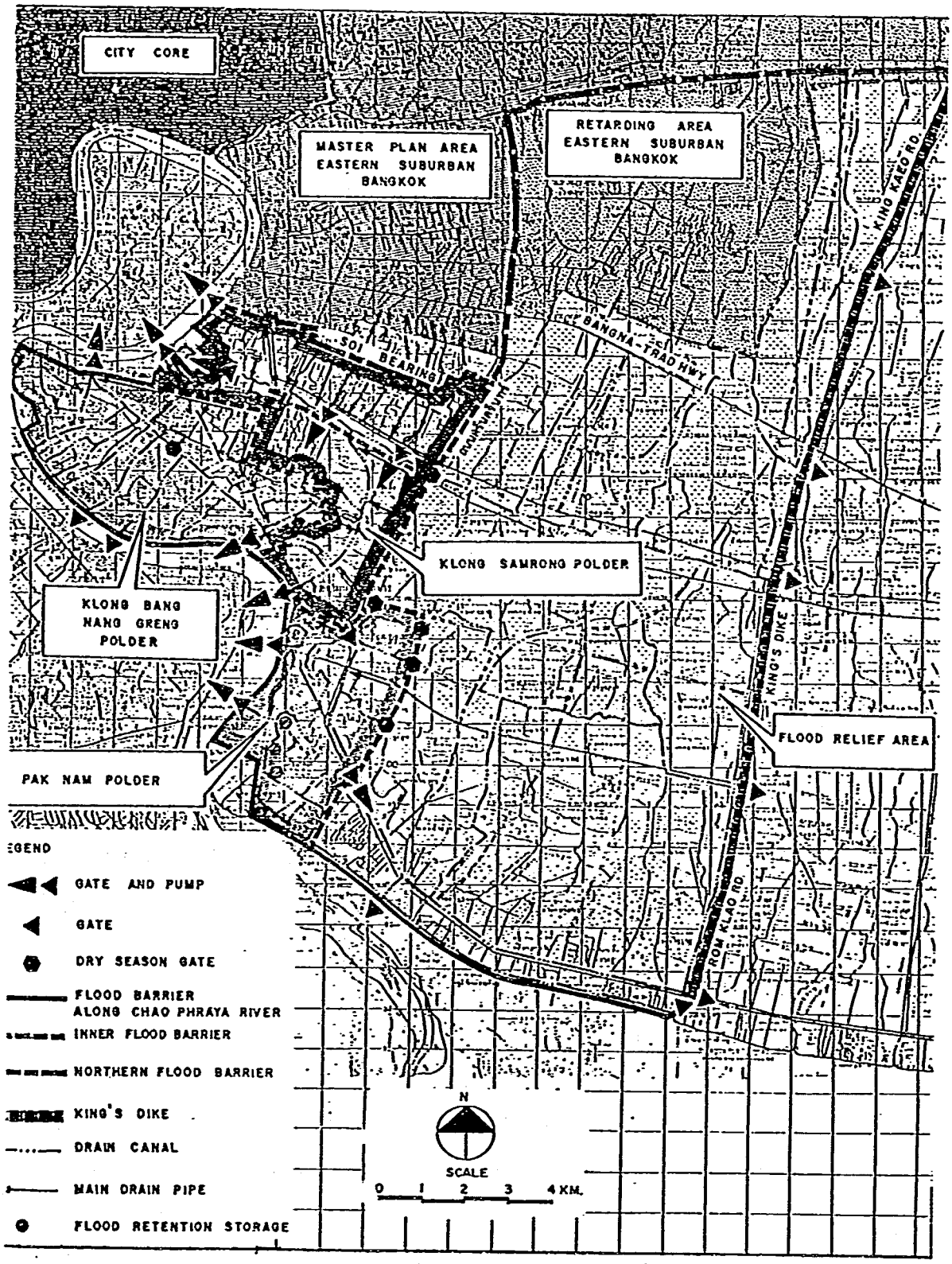


FIGURE 6.6

MASTER PLAN FOR FLOOD PROTECTION AND DRAINAGE IN SAMUT PRAKAN EAST

7. ACTIVITIES CONCERNING "HARMONY BETWEEN THE ENVIRONMENT AND IMPROVEMENT OF INFRASTRUCTURE"

7.1 SUMMARY OF ITEM 7

In Thailand, it is said that water pollution problem occurred in 1960's. About 15 years ago it is reported that Mae Klong River was severely polluted by industries. The damage was estimated to be 140 million Baht (US$ 5.4 million) at that time. However, there is no damage identified apart from this case. This does not mean that water pollution problem in Thailand is not critical. This is because the comprehensive survey on the damage caused by water pollution has not yet been conducted. There were several incidents of acute water pollution occurred in other rivers, especially the Chao Phraya River and Tha Chin River (figure 7.1). These mainly due to the discharge of industrial wastes. Therefore, policies, regulations and standards were prepared and issued mainly to control industrial wastes. The control effort succeeds in reducing some of industrial pollution, although there is room for even greater reduction. Nevertheless, the water quality of the rivers become more and more polluted. This is due to direct discharge of domestic waste from communities into the rivers, especially Bangkok Metropolitan Region and the regional cities. Now, the Thai Government has recognised the situation and the urgent need to solve the problem. The main technical objectives of this efforts can be stated as follows:

i. To reduce water pollution loads into the Chao Phraya and Tha Chin rivers so that the water quality in both rivers can be improved to meet the required standards within a suitable period of 10-15 years.

ii. To control the water quality in both rivers so as to meet the expected quality of every reach to serve the needs of long term water use.

iii. To reduce water pollution loads discharged to the main canals within the BMR which drain to the Chao Phraya and Tha Chin rivers.

iv. To allow the long term multipurpose use of the rivers and canals for fisheries, navigation, etc.

v. To improve the general quality of life, with emphasis on public health, sanitation, environment and aesthetic aspects.

It is clear that the more industrail development the worst the environmental deteriorated. There must be some measures to help improve the ecology and still accelerating the economic growth in harmonously

7.2 PRESENT SITUATION AND PROBLEMS IN THE COUNTRY

The water quality control is the main problems to be carried out. Below, is the water quality report showing the present situation and problems in Chao Phraya River and Tha Chin River.

i. Chao Phraya River

Since 1985, the National Environment Board (NEB) has continually monitored water quality in the whole Chao Phraya river at 32 survey stations starting from the estuary mouth (km.0) to the furthest upstream station at Nakorn Sawan (km.379). Three levels of Chao Phraya water quality standards have been set as follows:

Standard level 4: The lower portion of the Chao Phraya River (km. 7 to 62)

Standard level 3: The middle portion of the Chao Phraya River (km. 62 to 142)

Standard level 2: The upper portion of the Chao Phraya River (km. 142 to 379)

The NEB monitoring results during 1985-1990 show that there is a yearly declining trend of dissolved oxygen (D.O.) in the Chao Phraya river. D.O. in the lower portion of the Chao Phraya river is

now less than the standard limit of level 4 (=2 mg/l). Most of the time, but especially during the dry season, the D.O. in the lower Chao Phraya declines to less than 1 mg/l.

The NEB monitoring data during 1975-1980 indicated BOD concentrations in excess of levels 2 and 4 (1.5 and 4 mg/l) in some stations of the upper and middle Chao Phraya river. The level of total coliform bacterial also has an increasing trend every year.

ii. Tha Chin River

In assessing the water pollution status of the Tha Chin river, three levels of water quality targets were set, in accordance with NEB standards, as follows:

Standard level 4: The lower portion of the Tha Chin river (km. 0 to 82)

Standard level 3: The middle portion of the Tha Chin river (km. 82 to 202)

Standard level 2: The lower portion of the Tha Chin river (km. 202 to 325)

The NEB monitoring programme during 1979-1980 centred on the reach between 20.5 and 112 km. from the Tha Chin estuary mouth. D.O. did not significantly change along the reach from km. 0-85 during the year 1979 to 1980. The D.O. concentration in upper reaches of the river was highest, gradually decreasing towards the estuary. In some stations, for example in Krathum Ban District, Wat Donkhai District and Sampran District, the D.O. was lower than the standard limit of water quality level 4 (2 mg/l D.O.). A monitoring programme carried out in 1989 found many samples with D.O. lower than the standard. These findings indicate a decreasing trend of water quality in the Tha Chin river, especially over the middle and lower downstream reaches.

The BOD concentration in the middle and lower reaches of the Tha Chin river shows an increasing trend compared with values in 1987. This trend is continuiing because of increasing domestic wastewater

discharges and higher polluting loads from aquacultural and agricultural activities along the river.

The total coliform count in all reaches of the river was in excess of the standard limit for levels class 2 and 3 (5,000 MPN/100 ml and 20,000 MPN/100 ml). The results indicate high domestic wastewater contamination in the river water, which will continue to increase in future years.

7.3 ACTIVITIES IN THE ORGANIZATION

The PWD was established in 1889 as the engineering agency of the Royal Thai Government (RTG). PWD has the responsibility to provide, when requested, technical assistance to municipalties and sanitary districts on drainage. This has been expanded to include wastewater. These functions are performed by the Sanitary Engineering Division (SED) of the department.

The SED has a general project process from project assessment to training of operating personnel and technical assistance following for local area, PWD is responsible for sewerage projects. A total of 34 sewerage systems nationwide are presented, of which 13 systems were constructed or under construction and 7 treatment plants are being operated. The capacity of the treatment plant in local area in small to medium size with the range of 2,200-32,000 m^3/day. Major treatment methods are rotating biological contactor (RBC), Oxidation ditch (OD) , and stabilization pond (SP). The areas (3) municipalities: Ayutthaya, Pathum Thani and Nonthaburi, and Rangsit area, Detailed design work for the industrial wastewater treatment plant in Rangsit area under the DIW has been completed recently. Other projects are still under feasibility study stage.

7.4 ACTIVITIES FOR INFRASTRUCTURE DEVELOPMENT TAKING ACCOUNT OF THE GLOBAL ENVIRONMENT AND THE LIVING ENVIRONMENT

As I have mentioned before about the water quality in the Chao Phraya and Tha Chin rivers. It is nessary to elaborate some methods of water quality evalnation. In orderr to analyze and asssess the future trends of water quality in both rivers under conditions of no-planning and selective-planning at various levels, it was necessary to develop a simulation of water quality with the aid of a mathematical model. The results of simulation are an important tool enabling decision makers to assess the necessity for prompt remedial action and preparation of mitigation plans for solving the water pollution problem.

Both ppollutant concentrations, which affect the water quality of the river, and flow volumes are important factors in a water quality model. It is apparent that deterioration of water quality in rivers usually increases during the dry season, due to low flow providing inadequate dilution. It was vital, therefore, in this report study to develop a simulation of flow in the river at various time intervals over the years which could be employed in the assessment of water quality.

7.4.1 Simulation of Flow

Flows released from the Chao Phraya dam in Chainat province to the lower Chao Phraya river and those released through the Phophraya barrage and diverted from the Mae Klong basin in the Tha Chin river are utilized, not only for agriculture and domestic purposes, but also to reduce the salinity intrusion problem near the mouths of the rivers. Salinity intrusions produce adverse effects on agricultural and aquacultural areas along the river banks. Cooperation in controlling water utilization has occurred among concerned governmental agencies, including the Royal Irrigation Department (RID), the Electricity Generating Authority of Thailand and

the Metropolitan Waterworks Authority (MWA). For example, the MWA extracts sufficient water to satisfy the demand for potable water in the service areas of the Bangkok Metropolitand Authority (BMA) and in Nonthaburi and Samut Prakan provinces, while the RID regulates the appropriate flow volumes for irrigation and to minimise sea water intrusion.

Currently, the routine work of the RID has included flow recording at various barrages as well as salinity determination at different locations along the lower Chao Phraya and Tha Chin rivers. From the collected data, the RID regulate the appropriate flows at the dam and barrages to maintain the desired salinity level.

In applying the mathematical model in this study, the net flow volume of the dam and barrages, after deduction of the amount utilized for condumption and irrigation purposes, has been used to assess the water quality situation.

The mathematical model adopted in the study, developed by Acre International Company, Canada was applied to study irrigation water uses in the lower Chao Phraya basin during the dry season, which is the worst case for pollution and salinity intrusion problems. For the Tha Chin river, which is separate from the Chao Phraya river and functions as a main canal of the lower west bank of the Chao Phraya project, the reach studied was from downstream of the Phophraya barrage to the river mouth. The results of the flow simulation modelling are summarized as follows:

7.4.1.1 Chao Phraya river

The model study revealed that, over the past 3 years during the March-April period, if a flow volume of 100 cu.m/sec was released from the dam (figure 7.2) and average potable water production by MWA was 28 cu.m/sec, the salinity concentration at Memorial Bridge was 0.1-0.3 parts per thousand (gm/l) and the remaining volume of 50-70 cu.m/sec provided protection

against sea water intrusion. When the dam flow decreased to 70 cu.m/sec, the flow available for mitigation of salinity intrusion was less than 30 cu.m/sec, resulting in a high potential for sea water intrusion. Such a situation has been experienced and salinity levels upto 11.75 ppt (April 1988) have been measured at Memorial Bridge.

It can be concluded that, for protection against sea water intrusion, the discharge flow must not be less than 60 cu. m/sec provided that the flow volume for consumption does not exceed 30 cu.m/sec. The total flow from the dam, therefore, must be not less than 90 cu.m/sec. In the future, the discharge from the dam must be increased in direct proportion to the increased demand for potable water supply by the MWA. However, a minimum flow volume of 60 cu.m/sec was use to assess the water quality situation in the Chao Phraya river.

7.4.1.2 Tha Chin river

Results from the model, in conjunction with recorded data at Phophraya barrage and records of water diverted from the Mae Klong basin though klong Jorakhe Samphan, klong Song Phi Nong and klong Tha San Bangpha, (figure 7.3), indicate that the remaining flow to the river mouth, after utilization for irrigation, was approximately 27-43 cu.m/sec. Under these conditions salinity concentrations measured at the Kra Thum Baen regulator were in the range of 0.4 - 1.4 ppt, which is considered to be permissible concentration for agriculture. It can be concluded that the required minimum flow to the lower Tha Chin river is 35 cu.m/sec and this figure has been used to assess the water quality situation in the river.

7.4.2 Simulation of Water Quality

In this study, a mathematical model was developed to estimate the water quality situation in the Chao Phraya and Tha Chin rivers under three scenarios, as follows:

(1) without investment in wastewater treatment systems,

(2) with appropriate investment in wastewater treatment system, according to the economic situation, and

(3) with wastewater treatment systems adopting best available technology.

For each case, to assess the potential trend of water pollution problems, simulation of water quality was carried out for the next 10 and 20 years. Dissolved Oxygen (DO) and 5-day Biochemical Oxygen Demand (BOD_5), were chosen as the most appropriate indicators of water pollution.

7.4.2.1 Results of the Chao Phraya river water quality simulation

To simulate the water quality situation along the Chao Phraya river for plannning purposes, the worst case situation was considered. In the dry season, a fresh water flow of 60 cubic metres per second has been considered to be the minimum to the lower Chao Phraya river, in order to control sea water intrusion.

1) Present condition - Based on data of wastewater presently being discharged into the Chao Phraya river via various canals and conduits, the results indicated that the simulated output agreed with the collected data representing used in the model had been assigned appropriate values.

2) Future predictions for the next 10 and 20 years without further wastewater treatment - Future predictions were based on the following assumptions. The flow and BOD_5 discharged into the river were assumed to increase by

2.0 per cent per year while the flow rate in the Chao Phraya river was kept constant at 60 cubic metres per second. The various model coefficients were assumed not to change. The results indicated theat BOD_5 will reach its maximum value at 50 km from the river mouth and that it will increase from 11 mg/l in the year 1990 to 13 to 16 mg/l in 2000 and 2010, respectively. The length of river over which the dissolved oxygen sag curve will fall below 2 mg/l will extend upstream from a point 50 km from the sea by approximately 5 km in the year 2000 and by 10 km in 2010. These predictions indicate the necessity of introducing control measures for wastewater discharges to the Chao Phraya river.

3. Future predictions for the next 10 and 20 years assuming appropriate investment in wastewater treatment - It was assumed that flow and BOD_5 will both increase by 2.0 per cent per year and that a wastewater collection system will be installed inside the BMA area. The clooection system was assumed to intercept 70% of all wastewater discharged in the BMA area and treatment was assumed to produce an effluent BOD_5 of 20 mg/l. Uncollected wastewater was assumed to continue to discharge into the canal system and the Chao Phraya river untreated. The simulation results revealed that the DO-sag curve in the years 2000 and 2010 will extend downstream to 8 and 4 km, respectively, from the river mouth. Also, the polluted condition of the Chao Phraya river will extend from the river mouth to an upstream point at 65 km. For an appropriate investment in wastewater collection and treatment system in the years 2000 and 2010, the polluted

stretch of the river will be from km 15 to km 55 and km15 to km 60, respectively.

The minimum DO levels in the river will increase from zero to 1.5 mg/l in 2010 and to 1.0 mg/l in 2010. For maximum BOS_5 levels in the years 2000 and 2010, the existing level of 10.5 mg/l at a distance of 50 km from the sea will decrease to 5.0 mg/l and 6.2 mg/l, respectively.

4. Future predictions for the next 10 and 20 years with the best technically feasible wastewater collection and treatment system

- wastewater flow and BOD_5 were again assumed to increase by 2.0 per cent per year. However, 90% of all wastewater was assumed to be collected and treated to a BOD_5 standard of 20 mg/l. The simulation results indicate that there will only be a marginal difference in the shape of the dissolved oxygen sag curve between the years 2000 and 2010. This level of collection and treatment will further reduce the length of river remaining below 2 mg/l dissolved oxygen to approximately 35 km, ie. the location of the heavily polluted section of the river will change to the distance intervals of km 20 - 53 and km 20 - 55 in the years 2000 and 2010, respectively. The existing maximum BOD_5 value of 10.5 mg/l at a distance of 50 km from the sea, will decrease to 5.0 mg/l both in the years 2000 and 2010.

7.4.2.2 Results of the Tha Chin Water Water Quality Simulation

The water quality simulation results were based on worst case assumptions of dry season low flow conditions with an additional continuous freshwater release of 35 cubic metres per second into the Tha Chin river.

1) Present condition - The results indicated that the model simulation curves gave good agreement with the dissolved oxygen and BOD_5 data collected from the Tha Chin river. The ability to simulate present conditions gave confiditions gave confidence in using the model to predict future conditions.

2) Future predictions for the next 10 and 20 years without further wastewater treatment - the results showed that an increase in the length of river with dissolved oxygen less than 2 mg/l from the present level of 45 km to 60 km in the year 2000 and 65 km in 2010 will occur. The DO-sag curve will extend upstream from present conditions by 5 and 10 km in the years 2000 and 2010, respectively. The minimum dissolved oxygen level will reduce from approximately 1.8 mg/l at a distance of between 40 and 90 km from the river mouth, will increase to 11.0 mg/l and 14.0 mg/l in 2000 and 2010, respectively.

3) Future predictions for the next 10 and 20 years assuming appropriate investment in wastewatew treatment - Assuming 70% of wastewater is collected and treated, the simulation results showed that the minimum dissolved oxygen level in the river will improve to 2.5 mg/l in the year 2000 but will fall back to 2.0 mg/l in 2010, due to the increase in BOD_5 load. The DO-sag curve, in the years 2000 and 2010, will extend downstream from the present condition by 5 and 2 km, respectively. In the years 2000 and 2010, no stretch of the river from the river mouth to km 45 will fall below 2 mg/l DO, which will provide considerable improvements in aquatic life and aesthetic qualityu. The existing maximum BOD_5 value of 8.0 mg/l at a distance of between 40 and 90 km from the river mouth

will change to 7.5 mg/l and 9.5 mg/l in the years 2000 and 2010, respectively.

4) Future predictions for the next 10 and 20 years with the best technically feasible wastewater collection and treatment system - Assuming a 2 per cent per year increase in wastewater flow and BOD_5, with 90% collection and treatment, the model results indicated that the minimum dissolved oxygen concentration in the river will be 2.5 mg/l in the year 2000 and 2.2 mg/l in 2010. The DO-sag curve will extend downstream from the present condition by 12 and 10 km for the years 2000 and 2010, respectively. The existing maximum BOD_5 value of 8.0 mg/l at a distance of between 40 and 90 km from the river mouth will change to 7.0 mg/l and 9.0 mg/l in the years 2000 and 2010, respectively.

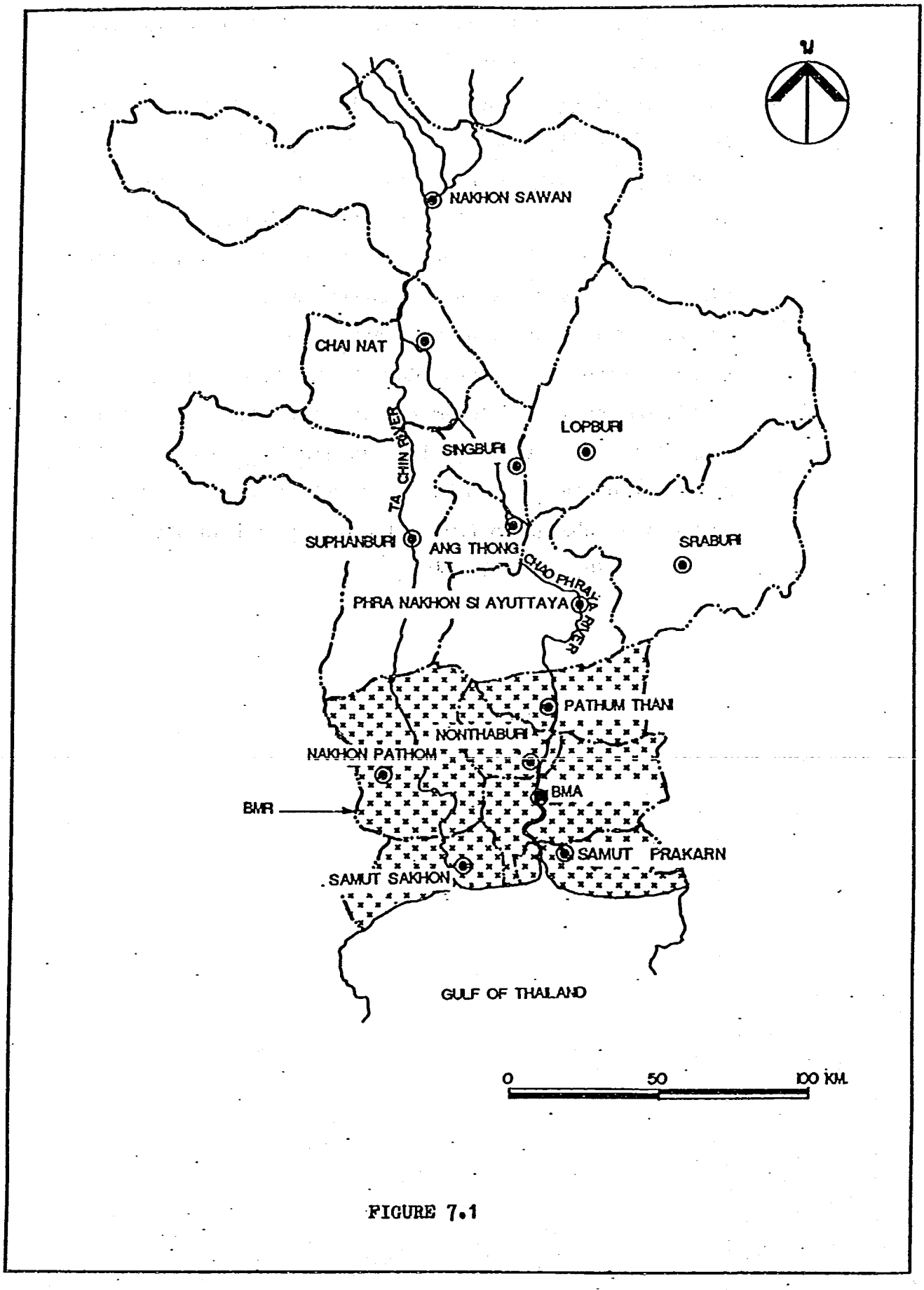

N
NAKHON SAWAN
CHAI NAT
TA CHIN RIVER
LOPBURI
SINGBURI
SUPHANBURI
ANG THONG
CHAO PHRAYA RIVER
SRABURI
PHRA NAKHON SI AYUTTAYA
PATHUM THANI
NONTHABURI
NAKHON PATHOM
BMA
BMR
SAMUT PRAKARN
SAMUT SAKHON
GULF OF THAILAND
0
50
100 KM.

FIGURE 7.1

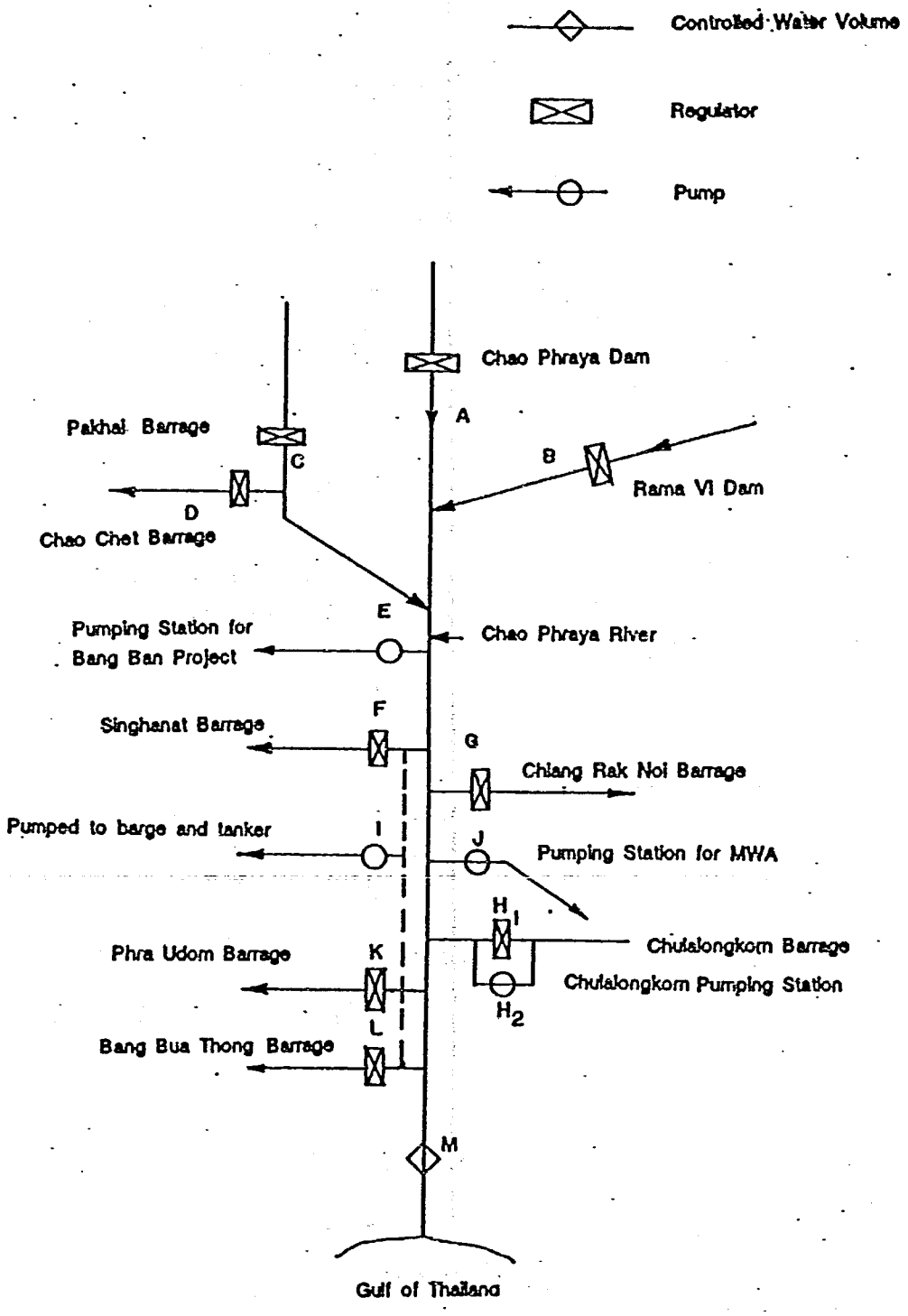

Controlled Water Volume
Regulator
Pump
Chao Phraya Dam
A
Pakhai Barrage
C
B
Rama VI Dam
D
Chao Chet Barrage
E
Pumping Station for
Bang Ban Project
Chao Phraya River
F
Singhanat Barrage
G
Chiang Rak Noi Barrage
Pumped to barge and tanker
I
J
Pumping Station for MWA
H1
Phra Udom Barrage
K
Chulalongkorn Barrage
Chulalongkorn Pumping Station
H2
L
Bang Bua Thong Barrage
M
Gulf of Thailand

FIGURE 7.2

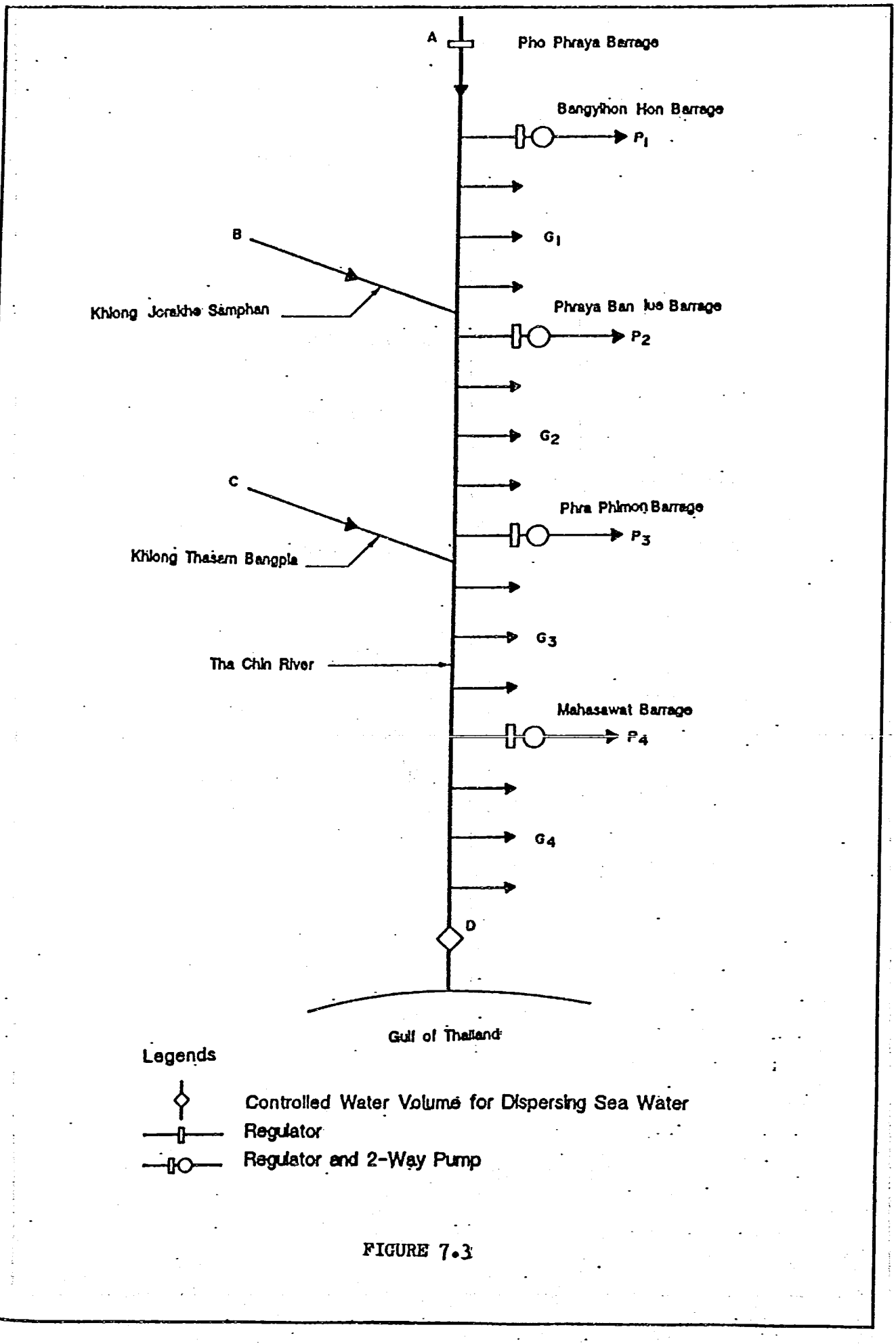

A
Pho Phraya Barrage
Bangyihon Hon Barrage
P_1
G_1
B
Khlong Jorakhe Samphan
Phraya Ban Iue Barrage
P_2
G_2
C
Phra Phimon Barrage
P_3
Khlong Thasam Bangpla
G_3
Tha Chin River
Mahasawat Barrage
P_4
G_4
D
Gulf of Thailand
Legends
Controlled Water Volume for Dispersing Sea Water
Regulator
Regulator and 2-Way Pump

FIGURE 7.3

8. PROPOSALS FOR FURTURE DISCUSSION

Asian common interest, actually in case of how to develop their countries, is the urgent need to upgrade the country by transfering of technologies. In fact, the technologies can be developed by research works in varicty. And the urgent need, should be far-reaching to their technological revolution.

The requirements for further discussion should be based upon the following items.

(1) The new development methods in constructions (Building, Bridge, tunnel, etc.)

(2) Update equipments, machines for constructions and update research equipments or testing equipments.

(3) New construction products resulting from researchs.

However, many countries, for example some in Indochina, less emphasis has been given to various aspects and element of new technology planning and application. Moreover, some regions in Asia also include least developed, where transfer, development and use of technologies have not made much progress.

Consequently, the strategy for developing to manage and harness new technology will vary in different countries, depending on their respective overal level of social and economic development, particular needs and prioities, resources and traditions.

To proceed the target, transfering of technologies should be progressively performed. Aim at constructions, among them, Public Works Research should play an impotant role. The activities would be consolidated and expanded.

The functions cannot carry out unless extra budgetary programme fund are made available by donor countries or some agencies, i.c. Japan or JICA, for example. And, also research pundings, research exchange programmes and the regional research seminars should be provided.

VIII. Japan

Dr. Takashi Iijima, Assistant Director-General,
Public Works Research Institute, Ministry of Construction

Dr. Kenneth Hipps, Assistant Director General
Public Works Research Institute, Ministry of Construction

1. Outline Features of Japan

Japan is a country of islands arranged in an arc-like formation stretching for a total length of 3,000 kilometers (1,860 miles) to the east of the Asian continent. In addition to the four main islands of Honshu, Shikoku, Kyushu, and Hokkaido, the country is made up of more than 4,000 scattered islands. The capital, Tokyo, stands at east longitude 140° and north latitude 36° The Japanese Archipelago lies on the Pan-Pacific volcanic belt, and it is one of the world's most prominent areas of seismic occurrences, with a great deal of volcanic activity. Mountains cover 67% of the land, and many of the mountains are covered with forests. Farmland takes up 15%, housing land 3%, and industrial land a mere 0.4%.

Japan is spread over about 31 degrees of longitude and about 25 degrees of latitude, thus there is a large difference in climate from the north to the south. Annual rainfall in Japan as a whole is about 1,800 mm. This varies, however, greatly from region to region, for while Setouchi (Takamatsu) and eastern Hokkaido (Asahigawa) have around 1,000 mm, in certain areas on the Pacific side of southwest Japan it reaches almost 4,000 mm. In terms of monthly variations in rainfall, the tendency is for the greatest rainfall to come in the "*tsuyu*" (rainy season) in Kyushu and Shikoku, in the winter in heavy snowfall areas on the Sea of Japan (Joetsu District), and in other areas in autumn, when typhoons are frequent. The characteristics of precipitation in Japan are marked by the three elements of snow, the "*tsuyu*" rainy season, and typhoons. Three or four typhoons score direct hits on Japan every year and deposit large amounts of rainfall over wide areas. And in terms of Japan as a whole, one-quarter to one-third of the annual precipitation is said to be brought by typhoons. Rainstorms of this sort caused by fronts frequently lead to large-scale flooding, and can cause disasters across the nation.

The population of Japan has increased dramatically in line with the development of industry since the Meiji Reformation (in the second half of the 19th century), until at present it numbers around 120 million people. The population density per square kilometer is about 320 people. The distribution of population shows a large regional disparity. In particular, there is an outstanding concentration of population in major cities such as Tokyo and Osaka as well as in cities peripheral to these. In contrast to this, there are low population areas in Hokkaido, in southern Kyushu and the Pacific side of Shikoku, in mountainous areas in the interior of Honshu and on its Pacific side, and the depopulated areas are spreading.

The Japanese economy grew to a postwar revival from a period of extreme disorder at the end of the Second World War in 1945. Subsequently, in the space of about 19 years from around 1955 to 1973 (the year of the oil crisis) the actual economic growth of GNP recorded an annual growth rate of about 10%. The Japanese economy experienced four recessions within its period of high-level growth. In particular, that of 1965, caused by a surplus of capital equipment, was the most serious, and the government attempted to revive the economy by issuing deficit-covering national bonds. In spite of these recessions, at the end of the extended period of economic growth the GNP has now become the world's second highest, while the per capita national income has become the highest in the world.

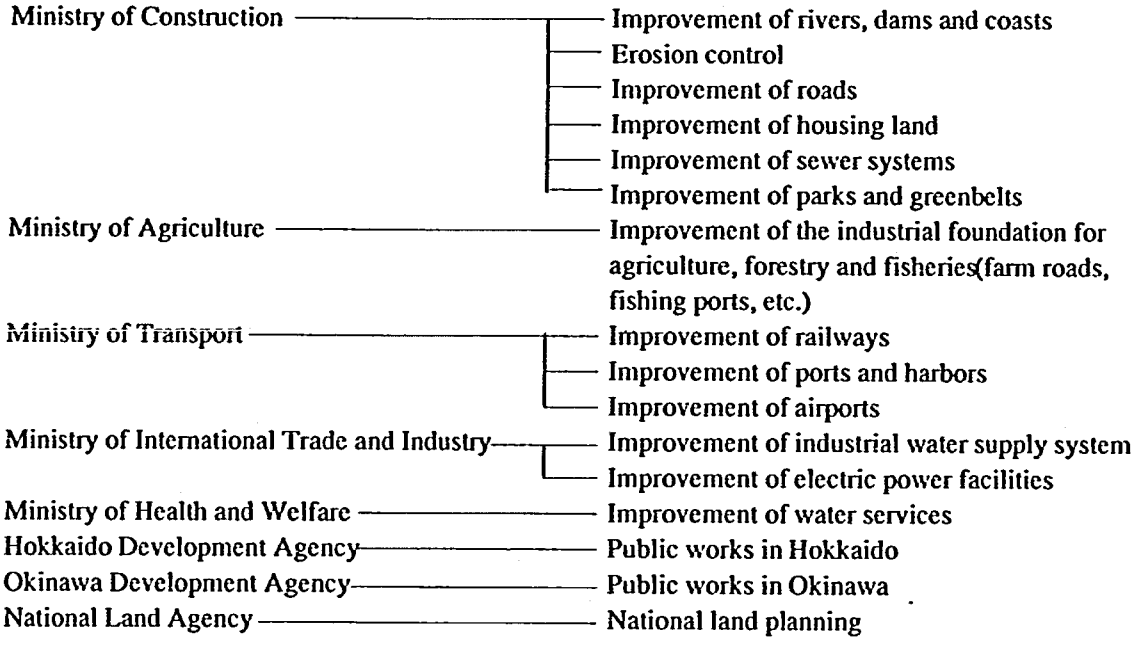
Meanwhile, Japan's international trade, in terms of its commodity structure, could be described as a classic processing trade (importing resources and exporting products) until 1970. The proportion of imports grew, topping 50% in 1990. With NIES and ASEAN products coming to the fore, and progressive industrialization in resource-exporting countries, Japanese industrial products, which amount to 99% of its exports, are going through a transition to higher added-value goods.

2. Current Status of Public Works in Japan

Laws relating to national land development in Japan comprise key laws such as the Comprehensive National Land Development Law, the Land Basic Law, the National Land Utilization Planning Law, and other laws peripheral to these; the National Capital Region Development Law and the Regional Development Promotion Law in order to promote the development of these respective areas, and related laws

Plans relating to the development of national land are largely based on the Nationwide Comprehensive Development Plan. At present the "Fourth Nationwide Comprehensive Development Plan" is under way. Moreover, for each project there are five-year plans in which more concrete medium- and long-term development objectives are stipulated, and thus development is being promoted in a systematic manner. Moreover, for each project there are five-year plans in which more concrete medium- and long-term development objectives are stipulated, and thus development is being promoted in a systematic manner. In the "Master Plan for Public Works Investment"(authorized in 1990), which shows the keynote for public works over the next ten years and the public investment plan in an approximate sum of 430 trillion yen.

National institutions and organizations (mainly responsible ministries) related in execution of public works are as shown in the following chart.



The following paragraphs describe the history of significant improvements of the infrastructure executed by the Ministry of Construction, and problems encountered during the progress of improvement.

a. River Works

Japan is situated in a typhoon zone and the present basis of flood control systems was set up by the "Erosion and Flood Control Emergency Measures Law" enacted and the "Flood Control Special Account Law" modified in 1960 with the large typhoons and heavy rainfalls repeated in 1945, 1947 and 1948 as a momentum. Legislative modifications and national land conservation have actively and continuously been promoted to provide multi-purpose dams, comprehensive erosion control measures, landslide disaster prevention and coast line conservation measures against excessively concentrated population. However, disasters still occur at various places every year and it is necessary to provide measures continuously in the future.

b. Highway Works

For the period from the first 5-year road improvement plan inaugurated in 1954 to the present 11th 5-year plan, diligent efforts have been made in improvement of roads. During the period in 1957, expressway construction work commenced. The rapid growth of the economy since 1955 and the mass popularization of automobiles since 1965 resulted in to lead a dramatic rise in traffic accidents. Consequently, measures have been provided to achieve the traffic safety. For the last 40 years, the road network of Japan has been steadily improved and vehicle transportation has occupied a large space of domestic transportation systems, but it cannot be determined that it fully corresponds to increasing traffic demands and diversified and intensified mobility. More efforts towards the next generation is deemed necessary.

c. Housing

Housing situation was in a state of critical shortage immediately after the war. The government provided 43,000 units of temporary prefabricated housing for disaster-hit cities as an emergency measure and made continuous efforts to meet increasing demands. As a result, the number of houses exceeded the number of households and the absolute shortage of housing was resolved in 1973. Although the shortage of housing was relieved, policy is being developed to improve the present housing standard of Japan which is characterized of small and low quality housing.

d. Sewer systems

Sewer systems have only a short history in Japan and the improvement of the systems had not been considered as a main national project until the late in 1955. The rapid growth of the economy since 1955 resulted in to cause significant deterioration of urban environment and water pollution, and demands for and the importance of sewer systems rapidly increased. Accordingly, five-year sewer systems improvement plans were set up since 1963 and efforts are being made towards the improvement of systems. Sewer systems have achieved the diffusion rate of 47% now.

e. Parks

As a result of the dramatic advancement of urbanization during the period of rapid economic growth, deteriorated living conditions and urban environment became a hot issue. In 1972, the first 5-year city parks improvement plan was made and city parks were quickly improved. However, the per capita area of city parks is still at a low level when compared with other advanced countries, and more active efforts will be required in the future.

Joint construction efforts by the government and private sectors have been continued up to the present, and the gross investment by the government and private sectors reached 85.8 trillion yen in 1992. In addition, gigantic projects such as the Trans-Tokyo Bay Highway, the Control Business Cities, the Kansai Culture, Science and Research City, the Kansai International Airport, the Honshu-Shikoku Bridge, and high standard arterial road construction projects including the Second Tokyo-Nagoya Expressway are being executed now towards the future.

3. Outline of Public Works Research Institute, Ministry of Construction

The Public Works Research Institute, Ministry of Construction was launched on September 30, 1922 as the Civil Engineering Laboratory, the Ministry of Internal Affairs. Subsequently its name was changed to the Public Works Research Institute, Ministry of Construction, in line with the creation of the Ministry of Construction on July 10, 1948, and in March 1979 all of its branch offices and Laboratories (except those of the Niigata Experimental Laboratory) were moved to new Tsukuba Science City. Over the 70 years since its establishment, the Public Works Research Institute has undertaken research from experimental to applied stages and technological development with the aim of solving problems of technology in connection with a wide range of construction projects.

The Public Works Research Institute, with the Director-General of Public Works Research Institute at its had, is composed of a Research Support Department (comprising a

General Affairs Department and a Planning and Research Administration Department). nine Research Departments consisting of Environment, River, Water Quality Control, Dam, Erosion Control, Road, Material and Construction Method, Structure and Bridge, and Earthquake Disaster, the Construction Management Engineering Research Center, and the Niigata Experimental Laboratory. There are 35 research divisions under the jurisdiction of the nine Research Departments, forming a structure which is able to handle research and development of civil engineering technology over a wide range of fields.

In promoting these research and development projects, in 1983 the Public Works Institute determined the future course of long-range research and development projects in conformance with the long-term program planned by the Ministry of Construction, and began setting up a 5-year plan to facilitate research and development projects efficiently and systematically, corresponding to the needs of the times. At present, research and development projects are underway to respond to diversified national and administrative needs, based on the third 5-year plan, started in 1992.

A new budget in the amount of approximately 11,200 million yen was authorized for Fiscal Year 1993. The budget is includes labor costs and office expenses of approximately 4,000 million yen, research and investigation costs of approximately 5,800 million yen, and facility maintenance costs of approximately 1,400 million yen. The total number of employees is 471, consisting of 310 research and 161 management and supporting personnel.

Approximately 450 subjects of study are scheduled to be finished during Fiscal Year 1993. Therefore, the average cost of one subject amounts to approximately 13 million yen. Each laboratory is organized with a little under 10 researchers and is responsible for an average of 12 subjects. These study subjects are scheduled based on the five-year plan set up by the Public Works Research Institute. Each laboratory is allowed to receive supporting guidance, counseling, and research coordination through in-house hearings headed by the Director-General of the Public Works Research Institute, or hearings to be held by the government or scholars and specialists.

Imminent and important themes that are in high demand by the administration and those that cover various fields are carried out in the project system participated by several institutes. The development of applied techniques depends greatly on commercial support, and the joint research system sponsored by public corporations or private sectors is often used as an effective means.

For general subjects of study, a budget is allocated with priority given to those subjects urgently requiring technical development and those requiring expensive cost of experiments. For the promotion of these subjects, management studies that can predict the future of the Public Works Research Institute, taking into account the changes in modern social conditions, will become important.

Recently, it is becoming more important for the Public Works Research Institute to push forward active personnel exchanges with private sectors and educational institutions, to lead the civil engineering research and development of Japan and to adjust the role of the government, academic societies and private sectors as a coordinator between universities engaged in fundamental studies and private sectors, engaged in research and development, concurrently with the promotion of characteristic studies as the civil engineering center of excellence (COE) of Japan.

4. Current Status of Major Research and Development of the Public Works Research Institute

4.1 Major Fields of Research and Development

The following six common functions of research and development are assumed by the Public Works Institute to meet the future requirements of Japan: (i) research and development responding to diversified needs for the provision of infrastructure, (ii) research and development for the benefit of users, (iii) research and development placing emphasis on the environment, (iv) research and development that is universal for all countries, (v) research and development that is peculiar to Japan, and (vi) research and development to improve the infrastructure for appearance, function, and durability. The following are major fields to be challenged under these common concepts of study.

(1) Acceleration of intensified use of national land.

(2) Construction of a stable and safe living environment.

(3) Construction of a society that matches well with the environment.

(4) Development of construction techniques to achieve efficiency and to improve safety.

(5) Development of civil engineering construction materials by practically using the results of all relevant fields.

(6) Improvement of maintenance methods with the intention of achieving maintenance free facilities.

(7) Advancement into new frontiers such as space and marine engineering.

(8) Establishment of comprehensive and reasonable construction management techniques.

4.2 An Example of Technical Research and Development Projects

"R&D on New Technologies for Improvement and Renewal of Social Resources" (1991 — 1995)

Public facilities of Japan have been properly maintained and improved, and these have reached an unwieldy size. In order to maintain these facilities in good condition, a research and development project is being pushed forward on the captioned subject as a research subject of comprehensive R&D projects, provided with guidance and assistance of various committees composed of scholars and specialists, or in joint efforts with private sectors.

Under this project, techniques of diagnosing and evaluating various structures by measuring are developed, as are materials and construction methods for replacement and improvement of functions. Also, management systems, intensified with primary techniques such as methods of evaluation and protection to achieve effective and economic maintenance and replacement, are developed, as well as techniques to reduce maintenance and replacement costs.

4.3 Problems in Promoting Research and Development

As construction projects have increased in size and have become diversified, the size of experiment equipment required for experiments is being increased and the period of research is being extended, but the number of problems that must be resolved in response to the progress of project is also increasing. For these reasons, it is becoming necessary to make detailed and flexible schedules of research to push forward the schedules more reasonably and efficiently.

It is necessary to obtain a sufficient budget for efficient research and development. In general, the budgets for research and development are often restricted or reduced when economical conditions are very severe but efficient execution by the rational operation of the budget and with the cooperation by outside organizations is required, along with efforts for obtaining a sufficient budget, having all related personnel understand the importance of research and development.

In addition, it is also important to establish a system that assures an environment comfortable for studies, by reorganizing, increasing the number of researchers, and securing sufficient time for the studies.

5. International Research Exchange Programmes in Asian Region by the Public Works Research Institute

5.1 Research Projects

The Public Works Research Institute actively participates in international research cooperation as the general research institute of the country responsible for engineering and improvement of the infrastructure. The following projects are currently under way in cooperation with other Asian countries within the framework of agreement for cooperation in science and technology, etc.

Table 5.1 Current Technical Cooperation Projects

No.	Name of Projects	Counterpart Organization
1	Studies on Mitigation and Control of Sediment Disasters	Institute of Mountain Hazards and Environment, China Academy of Railway Sciences
2	Studies on Mitigation and Control of Landslide, Debris Flow Disasters	China Academy of Railway Sciences
3	Exchanging Information About Urban Planning Technology	Ministry of Construction, China
4	Japan-China Conference on Rivers and Dams	Institute of Water Conservancy and Hydroelectric Power Research, Ministry of Water Resources, China
5	Improvement of Seismic Design Methods for Highway Bridges	National Bureau of Earthquake, National Mechanical Research Institute, China
6	Improvement on Seismic Design for Lifeline Facilities	National Bureau of Earthquake, National Mechanical Research Institute, China
7	Japan-Korea Technical Cooperation in Construction Technology	Korea Institute of Construction Technology, Ministry of Construction
8	Development of Urban River Improvement System	Korea Institute of Construction Technology, Ministry of Construction
9	Studies of Technology for Preventing Sediment Disaster on Alluvial Fans	Volcanic and Sabo Technical Center, Indonesia
10	International Joint Study on Development of Methods of Predicting Sediment Disaster in Volcanic Areas	Volcanic and Sabo Technical Center, Indonesia
11	Joint Research on the Change of Tropical Forests and Their Influences	Royal Irrigation Department, National Research Council of Thailand
12	Joint Research on the Enhancement of Remote Sensing Technology in Tropical Environment Monitoring with ASEAN Countries	Royal Irrigation Department, National Research Council of Thailand

In addition, the PWRI has been actively participated in multilateral cooperation including the United Nations Economic and Social Commission for Asian and the Pacific (ESCAP), and the Road Engineering Association of Asia and Australia (REAAA), etc.

5.2 Problems in Promotion

A procedure for technical cooperation in the future has already been established, in response to requests from international countries. International exchange of studies is being carried out only with countries based on an agreement signed for scientific technological cooperation, because funds are very limited, although the system is authorized. At present, the exchange of studies with other Asian countries is mainly made by technical cooperation and the exchange of researchers is not made too often.

The exchange of studies between Japan and other Asian countries has been made mostly by dispatching specialist engineers and inviting trainees through JICA. Therefore, these activities have been made mainly for the purpose of transferring technology.

However, difficult problems that cannot be solved by a single country, or problems that can greatly affect surrounding countries, including environmental problems, are increasing. Demands are increasing for all countries in Asia to develop their societies in close cooperation. Therefore, firm systems for exchange of technical information must be established, because it is becoming necessary to strengthen the technical research information network and to promote exchanges in a wide-ranging field of technical research and development.

6. Current Activities for "Damage from Disasters and Disaster Prevention"

6.1 General Description

Since Japan is located in a monsoon climate zone and 67% of the national land consists of steep mountainous areas, and is situated in the Pan-Pacific earthquake zone and surrounded by oceans, the land is often damaged by various natural phenomena. With such conditions in the background, the Public Works Research Institute actively attempts to reduce damage from natural hazards and to prevent disasters.

In this chapter, natural hazards in Japan are roughly classified, as shown below, to understand actual conditions and problems, and the current activities of the Public Works Research Institute for "damage from hazards and disaster prevention" will be discussed.

a. Damage caused by rivers
b. Damage along the coast
c. Water shortages
d. Sediment disasters
e. Damage due to earthquakes

In addition, the following preventative measures will be discussed.

a. General flood control measures
b. Measures to prevent damage to road slopes

6.2 Actual "Damage from Natural Phenomena and Disaster Prevention" in Japan and Future Subjects

1. Damage Caused by Rivers

Japan has been characterized as a country subject to frequent floods due to its peculiar land and climate conditions, and has suffered from flood damage every year dating back to ancient times. As a result of investments in flood controls, the number of floods is steadily being reduced and the number of deaths and injuries in recent times has been reduced remarkably. It is rare recently that wide areas are submerged. However, flood control facilities are still insufficient. After the 1960's in particular, the sum of areas being flooded tended to decrease, but damage to public assets tended to increase because the economy of Japan grew rapidly and population and assets concentrated into urban areas. Under such a situation, if economic limitations are taken into consideration future efforts will be directed towards more rational and efficient flood prevention measures, both structural and non-structural.

2. Damage Along the Coast

The coast of Japan have been repeatedly damaged by storm surges and tsunamis. Such damage is being reduced with the benefit of breakwaters and seacoast dikes, but beach erosion is still progressing at various locations and natural beaches are disappearing rapidly. These rapid erosion might be the result of the following causes.

a. The continuity of drifting sand along the coast has been shut off by breakwaters.
b. Wave shutoff areas have been formed by large-scale breakwaters.

c. The amount of sediment from rivers has been reduced.

3. Damage from Shortage of Water

The average annual rainfall in Japan is approximately 1,750 mm, which is about two times the world average; but the amount of rainfall per population is only a quarter of the world average. The amount of rainfall varies significantly in areas. The dependence on water resources and water demand are not balanced in these areas. The importance of measures to guard against the shortage of water is being rediscovered because of decreased precipitation in the last few years. The water demand is estimated to increase in the future, therefore approximately 340 dams and other water resources development facilities, including projects under construction, are supposed to be completed.

4. Sediment Disasters

The land in Japan is generally steep and the geology is weak. In addition, natural phenomena, such as heavy rainfalls, typhoons, earthquakes, and volcanic eruptions, often occur. Mountainous areas have been developed, and many people live in areas on slopes or in areas below mountains. Therefore, damage from what-is-called sediment disasters, such as debris flows, landslides, or steep slope failures, can easily occur. In mountainous areas, slopes alongside roads or roadway embankments often fail, and rockfalls and landslides frequently occur and disrupt traffic. Under these conditions, damage due to sediment disasters occurs at various locations and the number of deaths or missing people from sediment disasters reaches almost 60 percent of the total number of natural disasters. In order to prevent or reduce damage from sediment disasters, various measures, including disaster prevention facilities, are planned by the Ministry of Construction or prefectural governments in Japan, based on the Sabo Law, the Landslide Prevention Law and the Law concerning Prevention of Disasters due to Collapse of Steep Slope.

5. Damage from Earthquakes

Japan is one of the most earthquake prone countries in the world. Recently, the Kushiro-oki earthquake (magnitude of 7.8) occurred in January 1993 and the Hokkaido-Nansei-oki earthquake (magnitude of 7.8) occurred in July of the same year. During the latter earthquake, the number of deaths and missing people from tsunami and fires totaled approximately 250. Observing the damage from earthquakes in Japan, it can be seen that the type of damage changes with the times. A striking trend is the increase in city-type damage, represented by damage to lifeline facilities, which can be pointed out as a new type of damage. In Japan, where the population and infrastructure are concentrated, preventive measures against damage from earthquakes are imminently required. The great fires which occurred during the Hokkaido-Nansei-oki earthquake are a warning for the need to prevent future damage to urban areas. There is also an urgent need to prevent or reduce conventional damage from earthquakes, including damage resulting from slope failures, liquefaction and tsunamis.

6.3 Current Activities of the Public Works Research Institute for "Damage from Hazards and Disaster Prevention"

1. Techniques to Prevent Damage Caused by Rivers

The minimum level of safety for flood control is being secured in Japan, but studies are being made at present to construct even safer rivers with their peculiar attraction. Since it is necessary to control rivers by engineering means and to understand the hydrologic cycle under natural conditions for preventing damage from floods, and assuring water resources for creating rich and safe living conditions, investigations and studies are being made on: (i) development of hydrological observation technology, (ii) research on the runoff of rivers, and (iii) the effect of changes in the global environment. Because it is necessary to provide multiple measures, not only for rivers but also for river basins, to cope with flood problems

on rivers in urban areas and their river basins, investigations and studies are being made for settling various issues related to such comprehensive flood control measures.

2. Techniques to Prevent Damage Along the Coast

Studies are being made on the headland method as a means of preventing beach erosion and with the manmade reef method as a means of preventing storm surges. The headland method is used for stabilizing the shoreline by checking drifting sands between groups of headlands, constructed at appropriate spaces on a long sandy beach. The manmade reef method is used to settle background areas causing waves to break in shallow water areas, and is constructed by riprap or concrete blocks laid on the offshore sea bottom.

3. Techniques to Prevent Water Shortages

The construction of dams as water resource facilities covers diversified fields of engineering and the related construction problems also cover many different fields. To settle such technical problems, the Public Works Research Institute deals with studies on the planning and operation of water resources development facilities, the effect of global warming on water resources, the methods of designing dam bodies and rock foundations, dam materials and improvement of construction methods, methods of design of hydraulic structures, the safe management of dams, and measures for preventing the depositing of sediment.

4. Techniques to Prevent Sediment Disasters

In order to develop techniques to prevent and mitigate damage caused by sediment disasters, as well as debris flows, landslides, steep slope failures, and road embankment and roadside slope failures, the Public Works Research Institute deals with studies on the following subjects. At first, analyses are made on the mechanism of slope movement causing sediment disasters by model experiments or computer simulations. With results of experiments or simulations, methods of investigating hazardous areas, methods of evaluating dangers, and methods of predicting sediment disasters are being developed. The methods developed are applied to the improvement of warning and evacuation systems at times sediment disasters occurs and to the planning and design of rational prevention facilities. Also, various methods are developed, based on model experiments or field tests, to provide efficient sediment disaster protection facilities, and various technical guidelines are established based on the results of studies made on the methods of investigation, design and construction.

5. Techniques to Prevent Damage from Earthquakes

In order to improve the techniques of preventing damage from earthquakes, the projects "Development of New Methods of Earthquake Resistance Design (FY 72 — 76)," "Development of Techniques for Restoration after Earthquakes (FY 81 — 85)," and "Development of Disaster Information System (FY 87 — 91)," are being executed under the comprehensive technical development project of the Ministry of Construction and wide results of research are being achieved. Beginning in 1992, a new project called "Development of Technique for Preventing Earthquake Damage in Major Cities" is being executed, based on the 5-year plan. Studies on development of earthquake resistance design methods for roads, rivers and lifeline facilities are being made separately. The results of these studies are being applied to various earthquake resistance design standards. Only recently started, studies are being made on the development of new methods of earthquake damage prevention, including earthquake resistant design of bridges and measures for preventing ground movement.

6.4 Comprehensive Flood Control Measures

1. Introduction

Rivers of Japan, and those in urban areas in particular, have recently been faced with changes in runoff flow patterns, characterized by an increase in the discharge rate during floods and a decrease in the flow rate during normal periods. The Japanese economy has grown rapidly since World War II, and this growth has resulted in the dense accumulation of population and assets in urban areas, including major cities and other population centers . On the other hand, this trend has depopulated rural areas. With this rapid economic growth in background, river basins have lost their primary water retention and retarding function due to significant changes in the river basins caused by housing land development or diversion of farmlands.

Such changes in land use have also resulted in a reduction in the effectiveness of flood control projects. In areas that were drastically developed and urbanized, demand for land increased and land prices rose. Those who wanted to obtain land at lower prices were forced to purchase land in the flood-prone areas of old low lands. In the highlands and hill sides near urban areas, farmlands and forests gradually disappeared as housing, office buildings and factories were built, causing a change in the effects of floods.

In July of 1974 there was a downpour of 444 mm in a 7 hour period, with 497 mm falling in a 12 hour period, in the river basins feeding the Tomoe River, in the vicinity of the two cities of Shizuoka and Shimizu. This downpour caused 16,000 houses to be flooded above their floor level, and caused some damage to an additional 20,000 houses. The effect was substantial for a small river having a catchment of only 100 km^2. As the low land upstream from the river was completely flooded at the time, damage to the downstream areas was significantly reduced. This helped recognizing the necessity of flood control measures to take into full account the mitigating function of lowlands, i.e., the basin-wide flood control.

Before that time, new policies in management of flood plains that began in the middle 1960s in the United States drew attention of researchers of the Public Works Research Institute and the efficacy of providing flood control measures only with the improvement of rivers was questioned. It can be determined that the need for this new approach was fully understood, and the movement towards comprehensive flood controls was accelerated after the damage caused by the Tomoe River flood and the successive city-type floods from a typhoon in 1976.

In October 1976, the "Small Committee of Comprehensive Flood Control Measures" was organized within the River Council, and recent flood damage including city flood damage problems were examined. In the interim report for promoting comprehensive flood controls, submitted by the River Council to the Minister of Construction in June 1977, basic concepts for comprehensive flood control measures for Japan are described. These concepts include the subjects of securing water retaining and retarding functions, establishing and publishing flood hazard areas and mudflow hazard areas, making urgent improvement plans for flood control facilities, setting up safe land use methods and construction methods against flood damage, and improving the coordination systems among interacting departments and local public organizations. Upon acceptance of this report, the River Bureau of the Ministry of Construction started an institution of "Comprehensive Flood Control Projects for Specific Rivers" in 1979, after repeated discussions held with related ministries and within the Ministry of Construction. This institution was epoch-making because the river administration authority, which had dealt only with river space attempted first to work actively and face to face upon river basins. This was an institution, combining and developed from those used by local governments through ordinances and standards, and those examined within the Ministry of Construction as well. In the following sections, a general description of Comprehensive Flood Control Projects for Specific Rivers will be given, and the concepts of comprehensive flood control that has been adopted in Japan will be introduced, together with a discussion of some of the supporting studies carried out in the Public Works Research Institute.

2. Comprehensive Flood Control Projects for Specific Rivers

The Comprehensive Flood Control Projects For Specific Rivers started in 1979 for rivers having river basins where urbanization was progressing rapidly. The targets of the projects were set up to assure within some ten years, the safety of flood controls for rainfall equivalent to the hourly rainfall of 50 mm (excess probability of 1/5 to 1/10). For this purpose, it was decided to carry out activities such as, (i) active promotion of river improvement projects, (ii) preparation of basin-wide improvement plan, (iii) publishing records of flooding, and (iv) approach local residents to obtain understanding and cooperation.

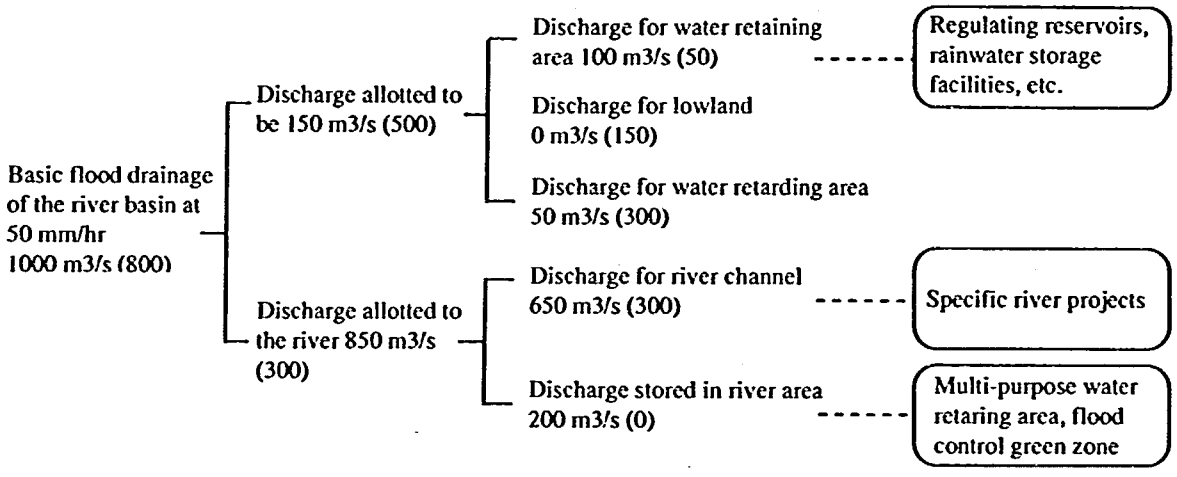
It was decided to set up for each river basin a council of comprehensive flood control measures for the basin, with members from the Regional Construction Bureau, Ministry of Construction, and from related departments for rivers, cities, housing, and land within prefectural and municipal governments, based on the agreement made among local public organizations within the basin to discuss comprehensive flood control measures for the river basin to contribute for assuring effective measures. The following guidelines were presented for each council to follow.

- Identify areas of possible flooding, to use these data as administrative data among members of the council.
- Publish the historical record of past floods.
- Classify river basins into categories of water retaining areas, water retarding areas, and lowland areas, according to their role in flood control.
- As for land with water retarding capability, secure areas necessary for planned flood controls as planned water retarding basins.
- Subsidize the construction cost of regulating ponds that are necessary in flood control plans with respect to large-scale development of housing lots.
- Subsidize the construction cost of rainwater storage facilities as one of the measures for increasing and maintaining water retaining and retarding functions.
- Promote the construction of water storage facilities between apartment buildings, and in recreation fields or plazas to assure their water retaining and retarding functions.
- Improve water retaining capability by the use of drainage asphalt pavement for sidewalks.
- Make an effort to examine guidelines and provide necessary measures to assure the storage capability of wastewater systems.
- City planning authorities will fully consider the land having water retaining and retarding capabilities in urbanization control areas in assigning the designation (or changing the designation) of urbanization areas or urbanization control areas.
- For the purpose of maintaining the water retaining and retarding capabilities of river basins and for promoting safe land use and safe construction methods to minimize damage with existing flood control facilities, make leaflets describing (i) the need for maintaining water retaining and retarding capabilities of river basins, (ii) the encouragement of providing water storage at individual houses and constructing elevated buildings, and (iii) the control of banking meeting local conditions. These leaflets should be distributed by the council of comprehensive flood control measures to local residents, construction contractors, and developers, through municipal offices, to obtain their understanding and cooperation.
- For the designation of hazard areas, discussions are to be held between river and construction departments for areas.
- As a rule, areas within urbanization control areas in danger of being damaged by floods, inundation, tsunamis or high tides should not be designated as urban areas to be urbanized within 10 years.

As a sample discharge allotment in a basin-wide improvement plan, the one shown in figure 6.1 was presented. The discharge allotment for each river basin was planned in reference to this concept and based on the specific characteristics of each basin in the Comprehensive Flood Control Projects For Specific Rivers.

In the example shown in figure 6.1, it can be seen that at present basic flood discharge of 800 m^3/s for a one-hour precipitation of 50 mm, and of this, 300 m^3/s is handled by the river channel, 50 m^3/s in the remaining 500 m^3/s is handled by disaster prevention regulating reservoirs in a water retaining area, 300 m^3/s is handled by a retarding area, and 150 m^3/s is ponded in a lowland.

Other the other hand, it can be estimated that basic flood discharge of the basin will increase to 1,000 m^3/s as a result of the development of the basin after 10 years, the target year for the river basin improvement plan. 850 m^3/s is to be allotted to rivers and that the capacity of river channel is increased to 650 m^3/s from 300 m^3/s the Comprehensive Flood Control Projects For Specific Rivers. 200 m^3/s out of the 300 m^3/s in the retarding area is to be handled by multi-purpose water retarding projects. Even with the above allotment, the sum will not reach the basic flood discharge at the river basin, 1,000 m^3/s. Therefore, 150 m^3/s will have to be allotted to the river basin. The example shows that discharge from the water retaining area is increased from 50 m^3/s to 100 m^3/s under the disaster prevention regulating reservoir projects, then the lowland discharge of 150 m^3/s is changed to 0 m^3/s.



Note: Numbers show the value for the target year (10 years later) of the basin-wide improvement plan.
Numbers in parentheses ( ) show the present value.

Fig. 6.1 Discharge Allotment for River Basin Improvement Plan (Example)

The following example was given for composing a basin-wide improvement plan.

1. General description (objectives of making a plan, planning period, etc.

2. Present conditions of the basin
   a. General description of river basin and rivers (various parameters [area, total length of watercourse, population, etc.] and existing condition of rivers)
   b. Land use (classification of districts in city plan, current land use situation)
   c. Record of inundation (description of major floods in the past, typical flood damage, etc.)

3. Basic guidelines for improvement of river basin
   a. Area classification of flood control functions (categories of water retaining, water retarding, and lowland)
   b. Basic guidelines for improvement of river basin
      (1) Preposition for improvement of river basin (expected development in the basin including urbanization of river basins)
      (2) Basic guidelines for flood control (guidelines of long-term flood control plan [construction master plan, etc.])

(3) Basic guidelines for tentative flood control plan (basic guidelines for improvement of flood control facilities corresponding to the planning period of basin-wide improvement)
(4) Basic guidelines for measures taken in the basin (basic guidelines for measures taken in the basin and basic guidelines for land use)

4. River improvement planning
   a. Existing condition of flood control facility improvement (existing condition of each river)
   b. Flood control plans (construction master plan, etc.)
   c. Tentative flood control plans (target of the improvement, project description, construction period, construction cost, etc.)

5. Improvement planning in each area category
   a. Water retaining areas
      (1) General description (land use in the area and outlined water retaining capability)
      (2) Measures for preserving water retaining function (disaster prevention regulating reservoir, temporary reservoir, rainwater storage, use of drainage asphalt pavement, consideration for storage capability of wastewater systems)
   b. Water retarding areas
      (1) General description (land use in the area and outlined water retarding capability)
      (2) Measures for preserving water retarding function (planned retarding area and multi-purpose retarding pond)
   c. Lowland
      (1) General description (land use in the area and inundation conditions)
      (2) Measures for preserving lowland (measures for drainage systems [including landside water drainage system], designation of hazard areas, and assuring the safety against flood controls in land use)

6. Miscellaneous items (evacuation and warning systems, flood fighting activities, etc.)

When the project of comprehensive flood control projects for specific rivers began in 1979, 10 rivers were designated as specific rivers, but the number increased to 14 rivers by 1982. Since it was determined in 1988 that comprehensive flood control measures should also be provided for existing urban river basins which have already had most of their areas urbanized, in addition to river basins where urbanization is progressing rapidly, three rivers were added and a total of 17 projects are now underway.

3. Activities of the Public Works Research Institute

The Public Works Research Institute contributed greatly to the introduction of the concept of comprehensive flood control measures in Japan, and to the understanding of this concept as a new approach for flood control projects. In addition, since the Flood Disaster Prevention Division was established in 1979 as an organization to conduct research and investigations for comprehensive flood controls, untiring efforts have been made to obtain solutions for technical problems encountered in pushing forward comprehensive flood control measures. The Flood Disaster Prevention Division was reorganized and started as the Urban River Laboratory in April 1993. We will introduce here major studies made by the Flood Disaster Prevention Division how such studies were applied. All subjects dealt by the Flood Disaster Prevention Division, including those to be introduced here, were turned over to the Urban River Division.

a. Flood Hazard Maps

Studies on the use of flood hazard evaluation maps as a medium for evaluating the dangers of floods began in 1981. In the year, to obtain methods of developing maps comparisons and analyses were made of various evaluation methods, including geographical methods, methods based on the history of past floods, hydrological and hydraulic methods, and methods based on damage records. As a result, the primary characteristics and effectiveness of each method and their relationship with flood control measures were clarified. Then, inundation maps based on past floods were published in a number of rivers and streams. In 1985, investigations started on the method of developing flood hazard maps using hydrological and hydraulic methods and their applications. As a result, in 1987, the first flood hazard map was published for the Shinkashi River. Flood hazard maps were originally planned for government use, but were eventually published for the public. The map was developed based on calculations of runoff, flood discharge and inundation for the rainfall expected once in 100 years. Areas expected to be flooded are shown with the expected depths of flood water. Areas of possible inundation judging from their geographical configurations are also indicated. This flood hazard map was published with the following intentions: (i) to have people understand the possible occurrence of flooding in the area, (ii) to draw people's attention to flood fighting activities and to serve for flood fighting and evacuation in a case of an emergency, and (iii) to encourage people to create a living style to minimize flood damage. It was first feared that the publication of this map might affect such things as land prices, but the map was favorably accepted by residents without any confusion.

Similar maps for other three rivers have been published now.

b. Evaluation of Flood Control Facilities in River Basin

Runoff control facilities are considered among the most important measures used for flood control in river basins. It can be said that the first runoff control facility in Japan was the disaster prevention regulating reservoir constructed by the Japan Housing Corporation (presently the Housing and Urban Development Corporation) in the early 1960s. Technical standards have been well established for these storage type runoff control facilities and the capability of individual facilities has been verified by hydraulic calculations. The Public Works Research Institute made field observations to verify the actual regulating capability of these reservoirs, analyzed bulky data on installed reservoirs, proposed the multiple use of regulating reservoirs, and studied for resolving maintenance problems.

Investigations of infiltration type facilities, one of the major techniques used for runoff control in addition to storage facilities, was started by the Hydrology Division in 1978. After the Flood Disaster Prevention Division was organized in 1979, experiments were made on clogging, to evaluate the capability of infiltration facilities and to determine the effects of the size of the facilities on the infiltration capability. In the course of these experiments, how to evaluate the infiltration facilities as runoff control facilities were questioned. Since various technical or administrative problems occurred as field construction proceeded, it became necessary to make immediate technical evaluation of these facilities. With these situations in the background, the Division prepared a draft infiltration evaluation manual for infiltration-type runoff control facilities, based on the results of hydraulic model experiments and field tests, and presented a method of obtaining design infiltration capability with a simple field experiment, as a practical approach to the problem.

The runoff control capability of infiltration facilities has not been understood quantitatively. Infiltration facilities are now used in many cases to provide design redundancy. It is necessary to set up a method of determining design infiltration capability, which is required for incorporating the design of infiltration-type runoff control facilities in flood control plans. For this reason, research and investigation has been continued to determine the basic properties of infiltration facilities (ground properties, types of facilities, clogging properties, etc.) with more detailed field experiments.

c. Flood Fighting

In Japan, people have attempted to minimize flood damage mainly with river improvements and flood fighting activities ever since ancient times. In rural areas mainly covered by paddy fields, flood fighting activities could not be ignored as a self-protection means to protect farmlands from flood damage and inundation. However, social conditions quickly changed with economic growth in the 1960s and innovative waves came rolling on to change the industrial structure from agriculture to industry and to service industries, resulting in the concentration of population in urbanized areas. Rural community spirit decreased and flood fighting organizations and their environment changed widely, and it has become necessary to reconsider the presence of flood fighting activities. Evacuation, guidance, rescue, and relief aid are effective media for reducing personal injuries, but it is presumed that the capability of residents for fighting unexpected conditions by these means has greatly decreased with the development of river improvement works and the reduced damage from floods. The Public Works Research Institute has contributed greatly to the strengthening of flood fighting systems through various studies on water-related disaster prevention systems, including flood fighting, evacuation and warning systems.

4. Conclusion

Comprehensive flood control measures were applied to a limited number of rivers at first, but this concept is now being applied widely to many rivers. In short, comprehensive flood control measures, for coping with rainfall in river basins, are an approach that includes all measures, not only river improvement works. It is an attempt to share the efforts of flood control among many people in a river basin, not only from the view of river administrators responsible for river improvement works. In other words, this is a way of thinking about comprehensive measures, including non-structural measures, such as evacuation and warning systems, water-resisting construction, and public awareness, and social measures and institutions of restricting the use of land, and does not just rely on civil engineering structures such as levees and dams.

In Japan, major concern was the increase in flow discharge where significant urbanization has taken place. It can be pointed out that there are three major aspects in comprehensive flood control measures: (i) emergency measures against floods exceeding planned magnitude, (ii) temporary measures to urgently achieve required safety, and (iii) measures carried out in the entire river basin, not only with a lineal approach by use of river improvement works. It can be determined from a general viewpoint that comprehensive flood control measures are the concept of reducing the danger of floods by various measures, carefully maintaining the relationship between local residents and rivers, not only to deploy civil-engineering-oriented flood control projects. It can be presumed that these measures can be applied, not only to existing urban areas, but to any other area that is being developed, under diversified natural, social and economic conditions, as an approach to be combined with various other flood control measures.

6.5 Roadside Slope Protection

1. Actual Roadside Slope Failures

a. Geological Conditions

Japan is located in part of the Pan-Pacific volcanic zone and often suffers from damage caused by natural phenomena. Its tectonic geology is roughly divided into two parts by the Fossa Magna (Itoigawa-Shizuoka tectonic line) traversing the center of the main land (see Fig. 6.2).

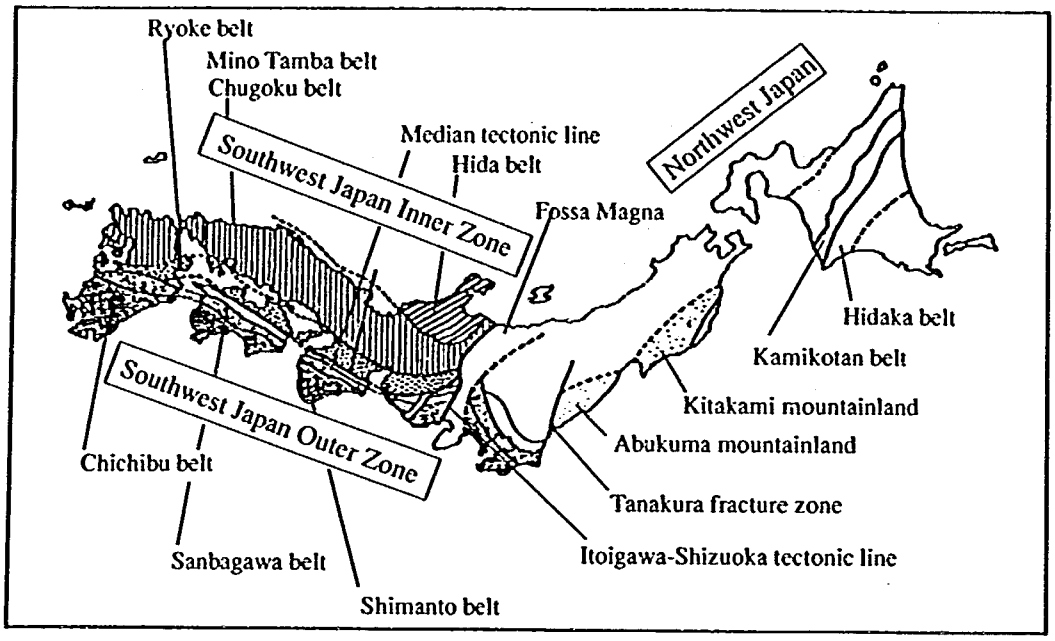


Fig. 6.2 Geological Structure of Japanese Islands

Approximately 67% of the land consists of mountainous areas, characterized by steep slopes. Therefore, slope failures or landslides often occur after the construction of roads and dams. It is an exigent necessity to reduce the damage being incurred and to prevent disasters.

b. Weather Conditions

Japan is located in the monsoon climate zone and the changes of the seasons are distinctive. There are heavy rainfalls throughout the year, especially during the rainy season in the months of June and July, during the typhoon season of September, and the snow season between December and February. The annual precipitation for the country is 1,800 mm on the average, but it reaches 4,000 mm in some areas. Therefore, mudflows often occur during typhoons, storms and heavy rainfalls, resulting in severe damage not only to road facilities but to all traffic systems.

c. The Types of Damage and Changes in Frequency of Damage Occurrence

Table 6.1 shows the number of times damage occurred for the recent five year period (1987 through 1991) on express highways and municipal roads. The damage tabulated in this table was caused by natural phenomena, such as typhoons and heavy rainfalls, and some traffic regulations were carried out at the time of incident. The types of damage are classified into the categories of "rockfall," "embankment and slope failures," "retaining wall failures," "landslides," "scouring," "bridge failures," "tunnel failures," "snow avalanches," and "others." The number of damage occurrence varied within the range from 15,000 to 20,000, and 5% of the total were "embankment and slope failures."

Table 6.1 Damage to Roads Caused by Natural Phenomena

Type of Damage/Cause	1987	1988	1989	1990	1991	Total
Rockfall	2,691	3,737	3,692	4,208	4,180	18,508
Embankment and slope failures	7,825	10,706	10,650	11,455	8,959	49,595
Retaining wall and similar structures	2,737	3,809	3,129	3,017	2,382	15,074
Landslide	233	250	321	349	572	1,725
Scouring	774	980	1,410	1,428	1,335	5,927
Bridge	206	238	285	298	251	1,278
Tunnel	11	22	6	5	8	52
Snow avalanche	86	19	36	40	39	220
Various causes	895	636	773	981	1,727	5,012
Total	15,458	20,397	20,302	21,781	19,453	97,391

2. Current Status of Road Disaster Prevention Measures and Relevant Problems

a. Exercise of Disaster Prevention Projects

The Ministry of Construction began to inspect all hazardous locations of rockfall damage after the fall of a bus into the Hida River, which resulted in the deaths of 104 people in 1968. These inspections were conducted regularly by road administration managers for all national roads, prefectural roads and major municipal roads. Inspections were conducted in 1970, 1971, 1973, 1976, 1980, 1986 and 1990, and road disaster prevention measures are planned based on the results of these inspections. Table 6.2 shows the history of annual inspections, Table 6.3 shows the items of inspection conducted during Fiscal Year 1990, and Table 6.4 shows the number of locations requiring protection, project costs, and the progress of each project during the period covered.

Table 6.2 Records of Regular Inspection of Hazardous Locations of Roads

Date	Event
Aug 1968	Accidental fall of the Hidagawa bus on the national highway route 41, Gifu prefecture.
Sep 1968	The first inspection for the above accident.
Oct 1970	The second inspection in response to the judicial decision for debris flows occurred on the national highway route 56.
Jul 1971	Rockfall occurred at Okuzure beach in Shizuoka City on the national highway route 150 (one person was killed).
Jul 1971	Debris flows occurred on the national highway route 250, Hyogo prefecture (3 persons killed).
Jul 1971	The third inspection for rockfall occurred at Okuzure beach.
Oct 1973	The fourth inspection to verify the results of investigation conducted in 1971.
Jul 1976	The fifth inspection conducted as road conditions significantly changed.
Mar 1980	The sixth inspection conducted as road conditions significantly changed.
Sep 1986	The seventh inspection conducted as road conditions significantly changed.
Jul 1989	Rockfall occurred in areas of the Tamagawa river, Fukui prefecture, on the national highway route 305 (15 persons killed).
Jul 1989	Exigent inspection conducted for selecting the site of construction of rockshed.
Sep 1990	The eighth inspection conducted.

Table 6.3 Items of General Inspection for Rockfall Hazardous Locations, FY 1990

(1) Rockfall and slope failure	(7) Earth retaining wall
(2) Rock failure	(8) Bridge (scouring to bridge foundations)
(3) Landslide	(9) Heavy snowstorm
(4) Snow avalanche	(10) Rockshed
(5) Debris flows	(11) Tunnel (see note)
(6) Embankment	(12) Various items including rainfall, wave actions and irrigation

(Note) Investigations for tunnels were conducted in FY 1991.

Table 6.4 Record of Disaster Prevention Activities

(Units: number of locations, 100 million yen, %)

	Project Load	Project Cost
Investigations during 1976	75,765	11,881
Record for the period from 1986 through 1979	27,070	4,297
Rate of achievement	35.7	36.2
Investigations during 1980	77,044	14,836
Record for the period from 1980 through 1986	49,186	11,013
Rate of achievement	63.8	74.2
Investigations during 1986	67,282	16,429
Record for the period from 1987 through 1990	34,480	9,980
Rate of achievement	51.2	60.7
Investigations during 1990	74,085	24,005
Record for 1991	9,509	2,699
Early 1992	8,308	2,733
Rate of achievement at the end of 1992	24.0	22.6

b. Exercise of Taffic Regulations

Together with construction projects provided for the locations requiring protection, road traffic is regulated in Japan in advance of expected irregular weather conditions to secure the safety of roads for users. This advance traffic regulation was introduced after the experience of the bus fall into the Hida River, and it is classified into the two categories of "Traffic Regulation" and "Special Traffic Regulation." The former is exercised when the rainfall is expected to reach a predetermined depth, and the latter is exercised as required, based on judgment made by field patrols. The regulation is classified into the categories of "Proceed with Caution" and "No Closure." Similar regulations provided at any time as required except traffic regulation sections. Table 6.5 shows the total length of roads where traffic regulations were exercised under irregular weather conditions throughout the country, and figure 6.3 shows the distribution of traffic regulation sections in the Shikoku District.

Table 6.5 Traffic Regulation Sections(April 1, 1991)

Type of Road	Total Length Controlled (A)	Regulation Section		(B)/(A)
		Number	Total Length (km) (B)	%
Express highway	4,869.4	0	0	0
Honshu-Shikoku Bridge	107.4	0	0	0
Express highway in major cities	465.2	0	0	0
National road (designated area)	20,113.3	264	1,515.9	.7.5
National road (non-designated)	26,112.9	790	5,339.1	20.4
Prefectural road	129,761.6	2,985	14,995.7	11.6
Municipal road	963,745.1	15	28.6	0.0
General toll road	2,187.3	66	555.5	25.4
Total	1,147,362.2	4,120	22,434.8	2.0

(Note) Controlled areas include specific designated areas (715 locations in total length of 3,214.1 km).

Source: Road Traffic Control Census (1991), Road Bureau, Ministry of Construction

c. Classification of Disaster Prevention Measures

To provide disaster prevention measures, project areas are selected based on the results of the aforementioned inspections, and design, construction and maintenance are planned in accordance with the road earthwork guidelines. In these guidelines, prevention measures are classified into the categories of "Slope Protection," "Rockfall Prevention," "Landslide Prevention," "Debris Flows Prevention," and "Earth Retaining Walls," and

detailed methods for each category are listed and methods of selecting a specific prevention measure are described. As an example, a list of slope protection methods and a method selection flow chart are shown in Table 6.6 and figure 6.3, respectively.

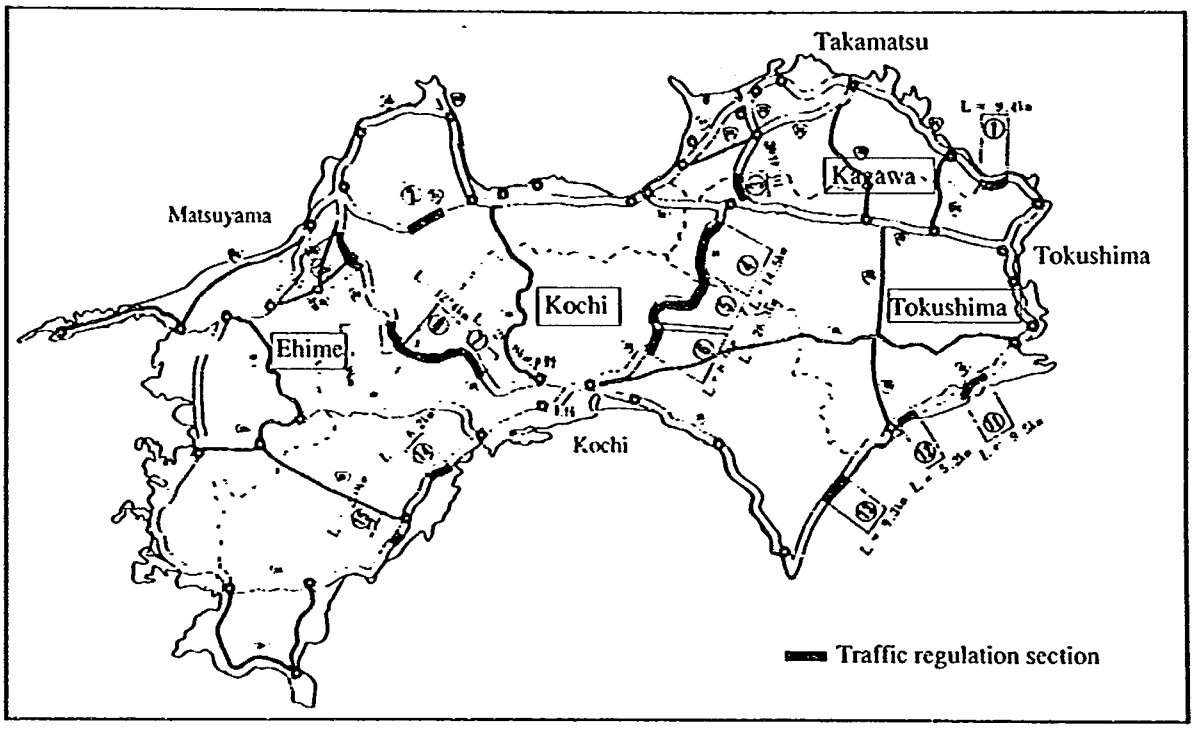


Fig. 6.3 Traffic Control Distribution Map for National Roads in Shikoku

Table 6.6 Types of Slope Protection and Purpose for Use

Category	Type of Work	Purpose of Use and Special Features
Planting	Hydraulic seeding Hydraulic seeding on borrow material Thick base material spraying Sodding Vegetation matting	To prevent erosion by complete surface covering with vegetation (green zone).
	Vegetation strips Simple sodding	To protect sloped embankment from erosion with partial vegetation covers.
	Tree planting	To preserve the environment by landscaping.
	Sandbag protection vegetation pit	To protect poor soil slope and rigid soil slope from erosion with partial vegetation covers.
Structural Slope Protection	Cement mortar spraying Spraying Stone pavement (or pitching) Concrete masonry pavement Precast concrete crib work	To prevent weathering and erosion. Dry masonry backfilled with sand or cobbles is used for preventing erosion.
	Concrete block pitching Shotcrete cribwork Cast-in-place concrete cribwork Anchoring	To prevent failure of sloped surfaces, to retain slope in danger of something affected by earth pressures, and to prevent failure of rock surface.
	Net hurdling Gabions	To control the slide of sloped surfaces due to erosion or groundwater infiltration.
	Rockfall prevention net work	To prevent the fall of rocks.
	Block (masonry) earth retaining wall Gabion or cylindrical concrete retaining wall cage Lattice retaining wall Piling work Reinforcement earthwork	These structures will resist earth pressures and control failures.

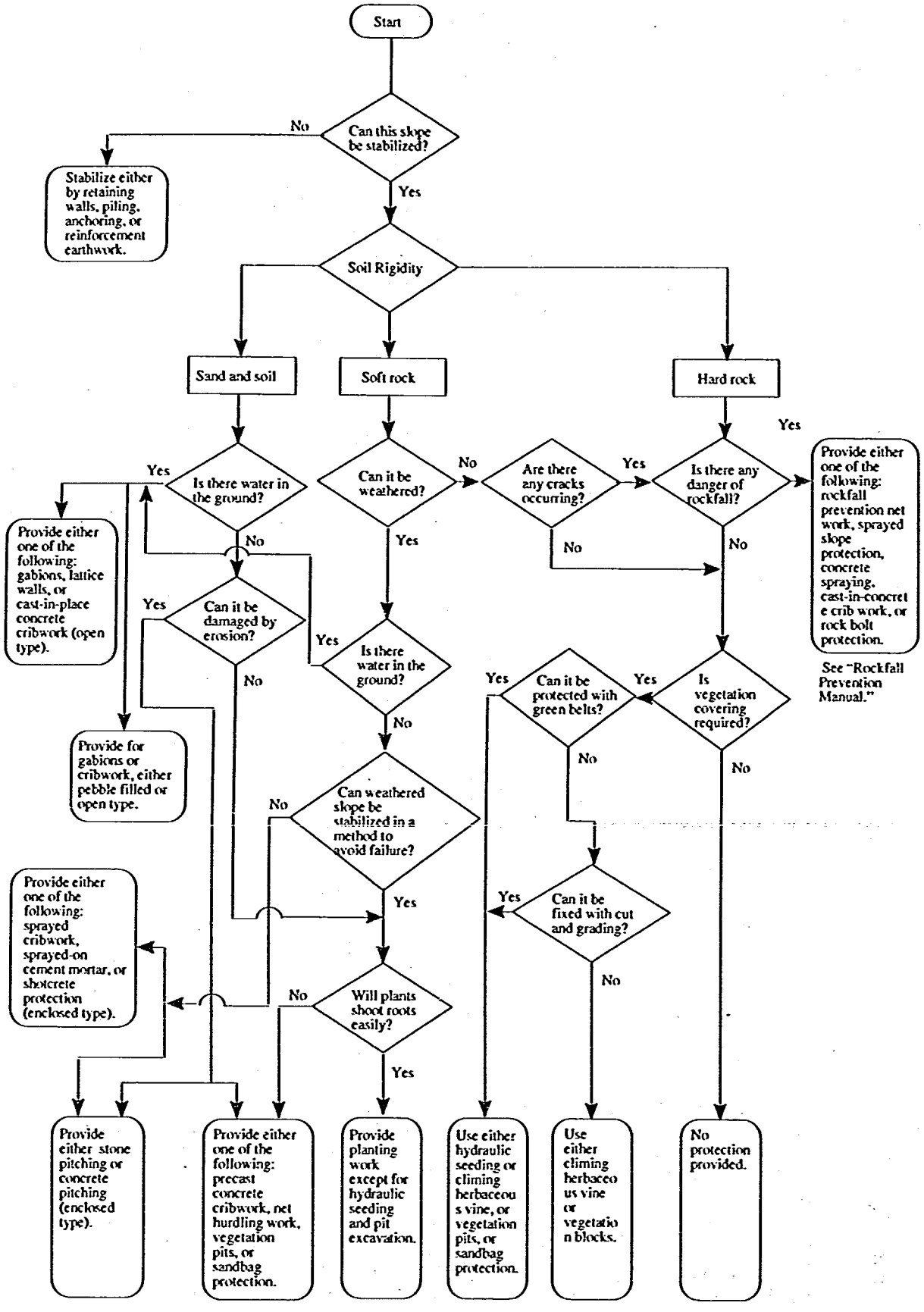


Fig. 6.4 Flow Chart of Determining Protection Method for Cut and Sloped Surfaces

d. Future Problems

① Constructing a disaster-resisting road network
Prevention measures have been provided and the standards of roads have been improved, but traffic regulation sections have not been reduced as expected. Although individual prevention works are still important, it will be necessary to expand the size of prevention works which plays a vital role in the lives of the corresponding community.

② Strengthening road structure
Past prevention measures remained within the framework of disaster prevention structures, but it has become essential to pay more attention to the planning and design of road structures and the introduction of high standard road structures (grade separation structures or large-scale structures) cannot be avoided any more. Large-scale earthwork cuts that can cause environmental problems or concrete structures that may spoil the beauty should be avoided as much as practicable.

③ Constructing roads that can be quickly restored and are easily to maintain
Consideration should be given to assure the structure of roads that can be quickly restored and the traffic can be smoothly controlled in the event they are damaged. For example, provisions of roads with multi-purpose shoulders, a center strip, waiting lanes, a falling rock trap zone, or a large-scale drainage channel should be considered. It will also be necessary to limit the use of roadside areas for proper maintenance of roads, for assuring the safety of roadside properties and for eliminating damage factors from adjacent areas outside the road.

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④ Gathering and providing disaster prevention data
Telemetric systems and radar-connected rain gauges have been provided as devices for gathering information, but it cannot be determined if sufficient necessary devices have been provided. It is necessary to strengthen observation systems for large events such as landslides and volcanic eruptions in the future, and to establish systems to provide users with the detour information. Also, it is important to standardize methods of providing road information to users and to promote the understanding of users.

3. Activities at the Public Works Research Institute

a. Danger of Slope Failures and Methods of Investigation and Observation for Their Management

① Studies on efficient methods for investigation of slope by geophysical exploration and other methods
Locations, size and type of slope failures vary depending on the geographical features and ground conditions of the slope. It is extremely important to understand the geological structure of the subsurface of the slope. However, geological surveys over wide areas and in steep mountainous locations are inefficient and often difficult. Therefore, studies are being made on efficient methods of investigating the geographical structure of sloped surfaces by the use of geological exploration such as AEM or underground radar exploration (see Fig. 6.5).

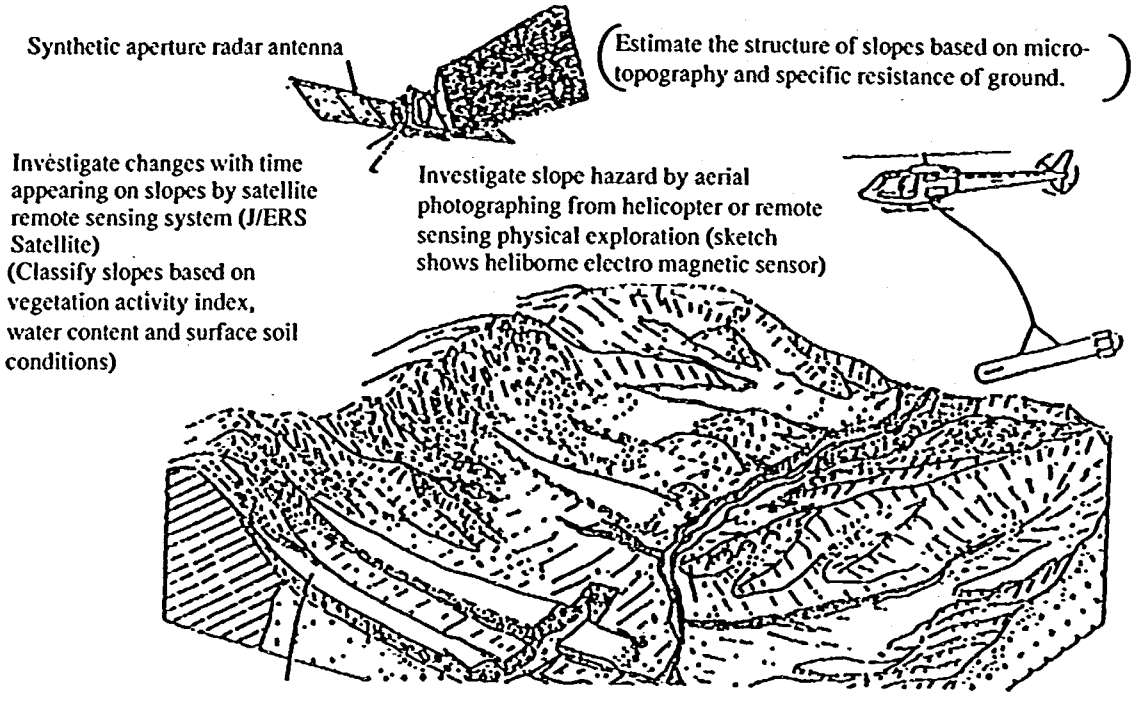


Fig. 6.5 Imaginary Sketch of Road Slope Hazard Investigation and Monitoring Systems

② Studies on methods of predicting slope failures by monitoring

Estimation of the roadside's slope stability can be an important factor to read administration such as advance traffic closure. Especially, understanding inner geological structure and monitoring its performance during the rainfall, are indispensable. Therefore, studies are now being made on methods of predicting the time and type of failures by monitoring the changes appearing on slopes during rainfall. The monitoring systems are designed mainly to gather data on rainfall infiltration into the subsurface by soil moisture gauges, and monitor the behavior of changing slope surfaces with high precision inclinometers (see Fig. 6.6).

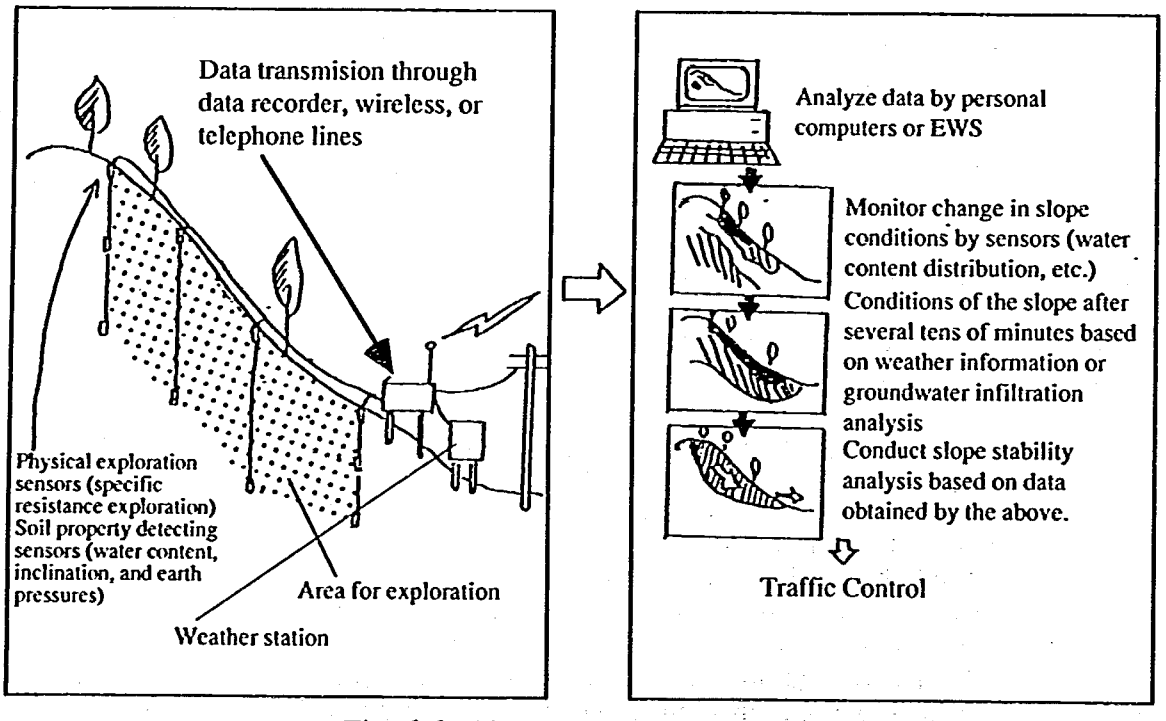


Fig. 6.6 Slope Monitoring System (studying)

③ Studies on techniques of investigating and maintaining shotcreted slopes

There are many examples of using shotcrete or cement mortar for roadside slope protection work. These protection works often become deteriorated and their effectiveness reduced because of underlying weathered rock that cannot be seen by visual inspection. Maintenance inspections are now mainly performed visually and the number of locations to check have become so many that field engineers are not able to check all of them. Therefore, the PWRI is studying the practical use of thermal infrared remote sensing to be able to complete wide-area inspections quickly, without breaking the protection work (see Fig. 6.7).

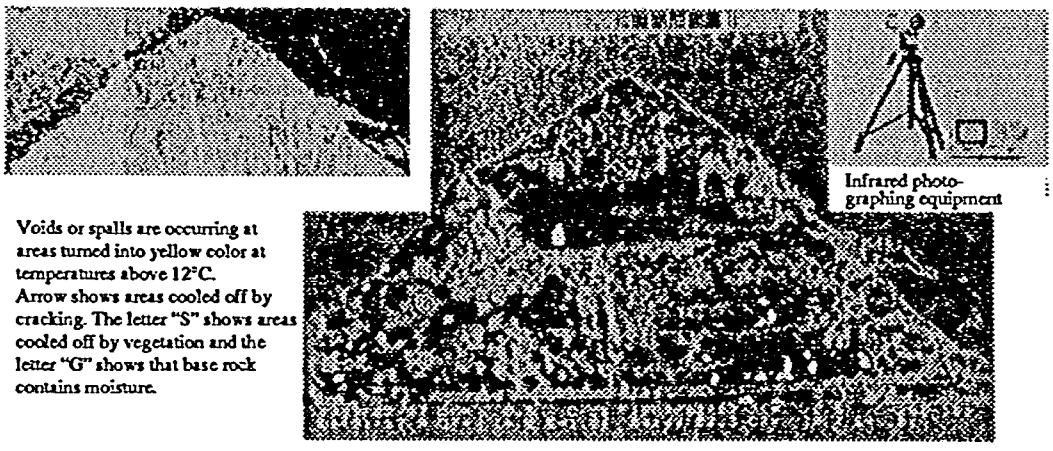


Fig. 6.7 Deterioration Diagnosis for Shotcreted Slopes by Thermal Infrared Remote Sensing

b. Studies on Methods of Investigating Dangers of Rockfalls and Rock Collapses

① Studies on methods of investigating the dangers of stone or rock falls

To protect roadside slopes from stone or rock falls, this institute is now examining methods of gathering data on the distribution and characteristics of discontinued surfaces in rocky slopes, which are used for these investigations, thermal infrared scanning and ground-probing radar exploration. Studies and examinations are being made now on methods of estimating the danger of slope failures by earthquakes, using a possibility linear regressive model based on fuzzy set theory factors such as rainfall, earthquakes and other geographical and geological factors.

② Studies on impact loads of falling rocks on rockshed

Studies are being made mainly on methods of predicting the trajectory and the impact of falling rocks on rock sheds. For the skip distance, rockfall tests are made using models and actual slopes to obtain the coefficients of restitution and friction based on the trajectory and to estimate the skip distance of falling rocks by numerical simulation. For the impact of falling rocks, theoretical equations to determine the impact force on the shock absorber (sand) laid on the rock shed roof slab were introduced and their applicability is being checked by a full-scale model.

③ Structural design of rockshed

For the structural design, the features of PRC structure that is combined by PC and RC structures, taking their excellent characteristics, were noted. Studies are being made to present the design method of PRC rockshed, and static and impact load tests are being made.

c. Studies on Measures for Preventing Landslides

① Studies on investigation for the hazard of landslides
For the investigation of landslides, efforts are now being made to develop test methods for determining strength characteristics of slip surfaces, methods of predicting the behavior and changes of groundwater, and wide-area and detailed sliding area exploration method, using ground exploration sensors. Considerations are made so that these methods can be applied also to deep slip surfaces. The technique of monitoring slipping areas to obtain the movement of earth mass, using GPS or a pulse range finder, is being developed.

② Studies on landslide prevention structures
In order to improve the efficiency of selecting the routes and the type of landslide prevention structures, the development of danger diagnosing system and selection system of prevention measures, based on the results of investigating the danger of landslides, described earlier, is scheduled to start soon.

③ Studies on landslide determent works
Studies are being made on methods of directly restraining landslides, including research to determine efficient spacing, arrangement and locations for driving piles, to solve the mechanism of breaking anchors, and to determine methods of anchoring.

d. Studies on Measures for Preventing Debris Flows

① Studies on investigating dangerous streams and methods of predicting the danger of debris flows
Simple and highly precise methods, using aerial photographs and topographic maps are being developed, to modify the conventional methods of investigation which consisted mainly of field surveys.

② Studies on active measures using structures
One major study is being made on the design of roads crossing streams, including methods of planning and designing safe structures against debris flows, and the another major study is being made to develop methods of preventing mudflows by use of structures such as aqueduct for debris flows or a steel trapping system. Since the large number of floating logs and woody debris carried by debris flows often close road culverts and bridges, causing floods and damage to roads, it is strongly desired that measures of preventing damage from floating logs be developed.

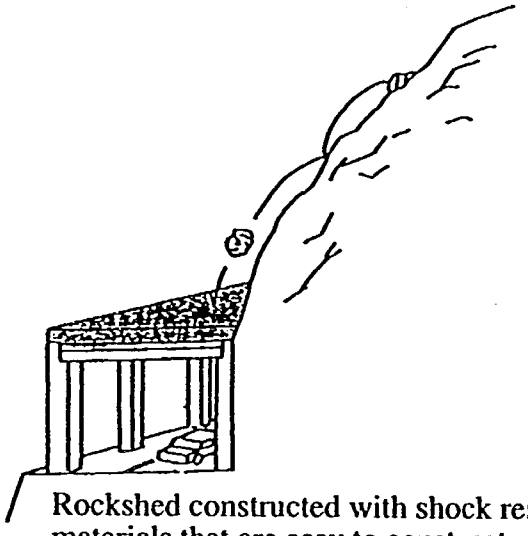
③ Studies on passive measures for road administration
A displacement detector system that detects the movement of slopes and ground and conveys such data to road administrators is being developed. To be able to use this system, it is necessary to research information conveying methods that can quickly analyze and determine the necessity of traffic controls, using short-period precipitation prediction data by the Meteorological Agency or the results of monitoring soil moisture.

e. Studies on Methods of Constructing or Reinforcing Earth Retaining Walls

① Studies on earth retaining walls
For concrete retaining walls, static earth pressures and earth pressures during earthquakes acting on gravity or cantilever retaining walls, and the effect of drainage systems have been verified through large-scale experiments or field measurements, and design methods for road retaining walls have been established. Studies are now being made on methods of using treated clayey soil from

construction sites for fill materials, methods of reducing earth pressures by replacing the fill materials with expanded polystyrene, methods of reinforcing fills with geotextiles, and new walls in replacement of concrete structures.

② Studies on reinforcing cuts and natural slopes
Studies are being made now on methods of reinforcing the cut and natural slopes around them with steel rods inserted into the surfaces of slopes and by grouting. In the future, studies may have to be made on methods of reinforcing the slope with inserted steel rods and vegetation on the surface of slopes, taking into account the appearance when viewed from surrounding areas.



Rockshed constructed with shock resisting materials that are easy to construct.

Fig. 6.8 Rockfall Protection by Rockshed

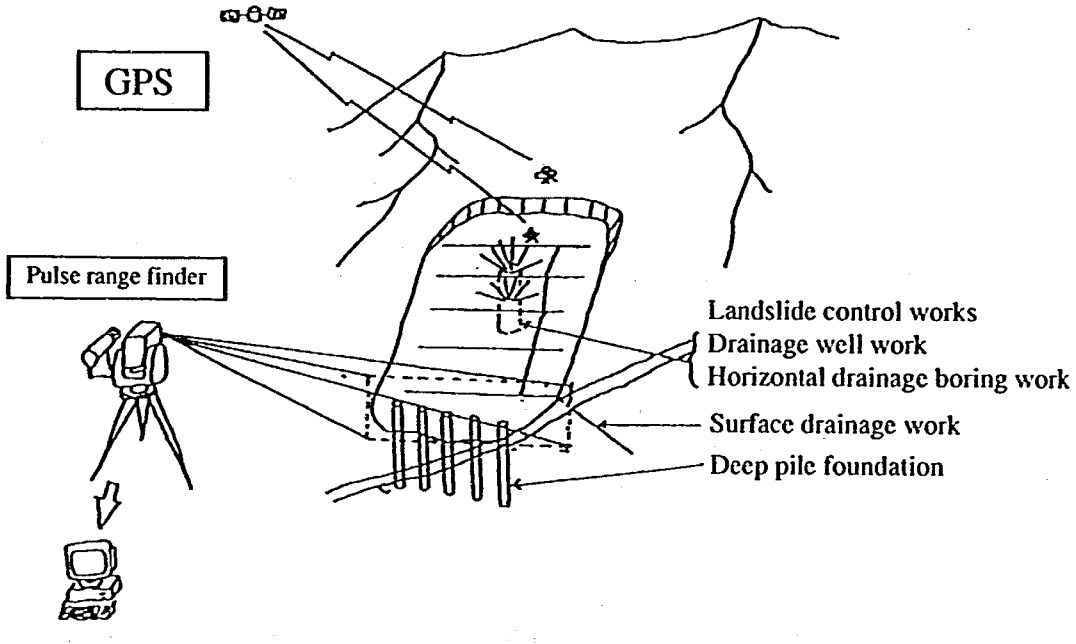


Fig. 6.9 Studies on Landslide

7. Current Activities for "Harmony between Environment and Infrastructure"

7.1 General Description

Up to now, in Japan emphasis has been placed on achievement of predetermined improvement targets, and environment concerns that benefit the people were apt to be ignored. However, it is now required that efforts to improve the infrastructure take into account environmental considerations. With a such situation in the background, the Public Works Research Institute actively participates in the preservation and restoration of the environment and in the development of creative technology.

In this chapter, we will discuss the current situation in Japan as well as problems in the following fields and relevant activities of the Public Works Research Institute.

a. Rivers and streams and their environment
b. Dams and their environment
c. Wastewater systems
d. Roads and their environment
e. Cities and their environment

Additional discussion will be made on the following activities regarding the improvement of the infrastructure, taking into account the global environment and living conditions that are common problems for all Asian countries.

a. Measures for preserving the water quality standards for dam reservoirs and rivers.
b. Measures to prevent air pollution and noise from the road traffic in cities.

7.2 Current Situations and Problems for "Harmony between Environment and Infrastructure" of Japan

After the war, national income standards increased through the economic period of rapid growth, but the natural environment of cities and water areas has become worse, and the delay in improvement of living conditions has become significant. Therefore, the preservation of the environment of the country has become critical.

1. Rivers and Streams and Their environment

With the quick development of urbanization in recent years, the water quality has become worse in public water areas, including rivers and streams, water affinity has lowered, and the environment has suffered. The desire of people for the improvement of the water resources and the preservation of the river and stream environment is increasing and is being diversified. Under these situations, various measures are being developed by the Ministry of Construction. As a primary investigation, the "Census of River Water Areas" was planned to investigate the inhabitants living near the water and the use of river and stream space, and the master plan for river environment management was set up to comprehensively and systematically execute the measures of preserving and creating a good water environment. In addition, various projects are being executed to preserve and improve the appearance, and to promote public awareness to the need for improvement of rivers and streams. The water quality standards are being improved by introducing clean water, dredging to remove sludge, and by the method of indirect pebble contact oxidation.

2. Dams and Their Environment

As environmental subjects for dam reservoirs, the topics "preservation of water quality," "preservation and creation of nature," and "creation of a hydrophilic environment" where people can enjoy fishing, swimming, picnic and water sports, can be taken up. As the living and action patterns of people have been expanded and diversified in recent years, demands are increasing for the improvement and use of environmental functions of dams. In order to

promote such environmental functions, various measures for preserving water quality and environmental improvement projects are being executed in dam areas.

3. Wastewater Systems

In accordance with the seventh 5-year program for wastewater system construction (gross budget of 16.5 billion yen), which began in 1991, wastewater systems that are primary facilities for cities are being developed. Under this program, wastewater systems are newly constructed for small municipalities where wastewater systems have not been sufficiently provided, advanced treatment facilities are introduced for preserving the water quality, and floods are controlled, in order to create comfortable and attractive living conditions and clean public water areas. Also, existing wastewater systems are improved for major cities and the multiple use of resources and energy generated from wastewater systems is encouraged.

4. Roads and Their Environment

Various measures have been planned and great effort has been extended in solving the environmental problems such as traffic noise and air pollution, but the expected environmental standards have not been achieved. For air pollution controls, emission controls have been provided for fixed sources and for automobiles, resulting in lower SO_2, CO and HC concentrations, as intended. However, NO_2 concentration has not improved for a long time. For traffic noise, individual restrictions have been strengthened for each road facility, but readings taken at most locations still exceed the required environmental standards.

5. Cities and Their Environment

For the enhancement of the appearance of cities, the Ministry of Construction established the "Model City System for Construction of Attractive Cities" in 1987 and the "Model Town System with Attractive Green Zones" in 1990 to construct a model city with an attractive appearance, and pushing forward city improvement plans, taking into consideration the formation of good city appearance in various cities.

For the vegetation of cities, the Ministry of Construction established the "Guidelines for Making Master Vegetation Plan" in 1977 and issued the Circular titled "Manual for Making City Vegetation Promotion Plan" in 1990 to promote the landscaping of cities. To contribute to the solution of global-scale environmental problems and the heat island phenomena noted in cities, it will become necessary in the future to strengthen the existing system of promoting city landscaping plans, to develop new technology that will enable vegetation of areas that have not been successfully vegetated, and to establish and operate a new system that will promote landscaping of privately owned land.

As described above, it can be seen that demands of people for a good environment are increasing, the improvement of the infrastructure covers a wide range of subjects, and unsolved problems have accumulated.

7.3 Public Works Research Institute Activities for "Technology of Preserving, Restoring and Creating a Good Environment"

Within the Public Works Research Institute, the Environmental Department was organized in April 1993 with five laboratories, consisting of "Environmental Planning," "Geology," "River Environment," "Traffic Environment," and "Vegetation and Ecology," to make studies, placing emphasis on the technology of preserving, restoring and creating the proper environment with respect to public works facilities.

The comprehensive technical development project titled "Development of Technology for Creating Beauty" began in April 1993. In this project, various subjects regarding the beauty of the infrastructure, such as methods of coordinating buildings and road facilities, technology of creating natural rivers, development of concrete materials to assure beautiful appearance, and development of a view simulator and view data base, including modifications of the Building Standard Law and the Road Structure Ordinance, are dealt with intensively.

The institute began studies also on the construction of an environmental database in improvement of the infrastructure and basic concept, and procedures for environmental impact assessment.

While the people's expectation for the preservation of nature increases, various projects for rivers, lakes and swamps, dam reservoirs, beaches and parks, are being developed, but there are many technical problems that must be resolved because these subjects are relatively new. Therefore, studies are being made to set up methods of investigation and on the technology of preservation.

For the preservation of road environment, studies have been made placing emphasis on methods of prediction and measures to reduce air pollution and noise. Methods of prediction have been established, as represented by the method of predicting the diffusion of automobile exhaust gas on general roads and the method of predicting roadside noise. These methods are being used for the environmental impact assessment. Efforts for developing new methods of prediction will be successively continued.

As measures of preserving the environment, investigations and tests are being made for the air contaminants absorbed by trees, the effects of air diffusion, techniques of eliminating NO_X, noise barriers, measures of sound absorption, and low-noise pavement. Investigations for methods of constructing roads that harmonized well with nature are also being conducted.

For vegetation technology, investigations and studies have been made for vegetation technology, characteristics of trees used for landscaping, and techniques of maintaining grasses, together with efforts for understanding methods of air cleaning (absorption of CO_2, dust collection, etc.), minor climate modification, and the construction of an attractive appearance that can be accomplished by landscaping. Also, technical guidelines such as the "Technical Guidelines for Preservation of Roadside Beauty" and the "Guidelines for Slope Protection and Stability of Sloped Surfaces" were published.

For the improvement and management methods for green zones of parks, investigations and studies are being made on the subjects of marine resort planning, methods of providing large-scale parks, grass restoration planning, improvement and management of sodded plazas.

7.4 Measures for Preserving Water Quality in Dam Reservoirs and Rivers

1. Water Quality in Dam Reservoirs

When a large-scale reservoir is produced along with the construction of a dam, hydraulic changes are often caused from the stay of the water inflowing from rivers and streams, resulting in the generation of water area patterns different from before the dam was constructed. Most significant water conditions are represented by the phenomena of cold water, prolonged turbid water, and eutrophication. The eutrophication often cause serious problems today.

a. Eutrophication

If the volume of nutrient salt flowing into reservoirs significantly increases along with the development of river basins, micro-organisms in the water reproduce vigorously and the existing amount of algae (phytoplankton) will increase. The term "eutrophication" means the unnatural increase in production of micro-organisms in reservoirs. Since micro-organisms are carried away before they increase in water areas such as rivers and streams where the flow velocity is relatively higher, the effects of eutrophication does not occur in the form of a large increase of algae. However, when temperatures, sunlight and other conditions are favorable in dam reservoirs, where the water stays longer than in rivers, various phenomena such as fresh water red tide or algae bloom are caused by eutrophication. These phenomena are called eutrophication. It is known that the increase of algae can be limited, even if the concentration of other substances is very high, if the concentration of a substance among various nutrient salt required for the increase of algae is lower than that of other substances. These substances are called limit elements. Rivers, streams and lakes of Japan contain sufficient elements, except for phosphorous and nitrogen, of the salt that is required for the increase of algae. Therefore, the concentration of phosphorous and nitrogen becomes important for discussion

of the eutrophication. For dam reservoirs, lack of phosphorous often limits eutrophication. The concentration of phosphorous can be an key yardstick for the eutrophication.

Eutrophication can cause serious problems such as changes in reservoir water surface by fresh water red tide or algae bloom, offensive taste of water, interference to coagulation and sedimentation pond and filtering pond, and colored potable water.

The fresh water red tide and algae bloom have characteristics with micro-organic elements in addition to physical and hydraulic conditions. Therefore, the mechanism of causing these phenomena can be greatly affected by the water temperature, sunlight and flow velocity, together with nutrient salt including phosphorous and nitrogen. The production of algae differs every year.

2. Measures for Preserving the Water Quality in Dam Reservoirs

a. Basis of Measures for Preserving Water Quality Standards

When water quality problems are expected to occur, or when such problems have already occurred, or when such problems are being developed, measures to assure water quality standards are required. The occurrence of water quality problems are greatly affected by natural and social conditions such as the characteristics of contaminants in river basins. Without reduction in the amount of offensive substances, such as muddy materials, organic contaminants and nutrient salt inflowing into reservoirs, the effects of protective measures in reservoirs and rivers are naturally limited. Comprehensive measures based on the plan for river basins must be developed in coordination with relative organizations.

There are various measures, including "measures to prevent cold water," "measures to prevent prolonged turbid water," and "measures to prevent eutrophication" for preserving the water quality. In the following sections, "measures to prevent eutrophication," which is the most serious problem today, will be discussed.

b. Measures Against Eutrophication

It is necessary to take measures against eutrophication appropriately for each reservoir, with full understanding of the mechanism of algae increase. Causes for increase of algae can be summarized as mentioned below.

① Inflow of nutrient salt.
② Environmental conditions required for photosynthetic reaction (light and water temperature).
③ Period of stay required for increase.

(i) Measures applicable for river basins

To provide substantial measures to control eutrophication, it is necessary to control the inflow of nutrient salts mentioned in ① above. For this purpose, measures for controlling the sources of contaminants (measures for reducing the inflow from river basins) are most effective. Therefore, efforts must be made to push forward the required measures in close contact with organizations responsible for the river basins. There are various types of nutrient salt that are generated in the river basins of dams, including those from livestock and those from domestic sewer water systems. Therefore, it is important to compost animal excretions and to improve sewage treatment systems. Often, treated water is sprayed over the ground, or soil treatment plants are provided to accelerate adsorption of nutrient salt into the soil. Since the soil from cropfields contains large amounts of nutrient salt, it is important that the measures used for preventing eutrophication prevent the flow of topsoil, not only just for protecting the water from turbidity. On the other hand, a large investment and a long period of time is required for river basins because sources generating contaminants are distributed over wide

areas. Therefore, measures like symptomatic treatment are often provided, as necessary, for river channels or reservoirs.

(ii) Measures applied to rivers

(a) Fore-reservoirs
Control of nutrients flowing into reservoirs can be achieved by use of fore-reservoirs provided at rivers flowing into the reservoir. Sufficient space is rarely available to provide a fore-reservoir having the necessary settlement time for rivers in Japan, but this system can be used in combination with the diverting channel described below. As the water level changes very little in the fore-reservoir, this scheme can also be used for water purification by means of lakeside vegetation, or used for recreation purposes.

(b) Diverting channel
Where the inflow of substances into the reservoir is limited to a few streams, the inflow can be stopped using a bypass channel, or the time of stay of water in the reservoir can be shortened by diverting the water into the intake area.

(iii) Measures applied to the inside of reservoirs
Measures applied to the inside of reservoirs can be executed with full understanding of the mechanism of eutrophication in reservoirs.

(a) Dredging
The amount of contaminants dissolved from sediment deposited in the bottom of dam reservoirs is generally small, compared with that from rivers. Those substances can be reduced by dredging the bottom and removing the contaminants.

(b) Circulation
The surface water of a reservoir is suitable for the increase of algae because the water temperature is comparatively high, heated by sunlight (euphotic zone). There is a method that controls the increase of algae by circulating and cooling off the heated water, using pumps.

(c) Fountain water
Fountain water developed from the water circulation can also be used. This system is based on the idea that rapid changes in water pressure passing through pumps kill algae in addition to the effects of circulation. This system will improve the appearance of the water surface of the reservoir.

(d) Intake of surface water
This method removes the surface water that is suitable for the increase of algae, in order to shorten the time the water stays on the surface of reservoir.

(e) Measures to apply after algae has formed
When there is an unusual increase in algae, even with the above measures, the following procedures can be followed.

① Intake of selected water
This is a method that intakes the water from a depth in the reservoir where there is little algae.

② Removal of algae
In addition to mechanical means for removing algae, in the future it will be necessary to study biotechnical or chemical methods that can kill algae.

c. Research and Development on New Measures for Preserving Water Quality for Reservoirs

The Public Works Research Institute is engaged in development of an innovative system of blocking the increase of undesired algae. This system consists of a "current control system" that controls the flow of river and reservoir water, making the environment so that it is difficult for floating algae to increase, and "filamentous algae system" that eliminates nutrient salt from the running water and the reservoir water using filamentous algae.

3. General Description of River Water Purification Projects

Water quality preservation projects of the Ministry of Construction began with the Sumida River Sludge Dredging Project in Tokyo in 1958. During 1958, the intake of clean water from the Akigase Weir to the Sumida River was inaugurated. This project is still underway as a river environment improvement project since 1969. The following four projects are water purification projects currently being executed by the Ministry of Construction.

① Introduction of purification water.
② Dredging of sludge.
③ Direct purification method by gravel contact oxidation.
④ Sewer water separator channel

4. Principle of River Water Purification Measures and Relevant Problems

The method, principle and problems regarding the above four purification projects will be simply described below.

a. Introduction of Cleaning Water (for increasing flow rate)

This is a method that introduces comparatively clean water to rivers, where contamination is developing, to thin the excessively concentrated water. This method is also used for the purpose of flushing contaminants deposited in the bottom of the water. It will not reduce the volume of contaminants directly, but being used or planned for approximately 30 rivers. Unexpected results, such as the return of fish, have been achieved in some rivers. This is effective for small and medium sized rivers where clean water can be introduced from a large river. In other words, a large volume of comparatively clean water must be available in areas close to subject rivers. Studies are being made on the use of treated water and groundwater for purification.

b. Dredging of Sludge

When biological dissolution discontinues as dissolved oxygen decreases, undissolved contaminants will turn into sludge and deposit in the river bed. Dredging of sludge is very effective because it will reduce the loads of contaminants. However, this can cause serious problems because dredging is very expensive and it takes a long time period for the sludge to dry and be treated. Studies are being made on the technique of removing sludge by turning it into a solid mass.

c. Direct Purification Method

① Aeration
This is a method that accelerates biological dissolution with increased dissolved oxygen in the water.

② Modification of river beds by laminar flow or shallow stream methods
This is a method that purifies the water over a river bed modified by providing laminar flow, a shallow stream bed, or paving with cobbles or artificial sod. The water is cleaned by dissolved oxygen which has been increased by a raised river bed or by disturbed water. At the laminar flow facility in the Saijo River, a tributary of the Yamato River, 14% of BOD and 41% of SS were removed in an area 300 m long. These methods can present problems such as maintenance of river channels closed by mudflows during floods.

③ Contact oxidation method
This is a method that uses the effects of oxidation, dissolution, adsorption and settlement by biological films (micro-organisms, bacteria and etc.) which have been increased over the surface of contact materials by sewer water flowing through contact materials. Gravels are normally used for contact materials. If aeration is used with the gravel contact oxidation method to activate biological films, excellent results can be achieved. It should be noted that a large site to lay out contact materials is required for the contact oxidation method. Also, a large volume of water cannot be treated at one time because this system relies on the oxidation of micro-organisms. Precautions are necessary to provide for floods and disposal of trash and soil. Also, sludge must be removed and disposed of.

④ Techniques being developed
Purification techniques current being developed include the following.

(a) Vertical movement purification system using charcoal
Purification (by micro-organic films) is accomplished by oxidation, dissolution, and filtering of muddy water running through charcoal filters at a velocity of 2 to 4 cm/minute .

(b) Natural diverse purification system
Techniques using rapids or deep water created for the purpose and methods of purification using vegetation or natural rivers are being developed.

d. Sewer Water Separation Channel

This is a method that provides a bypass channel on the river terrace to separate drainage water for preserving the water quality standards of subject areas. Higher effects can be expected with this system because sewer water is separated, but this is not effective for the purification of the water in closed water areas.

7.5 Measures to Reduce Air Pollution and Noise from Road Traffic in Urban Areas

1. General Description

Various systems or procedures have been set up or are being used to maintain a safe and comfortable environment in efforts to cope with environmental problems occurring gradually since 1960 in Japan. First, the Basic Law for Environmental Pollution Control was enacted in 1967 for the purpose of pushing forward comprehensive pollution control measures and preserving satisfactory living conditions. Also, the "Air Pollution Control Law" and the "Noise Control Law" were enacted as an individual control law. Environmental standards that are desired for maintaining the standards of preserving people's health and living conditions

are prescribed, and environmental conditions are monitored and measured based on these laws. For the environmental problems of air pollution and noise caused by vehicle traffic, various efforts have been made to assure harmony between the road and the environment with the improvement of vehicle design and road networks, the construction of noise barriers, buffer zones and greenbelts, and the requirement for environmental impact assessments prior to execution of a large-scale road construction projects.

2. Environmental Standards

There are environmental standards established to control air pollution and noise resulting from road traffic (see Tables 7.1 and 7.2).

Table 7.1 Environmental Standards (Air Pollution)

Substance	Sulfur dioxide	Carbon monoxide	Suspended particulate matter	Photochemical oxidant	Nitrogen dioxide
Environmental condition	Mean day value of hourly rate is below 0.04 ppm and the hourly rate is below 0.1 ppm.	Mean day value of hourly rate is below 10 ppm and 8-hour mean value of the hour rate is below 20 ppm.	Mean day value of hourly rate is below 0.10 mg/m^3 and the hourly rate is below 0.20 mg/m^3.	Hourly rate if 0.06 ppm.	Mean day value of hourly rate is within or below the range from 0.04 to 0.06 ppm.

Notes:
1. The word "suspended particulate matter" means the particulate matters suspended in the air 10 microns or smaller in size.
2. The word "photochemical oxidant" means the oxidants generated by photochemical reaction, including ozone, peroxide acetyl nitrate and other substances (nitrogen dioxide is excepted for the substance that isolates iodine from neutral potassium iodide solution).

Table 7.2 Environmental Standards (Noise)

Area Category		Time Zone		
		Daytime	Morning & Evening	Nighttime
AA		45 phons (A) or less	40 phons (A) or less	35 phons (A) or less
A		50 phons (A) or less	45 phons (A) or less	40 phons (A) or less
For areas facing to roads	2-lane traffic	55 phons (A) or less	50 phons (A) or less	45 phons (A) or less
	Multiple-lane traffic	60 phons (A) or less	55 phons (A) or less	50 phons (A) or less
B		60 phons (A) or less	55 phons (A) or less	50 phons (A) or less
For areas facing to roads	2-lane traffic	65 phons (A) or less	60 phons (A) or less	55 phons (A) or less
	Multiple-lane traffic	65 phons (A) or less	65 phons (A) or less	60 phons (A) or less

(Note) AA Areas significantly require calmness.
A Areas mainly used for housing district.
B Areas used for commercial and industrial districts mixed with resident district.

3. Environmental Impact Assessments

Considerations for the environment cannot be dismissed prior to the improvement of roads, and the environmental impact assessment is an important medium. Based on a decision made by the Cabinet in 1984, the "Rules for Executing Environmental Impact Assessment for Projects Authorized by the Ministry of Construction" were prescribed in 1985. Environmental impact assessments must be performed in accordance with these rules. Technical requirements are described in the "Recommended Guidelines for Environmental Impact Assessment of Road Construction Projects Authorized by the Ministry of Construction" and the commentary publication titled "Road Environment Improvement Manual."

a. Air Pollution

Prediction measurement items of air pollution caused by vehicle exhaust gases are prescribed as CO and NO_X. It is prescribed that prediction measurement must be made by the dispersion method, using plume or puff. Emission factors of pollutants (volume of pollutants emitted from vehicle per unit driving distance) and dispersion parameters are also prescribed.

b. Noise

The standard value for evaluating road traffic noise is prescribed to be the median (L_{50}) of noise level. It is prescribed that prediction measurement should be made by the method using a single-line equidistant sound power model, called the "Acoustic Society Method," as a rule. Evaluations are made using power pressure levels or correction factors for different predicting locations, taking into consideration the noise control.

4. Measures for Preventing Air Pollution from Vehicle Exhaust Gas

The classification of roadside environment conservation measures including measures for air pollution from vehicle exhaust gas are shown in figure 7.1. Actual examples are described below.

a. Improvement of Vehicle Designs

The most effective means of controlling air pollution caused by vehicles is to control the source of pollution. Controls have been gradually strengthened since 1973 (see Table 7.3 and Fig. 7.2). Control measures for gasoline engine vehicles are mainly based on a three-component catalyst system and these have significantly improved the quality of exhaust emissions, compared to the emissions experienced before controls were prescribed. However, practical control measures for diesel vehicles are very limited and definite improvement has not been achieved. Further technical development is expected. In an attempt to reduce exhaust gases, so-called low-pollution vehicles such as electric driven or methanol fueled vehicles are being developed, but they have not reached the level of public use.

b. Road Network

As shown in figure 7.3, the emission factor of pollutants varies by driving speed and tends to increase at a low speeds. Therefore, emissions can be controlled if vehicles run smoothly, and are not interrupted by traffic jams. The most effective measures used to achieve this are to provide bypasses or secure grade separation for belt highways and intersections.

c. Improvement of Road Structure

As shown in figure 7.4, the concentration of pollutants coming from roads tends to decrease because of dispersion at areas farther from the road. Therefore, buffer zones are often provided for major roads. If a road is raised by an embankment, or modified to an elevated road, the concentration of pollutants at the ground level can be reduced.

d. Absorption of NO_X by Vegetation

It is generally believed that vegetation can absorb or adsorb air pollutants. If greenbelts are provided it can be expected that air will be cleaned. As a result of exposure tests using a gas chamber (see Fig. 7.5), it can be seen that the higher the concentration of NO_X, the more nitrogen is concentrated in vegetation. As a result of estimation made on the amount of NO_X absorbed by greenbelts, it can been that greenbelts 7 meters wide on both sides of a road can absorb 5% of the NO_X emitted from 30,000 vehicles a day.

e. Absorption of CO_2 by Vegetation

Noting that carbon produced by photosynthesis is concentrated in vegetation as one of its components, studies are being made on a method of estimating the fixed amount of CO_2 by measuring the weight of vegetation organics. It is assumed that a *keyaki* (zelkova serrata) of an age of 4 to 8 years has the ability to fix CO_2 at a rate of approximately 21 kg/ year, a *yuri* (liriodendron tulipifera) of 7 to 9 years can fix approximately 26 kg/year, and a *shirakashi* (querucus myrsinaefolia) of 11 to 15 years can fix approximately 27 kg/year. There is a relationship between the breast height diameter of trees and the fixed amount of CO_2, as shown in figure 6, and this relationship can be approximated by the following equation.

Log (fixed amount of CO_2) = A·Log (breast height diameter) + B
(A and B are constants that vary with different species)

f. Low Concentration Denitration System

Large-scale roads in major cities are often constructed underground. Studies are being made on a low concentration denitration system that disperses vehicle exhaust gases emitted from ventilation towers. Denitration technology has already been used in factories to eliminate industrial pollutants. Since gases emitted from tunnels have the characteristics of a low NO_x concentration, normal temperatures, and a large air quantity, these problems must be solved.

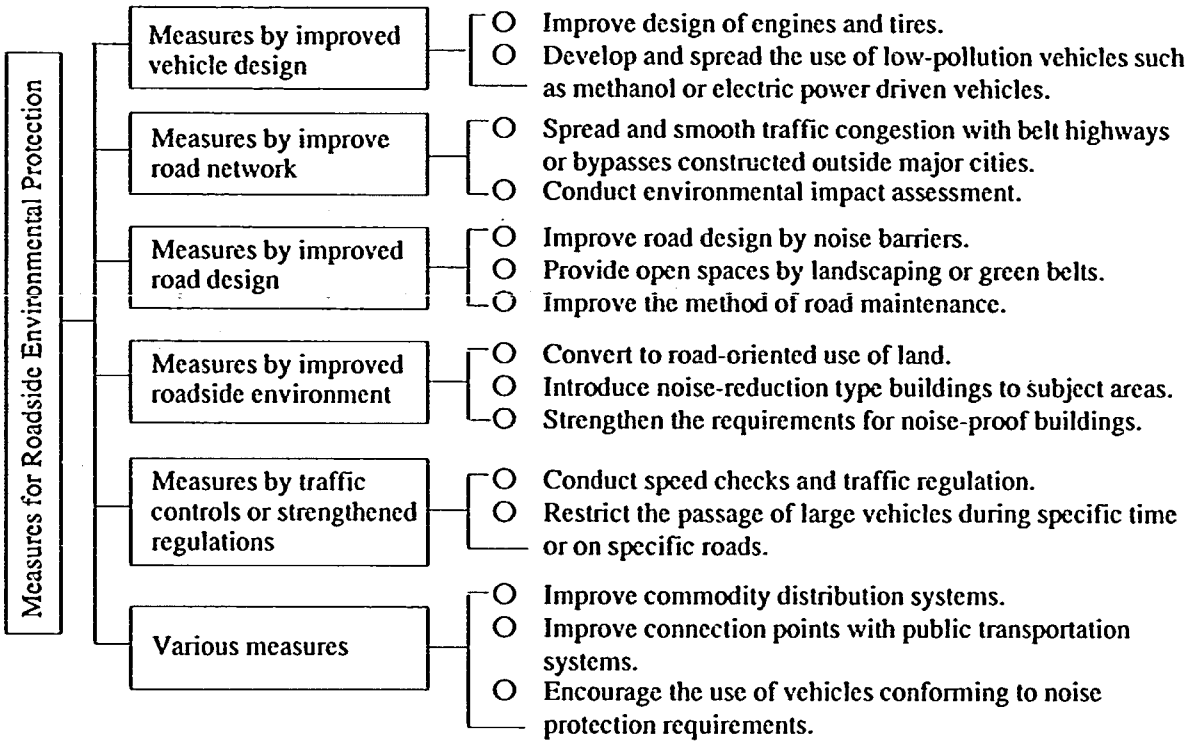
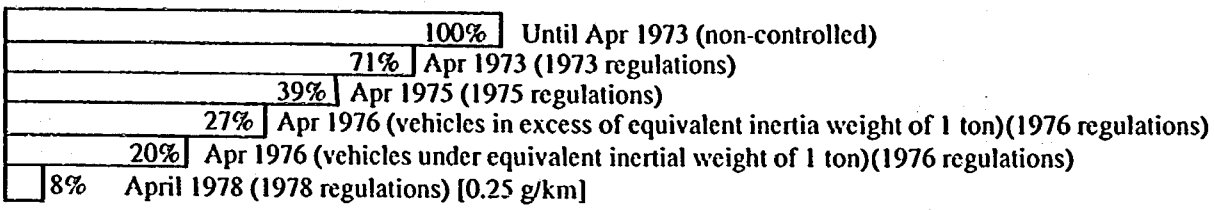


Fig. 7.1 Measures for Roadside Environmental Protection

Table 7.3 Summary of Exhaust Gas Controls for New Vehicle Models in Safety Requirements for Land Transportation Vehicles

Fuel Type	Type of Vehicle		Carbon Monoxide	Hydrocarbon	Nitrogen Oxide	Method of Measurement
Gasoline or Liquid Natural Gas	1. Standard or small passenger cars in capacity of 10 passengers or less not exceeding 1.7 tons in weight, and light-weight vehicles used for riding passengers.		2.7 g/km	0.39 g/km	0.48 g/km	10-mode 15-mode
	2. Standard or small passenger cars in gross weight of 1.7 tons or more and 2.5 tons or less.		17.0 g/km	2.7 g/km	0.98 g/km	
	3. Light weight cars not applicable to the requirements (1) above.	4-cycle type engine			0.74 g/km	
		2-cycle type engine		15.0 g/km	0.50 g/km	
	4. Standard or small vehicles in excess of 2.5 tons in gross weight.	Gasoline fueled	136 g/kwh	7.9 g/kwh	7.2 g/kwh	13-mode
		LPG fueled	105 g/kwh	6.8 g/kwh		
Gas Oil	1. Standard or small vehicles in capacity of 10 passengers or less, not exceeding 1.25 tons in equivalent inertia weight.		2.7 g/km	0.62 g/km	0.72 g/km	10-mode 15-mode
	2. Standard or small vehicles in capacity of 10 passengers or less, in excess of 1.25 tons in equivalent inertia weight.				0.84 g/km	
	3. Standard or small vehicles 1.7 tons or less in gross weight, not used mainly for riding passengers.					
	4. Standard or small vehicles in excess of 1.7 tons and less than 2.5 tons in gross weight.				1.82 g/km	
	5. Standard or small vehicles in excess of 2.5 tons in gross weight.	Direct injection type	9.2 g/kwh	3.8 g/km	7.8 g/kwh	D13-mode
		Sub-chamber type			6.8 g/kwh	

(1) Gasoline Engine Passenger Cars



(2) Diesel Engine Trucks and Buses

Direct-injection in excess of gross weight of 2.5 tons

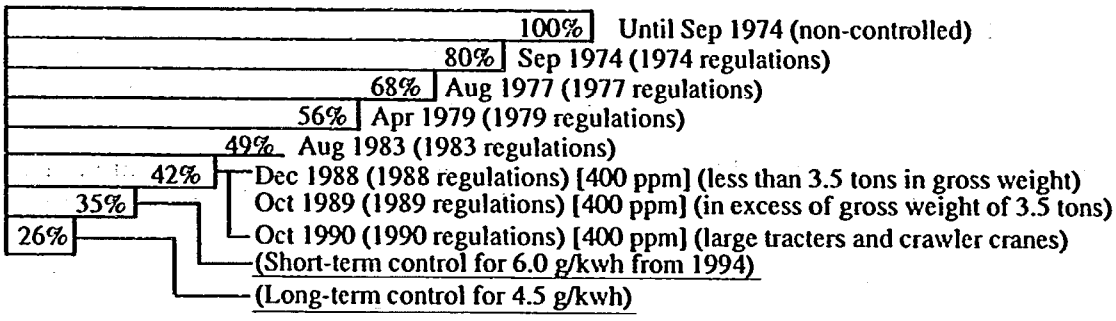


Fig. 7.2 Historical Changes in Effects of Controlling NO_x Exhausted from Vehicles (2 representative examples)

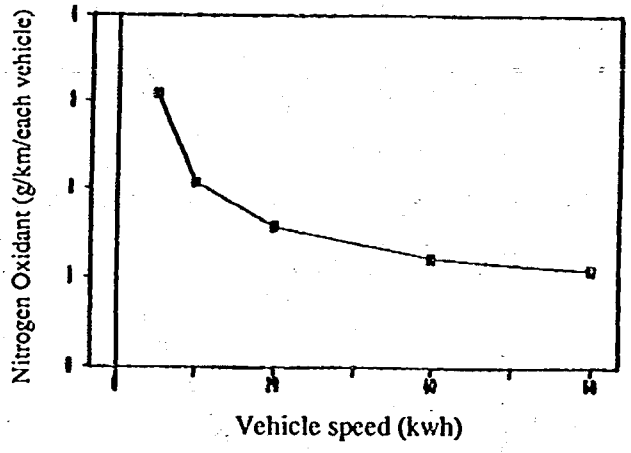


Fig. 7.3 Coefficient of Discharge at Different Vehicle Speed (example) (1988 controlled model heavy diesel truck)

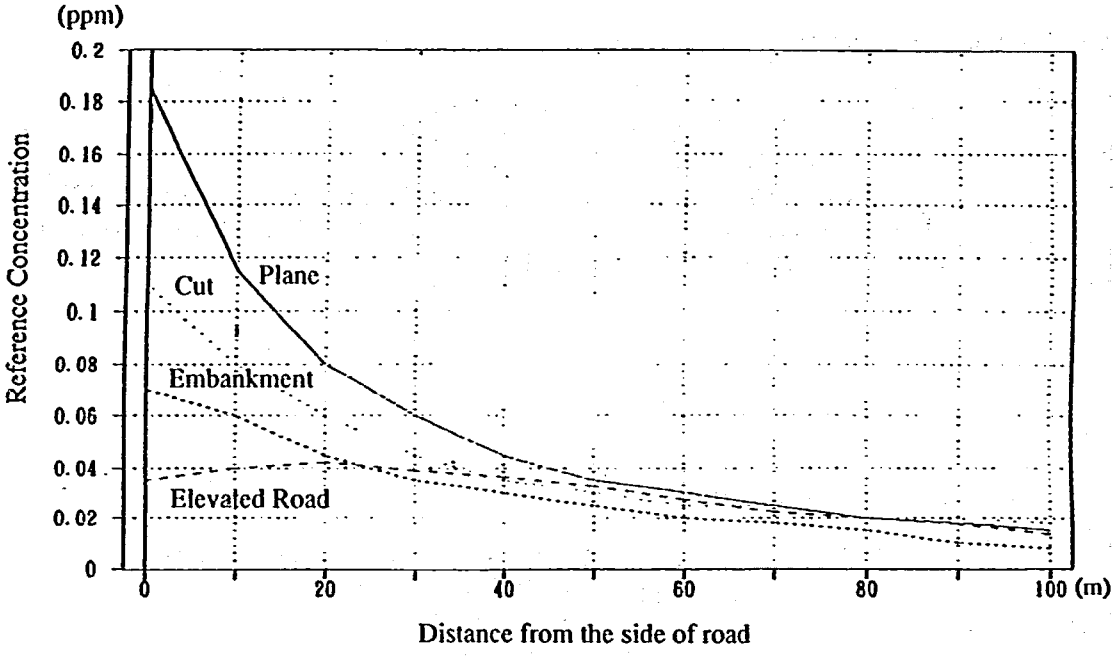


Fig. 7.4 Reduction of Standard Pollutant Concentration by Distance at Elevation of 1.5 m (Concentration at discharge rate of 1 ml/m/sec and wind velocity of 1 m/s)

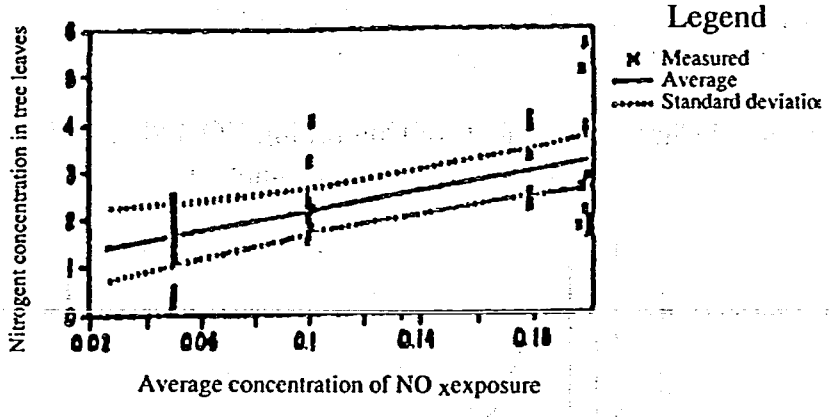


Fig. 7.5 Concentration of Exposed NO_x and Nitrogen Concentration in Tree Leaves

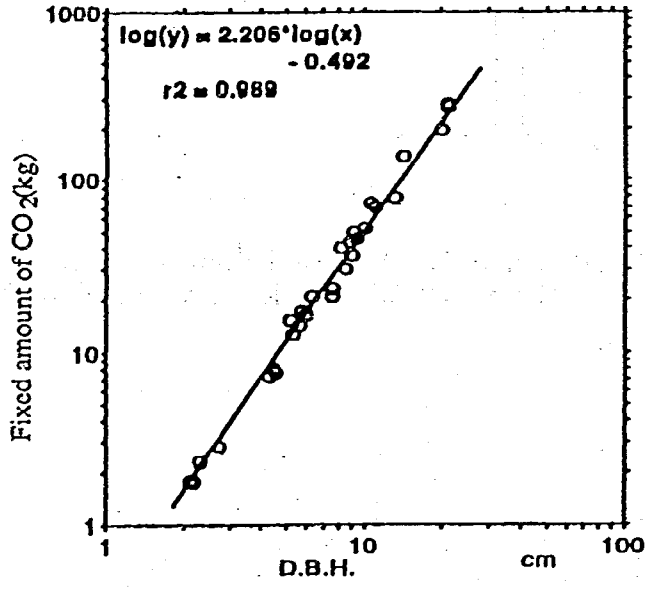


Fig. 7.6 Breast Height Diameter (D.B.H.) of *Keyaki* (zelkova) vs Fixed Amount of CO_2

5. Measures for Preventing or Reducing Vehicle Traffic Noise

Measures for preventing or reducing vehicle traffic noise are classified in figure 7.1. Actual examples are described below.

a. Improvement of Vehicle Design

The most effective means of controlling vehicle noise is to control the source of noise. Control of the noise of accelerating vehicles has been strengthened three times since 1971 (see Table 7.4). The sources of noise include engines, cooling fans, inlet and exhaust systems, and tires. Various measures have been implemented, such as controlling vibration, covering the source of noise, and modifying fans and exhaust systems.

b. Improvement of Road Structure

Noise can be attenuated by distance as well as by air dispersion. For this reason, buffer zones are provided for major roads to preserve the roadside environment. Studies are being made on acoustic protection for the underside of elevated roads and for wall surfaces.

c. Noise Barriers

It is known that noise barriers are very effective (see Fig. 7.7). Therefore, noise barriers have been provided in Japan at various places, mainly for highways, and their total length reached approximately 3,100 km in 1992. Conventional noise barriers are the wall-type, having the ability to both insulate sound and absorb sound. Increasing the heights of walls to reduce noise can cause various problems such as restricting light to adjacent buildings, appearance, and problems with foundation construction. Therefore, efforts are being made to develop innovative noise barriers that are more efficient with heights similar to conventional barriers, and translucent barriers to eliminate problems of appearance and the right to light.

Table 7.4 Changes in Requirements in Vehicle Noise Regulations

(Unit = decibel)

Vehicle Type			Normal drive noise		Close noise	Speed acceleration noise				
			Enacted in 51	1971 control	1986 to 1989	1971 control	1976 to 1977	1979 control	1982 to 1987	Target
Large-size	Gross weight in excess of 3.5 tons, having a engine 200 HP or more at maximum output	All wheel drive tractors and cranes	85	80	107 since 1989	92	89 1976 control	86	83 1986 control	82 (within 10 years)
		Trucks							83 1985 control	81 (within 10 years)
		Buses							83 1984 control	81 (within 6 years)
Medium-size	Gross weight in excess of 3.5 tons, having a engine 200 HP at maximum output	All wheel drive	85	78	105 since 1989	89	87 1976 control	86	83 1983 control	81 (within 10 years)
		Trucks and buses								80 (within 10 years)
Small-size	Gross weight less than 3.5 tons	All wheel drive	85	74	103 since 1989	85	83 1977 control	81	78 1985 control	76 (within 10 years)
		Trucks and buses							78 1984 control	
Passenger car	Mainly used for riding 10 passengers or less	Capacity in excess of 6 passengers	85	70	103 since 1988	84	82 1977 control	81	78 1982 control	76 (within 10 years)
		Capacity in less than 6 passengers								76 (within 6 years)
Two-wheel motor cycle	Two-wheel small cars in excess of 250 cc and two-wheel light cars between 125 and 250 cc	Small	85	74	99 since 1986	86	83 1976 control	78	75 1987 control	73 (within 10 years)
		Light				84			75 1985 control	73 (within 6 years)
Mopet	Type 1 motor cycle smaller than 50 cc and Type 2 motor cycles between 50 cc and 125 cc	Type 2	85	70	95 since 1986	82	79 1976 control	75	72 1986 control	71 (within 10 years)
		Type 1				80			72 1984 control	71 (within 6 years)

(Notes)
- Close area noise regulations apply to all vehicles manufactured (including used vehicles) since 1971.
- Reduction target is set at the value and time based on the 1992 council report (Nov 30, 1992).
- For the reduction target, the words "200 HP" should be replaced with the words "150 kilowatts.

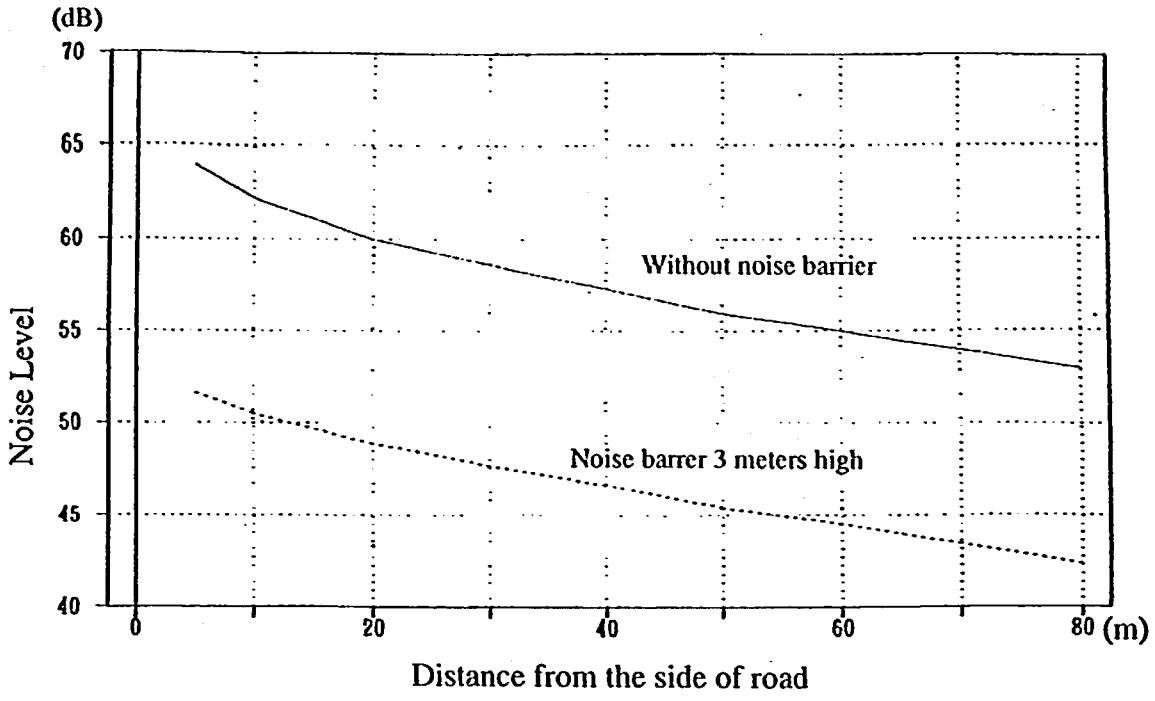


Fig. 7.7 Noise Attenuation by Distance

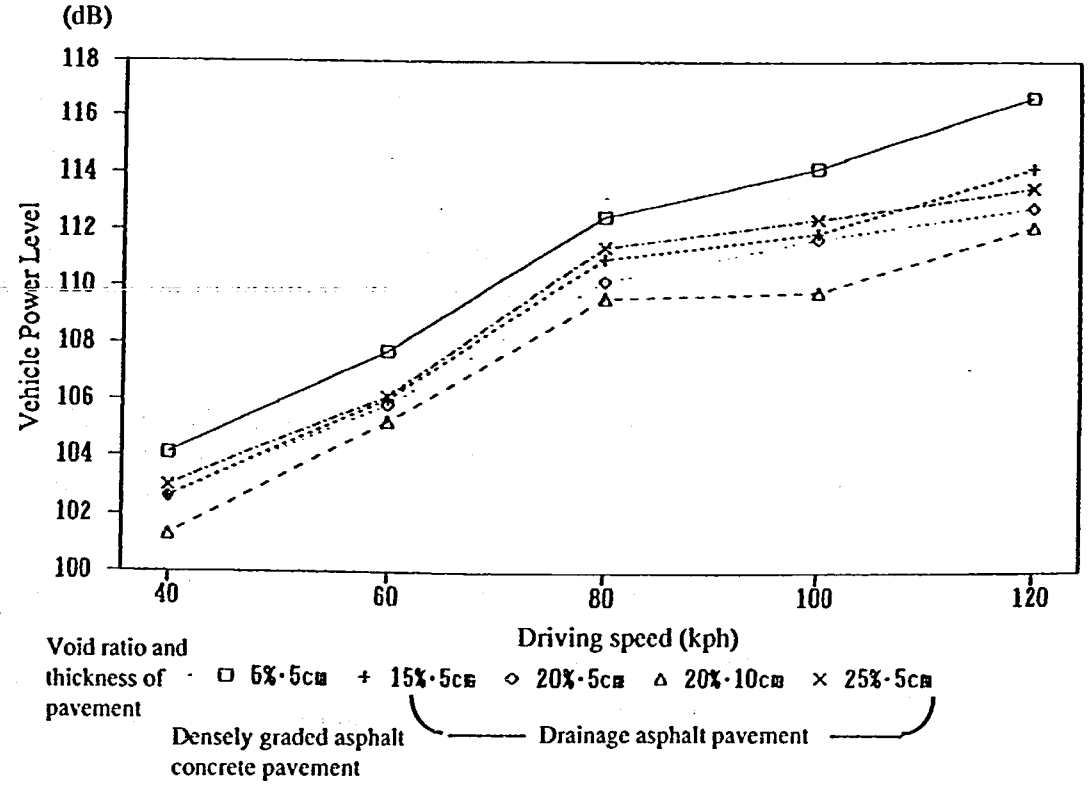


Fig. 7.8 Running Power of Vehicles Running on Different Roads

d. Low Noise Pavement

Drainage asphalt pavement attracts public attention as a low noise, or sound absorptive, pavement. It has been used experimentally at various places and measurements are being made to determine the permeability and noise reduction capability. Results of

measurements of noise power level made by the Public Works Research Institute are shown in figure 7.8. It can be seen that the measured power level of drainage asphalt pavement is lower than that of densely graded asphalt concrete pavement, and that the differences increase as the speeds increase.

8. Topics for Future Discussion

The following listed topics are common to all countries that are pushing forward with civil engineering research and development.

a. The role of national research institute and its proper attitude.

b. Methods of improving capability of researchers of the national research institute.

c. Establishment of a research information exchange system in Asia.

Topics to be discussed in specific fields include the following.

a. Striving for Water Quality Preservation and Present Situation of Sewage Works in Each Country (Water Quality Control Department)

b. Studies on Dam Construction Technological Development in Various Countries (Dam Department)

① Measures for control of sedimentation

In considering sedimentation in dam reservoirs, at the stage of planning it is important to properly estimate the volume of sedimentation, and to set up a system so that the dam is properly controlled and operated. Therefore, comprehensive measures are required to establish proper methods of estimating the volume and the type of sediment deposits, proper methods of investigation, planning, designing, maintenance for the control, disposition, and effective use of the sediment. It can be presumed that this topic is common to all dams in Asian countries, not only in Japan.

② Design and construction of small-scale dams
A number of small-scale dams will be required in Japan as the demands for local flood controls and water increase in mountainous areas, peninsulas and islands. Demands for such a small-scale dams may be different in every Asian country but the topic can be common.

c. Studies on Hazard Information in Various Countries (Erosion Control Department)

① Global-scale hazard monitoring systems
Discussion on the methods of monitoring floods, slope movements, volcanic eruptions, and earthquakes using satellite data and methods of prediction, and warning and evacuation systems.

② Method of developing wide area hazard maps
Discussion on methods of developing hazard maps for floods, slope movements, volcanic eruptions, and earthquakes, based on satellite data and small-scale topographic maps.

Appendix

I LAWS AND REGULATION FOR ROAD ENVIRONMENT

The relationship between the various laws and regulations concerning roads and the surrounding environment are set out in Fig. 1.

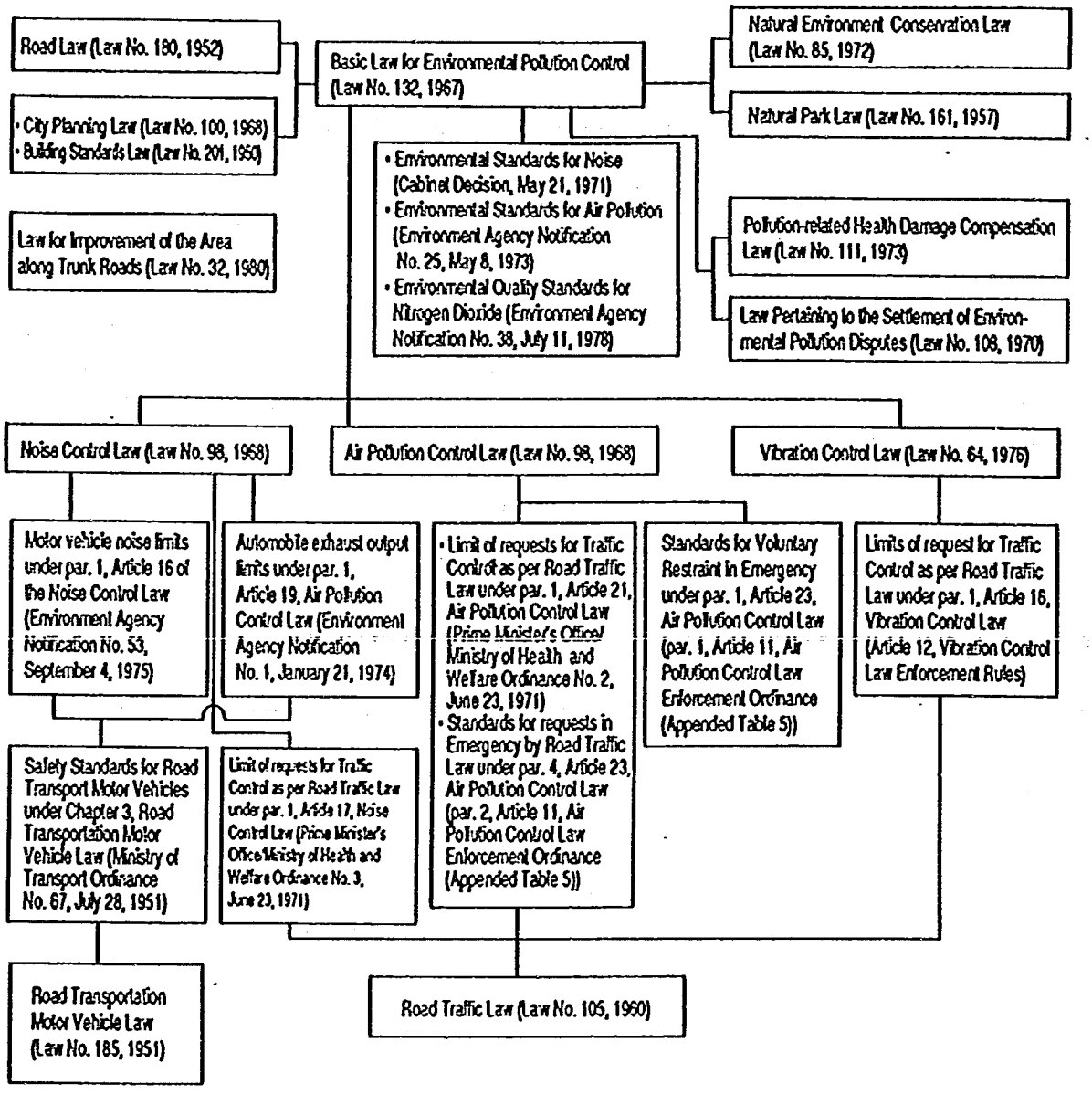


Fig. 1 Legal System for Road Environment

1. Laws and Regulations on Motor Vehicle noise, exhaust and vibration

Environmental pollution control is covered by the "Basic Law for Environmental Pollution Control". The "Noise Control Law" and "Law for the Improvement of the Areas along Trunk Roads (Roadside Law)" specify noise limits, the "Air Pollution Control Law" exhaust gas, and the "Vibration Control Law" vibration. The "Road Traffic Law" and "Road Transportation and Motor Vehicle Law" also contain provisions for control of noise level sand exhaust gas.

These laws specify environmental Quality standards and orders and, by issuing notices, illustrate certain standards for action.

(1) Environmental Pollution Control Measures in General

1) Basic Law For Environmental Pollution Control (Law No. 132 of 1967): Environment Agency

This law is the heart of environmental pollution control measures. By setting out the basic principles of pollution control it promotes pollution control strategies in a comprehensive manner.

This law lays down standards for environmental conditions such as air pollution and noise, designed to protect the health of people and to conserve the environment. These are called environmental quality standards. The law also provides guidelines on emissions (Article 10), land use (Article 11), protection of the natural environment (Article 17-2) and preparation of regional environmental pollution control programs (Article 19).

2) Road Traffic Law (Law No. 105 of 1960): National Police Agency

This is a general law designed to ensure safe and smooth road traffic flow. With respect to road traffic pollution the law provides that the Prefectural Public Safety Commission may control traffic voluntarily or as requested by the Prefectural Governor (Article 110-2).

3) Road Transportation And Motor Vehicle Law (Law No. 185 of 1951): Ministry of Transportation

This is a general law designed to ensure the safety of motor vehicles running along the roads.

The law requires that equipment for preventing noise, smoke and soot emission complies with certain technical safety standards (Article 41). Specific standards are set out in 'Safety Standards for Road Transport Motor Vehicles' (Ministry of Transportation Ordinance No. 67 of 1951).

(2) Noise

The legal system for noise is illustrated in Fig. 2.

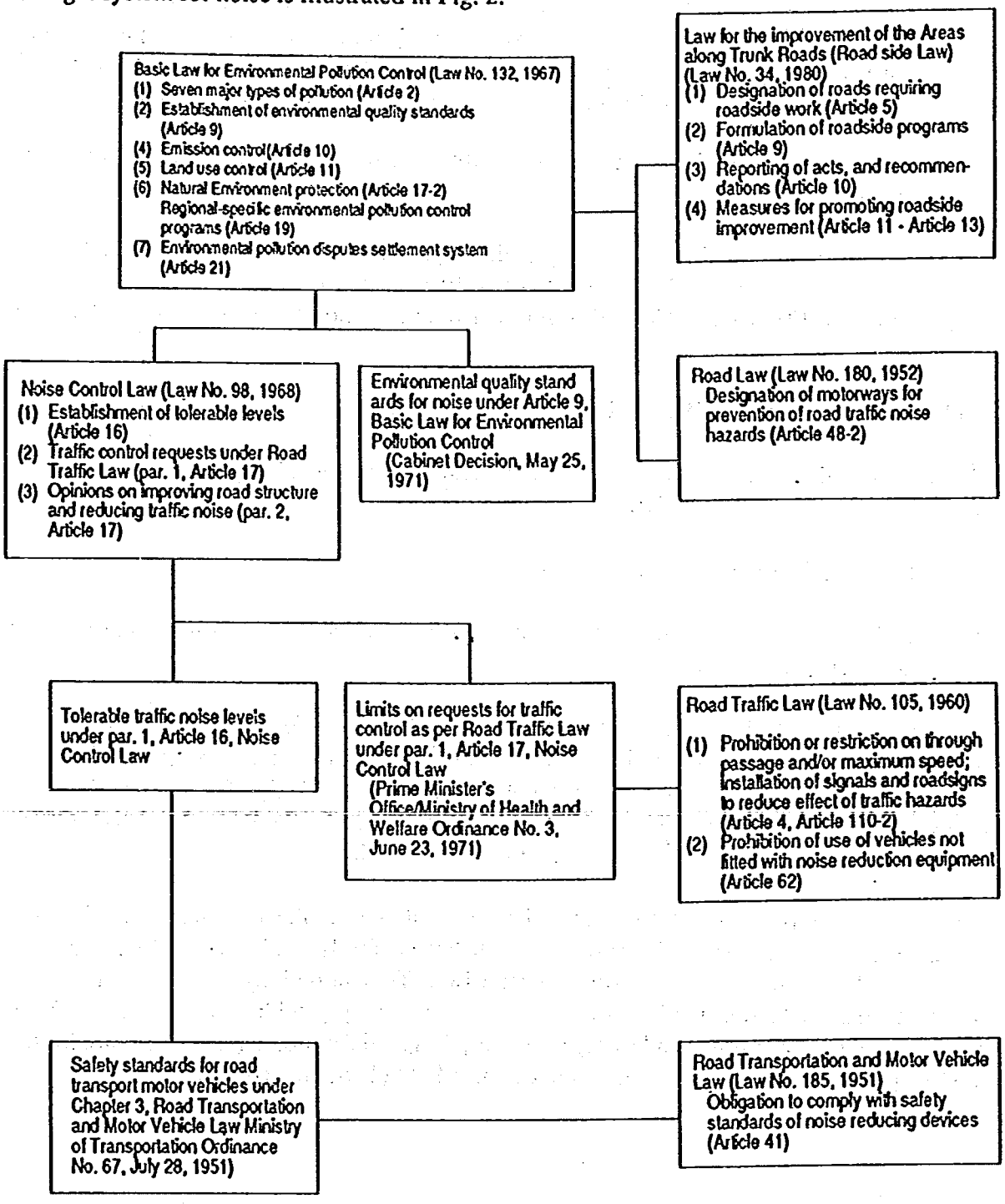


Fig. 2 Legal System for Noise

1) Noise Control Law (Law No. 99 of 1968): Environment Agency

The law describes regulation of noise levels over a wide range of activities, from business to construction, and establishment of tolerable levels for traffic noise (Article 16). It also provides that the Prefectural Governor may request traffic control from the Public Safety Commission (paragraph 1, Article 17) or express opinions to the road administrator (paragraph 2, Article 17).

2) Law for the Improvement of the Areas along Trunk Roads (Roadside Law)(Law No. 34 of 1980): Ministry of Construction

This law describes the designation of trunk roads with high levels of traffic noise for roadside work (Article 5), the design of roadside projects (Article 9) and measures for improving roadsides (Articles 11 through 13) to prevent hazards resulting from traffic noise and ensure proper land use on roadsides.

3) Road Law (Law No. 180 of 1952): Ministry of Construction

This law describes the designation of motorways (Article 48-2) where it is of particular importance to prevent hazards due to traffic noise.

4) Noise standards: Environment Agency

Environmental standards for noise are provided under Article 9 of the Basic Law for Environmental Pollution Control as set shown in Table 1.

Paragraph 1, Article 17 of the Noise Control Law provides that the Prefectural Governor may issue a request to the Public Safety Commission for traffic control according to the provisions of the Road Traffic Law should noise levels cross a set threshold (the request limit), significantly impairing the living environment near the road. The request limit is determined by the Prime Minister's Office and Ministry of Health and Welfare Ordinance, as shown in Table 2.

Paragraph 1, Article 16 of the Noise control Law describes how the Director General of the Environment Agency is obliged to determine tolerable levels of traffic noise with vehicles running under given conditions, while item 11, Article 41 of the Road Transportation and Motor Vehicle Law requires that noise reduction devices for motor vehicles comply with fixed technical safety standards. These tolerable levels and safety standards, designed for motor vehicles but not for the surrounding environment, will be discussed in Chapter 4, "2 (1) Source control."

Table 1 Environmental Standards for Noise (Cabinet Decision, May 25, 1971)

Area category			Time zone			Remarks
			Day	Morning/Evening	Night	
AA			Less than 45 dB(A)	Less than 40dB(A)	Less than 35 dB(A)	(Where applicable) In areas which the Prefectural Governor has designated according to the provisions of paragraph 2, "Cabinet Order regarding the Authority to designate areas of land and water with respect to Environmental Quality Standards." (Time limit) In areas facing roads, standards should be attained within 5 years of establishment. In areas facing trunk roads with high traffic volume where it is difficult to achieve target levels, the time limit may be extended but every effort should be made to achieve the target as soon as possible.
A			Less than 50 dB(A)	Less than 45 dB(A)	Less than 40 dB(A)	
	Special case of "area facing road"	2 lanes	Less than 55 dB(A)	Less than 50 dB(A)	Less than 45 dB(A)	
		More than 2 lanes	Less than 60 dB(A)	Less than 55 dB(A)	Less than 50 dB(A)	
B			Less than 60 dB(A)	Less than 55 dB(A)	Less than 50 dB(A)	
	Special case of "area facing road"	2 lanes	Less than 65 dB(A)	Less than 60 dB(A)	Less than 55 dB(A)	
		More than 2 lanes	Less than 65 dB(A)	Less than 65 dB(A)	Less than 60 dB(A)	

Note: AA Area requiring particular quietness
A Mainly residential area
B Residential area also used for commerce and industry
Lane A section of carriageway in the form of a straight belt of fixed width, allowing a line of motor vehicles to proceed safely and smoothly ahead

Table 2 Request Limits for Automobile Noise (Prime Minister's Office/Ministry of Health and Welfare Ordinance No. 3, June 23, 1971)
(Revision) Prime Minister's Office Ordinance No. 41, 1971)

Area classification	Number of lanes	Time zone		
		Day	Morning/Evening	Night
Class 1 area	1 lane	55 dB	50 dB	45 dB
	2 lanes	70 dB	65 dB	55 dB
	More than 2 lanes	75 dB	70 dB	60 dB
Class 2 area	1 lane	60 dB	55 dB	50 dB
	2 lanes	70 dB	65 dB	55 dB
	More than 2 lanes	75 dB	70 dB	60 dB
Class 3, 4 areas	1 lane	70 dB	65 dB	60 dB
	2 lanes	75 dB	70 dB	65 dB
	More than 2 lanes	80 dB	75 dB	65 dB

Notes: 1. Class 1 - Class 4 areas, designated by the Prefectural Governor, correspond approximately to the following areas.
Class 1 area: Class 1 dwelling area
Class 2 area: Class 2 dwelling area, and dwelling area
Class 3 area: Neighborhood commercial area, commercial area, and semi- industrial area
Class 4 area: Industrial area
2. Lane: A section of carriageway in the form of a straight belt of fixed width, allowing a line of motor vehicles to proceed safely and smoothly ahead

(3) Air pollution

The setup of the legal system pertaining to air pollution is shown in Fig. 3.

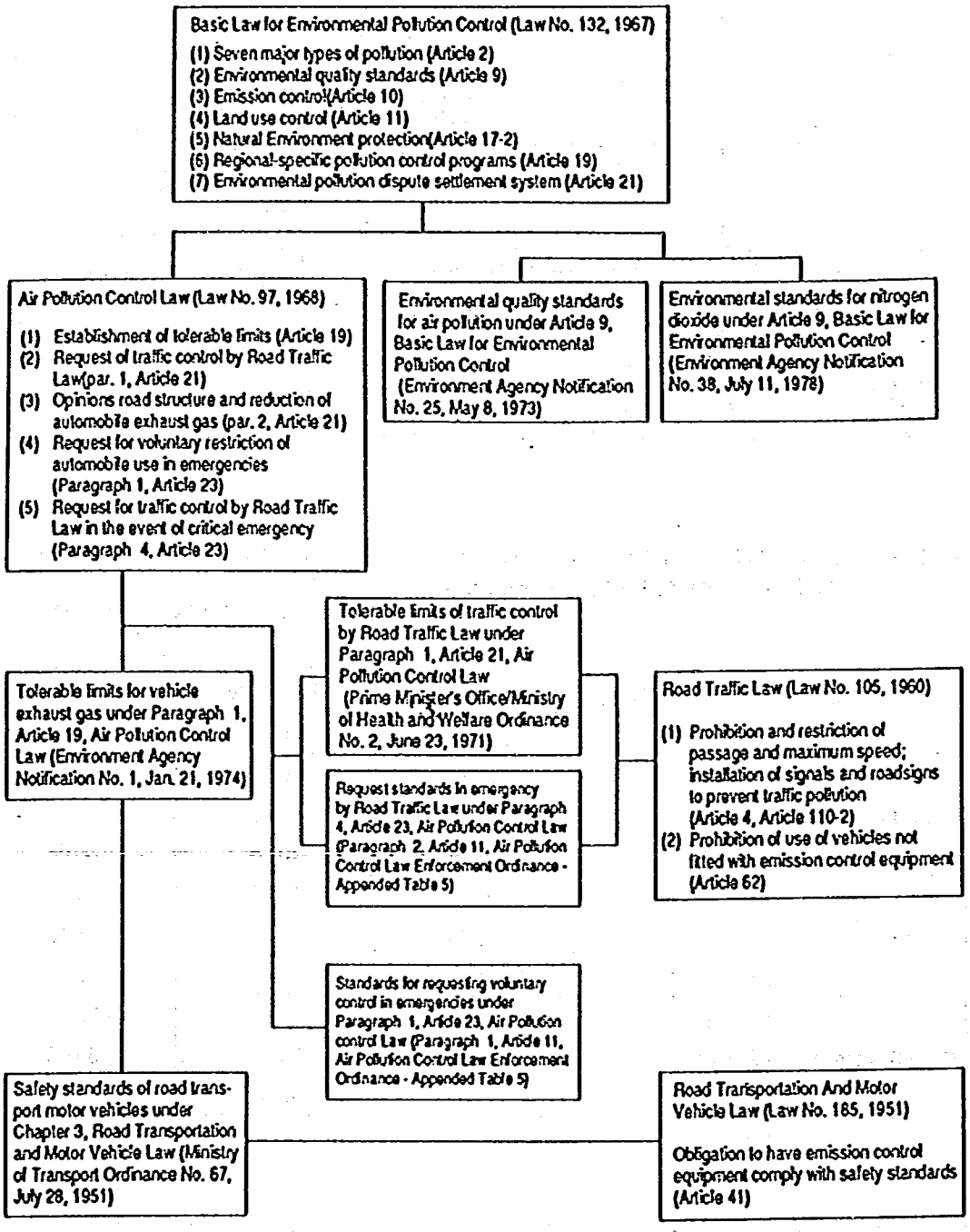


Fig.3 Legal System for Air Pollution

1) Air Pollution Control Law (Law No. 97 of 1968): Environment Agency

This law describes control of emission of industrial smoke and soot and establishment of tolerable limits for automobile exhaust gas (Article 19). It also provides, such as in the Noise Control Law, that the Prefectural Governor may issue a request for traffic control to the Public Safety Commission (paragraph 1, Article 21) or give opinions to the road administrators (paragraph 2, Article 21) in certain cases.

2) Standards for Air pollution Substance: Environment Agency

As with noise standards, environmental quality standards are specified for air pollutants under Article 9 of the Basic Law for Environmental Pollution , as shown in Table 3.

Paragraph 1, Article 21 of the Air Pollution Control Law provides that the Prefectural Governor may issue a request for traffic control under the provisions of the Road Traffic Law to the Public Safety Commission, in the event that air pollution exceeds a given limit (the request limit). The request limit is specified by a Prime Minister's Office/Ministry of Health and Welfare Ordinance as shown in Table 3.

Paragraph 1, Article 23 of the Air Pollution Control Law provides that the Prefectural Governor may ask for voluntary restriction of vehicle use when air pollution levels exceed a given standard and are considered likely to continue rising, this standard being specified in paragraph 1, article 11 of the Air Pollution Control Law Enforcement Ordinance (Cabinet Order No. 329 of 1968) shown in Table 3.

Paragraph 4, Article 23 of the Air Pollution Control Law provides that the Prefectural Governor may make a similar request where the request limit has been reached, in the event that air pollution levels have deteriorated rapidly due to weather conditions and exceeded a fixed standard (emergency request standard), and are considered likely to continue rising, this request standard being specified in paragraph 2, Article 11 of the Air Pollution Control Law Enforcement Ordinance in Table 3.

Paragraph 1, Article 19 of the Air Pollution Control Law provides that the Director General of the Environment Agency is obliged to determine allowable limits for exhaust generated by an automobile operated under certain fixed conditions, while item 12, Article 41 of the Road Transportation and Motor Vehicle Law requires that hazardous gas emission control equipment in automobiles complies with fixed technical safety standards. The allowable limits and safety standards are described in Chapter 4 under "2 (1) Source measures."

Table 3 Environmental Quality Standards and Request Limits for Air Pollution

Substances	Environmental quality standards for air pollution (Re environmental quality standards for air pollution [Environment Agency Notification No. 25, May 8, 1973]; Re environmental quality standards for nitrogen dioxide [Environment Agency Notification No. 38, July 11, 1978])	Time limit	Request limit (Order determining the limit of air pollution by automobile exhaust gas under the provision of Paragraph 1, Article 21, Air Pollution Control Law [Prime Minister's Office/Ministry of Health and Welfare Ordinance No. 2, June 23, 1971])	Request standards in emergency (Par. 2, Article 11, Air Pollution Control Law Enforcement Ordinance [Cabinet Order No. 329, 1968] - Appended Table 5)	Standards for voluntary regulation in emergency (Par. 1, Article 11, Air Pollution Control Law Enforcement Ordinance [Cabinet Order No. 329, 1968] - Appended Table 5)
Sulphur dioxide (Sulphur oxides in Air Pollution Control Law)	Daily mean of 1-hour values: 0.04 ppm or less 1-Hour value: 0.1 ppm or less	To be maintained, or limit attained within 5 years		1) 1-Hour value: 0.5 ppm or higher lasting for 3 hours 2) 1-Hour value: 0.7 ppm or higher lasting for 2 hours	1) 1-Hour value: 0.2 ppm or higher lasting for 3 hours 2) 1-Hour value: 0.3 ppm or higher lasting for 2 hours 3) 1-Hour value: 0.5 ppm or higher 4) 48-Hour mean of 1-hour values: 0.15 ppm or higher
Carbon monoxide	Daily mean of 1-hour values: 10 ppm or less 8-Hour mean of 1-hour values: 20 ppm or less	To be maintained, or limit achieved as early as possible	Monthly mean of 1-hour values: 10 ppm	1-Hour value: 50 ppm or higher	1-Hour value: 30 ppm or higher
Suspended particulate matter	Daily mean of 1-hour values: 0.10 mg/m^3 or less 1-Hour value: 20 mg/m^3 or less			1-Hour value: 3.0 mg/m^3 or more over 3 hours	1-Hour value: 2.0 mg/m^3 or more over 2 hours
Nitrogen dioxide	Daily mean of 1-hour values: Within the range 0.04 - 0.06 ppm or less	1. In areas where the daily mean of 1-hour values exceeds 0.06 ppm, a daily mean of 0.06 ppm of 1-hour values should be achieved within 7 years. 2. In areas where the daily mean of 1-hour values is within the range 0.04 - 0.06 ppm, the present level within the zone should be maintained as far as possible..		1-Hour value: 1 ppm or more	1-Hour value: 0.5 ppm or more
Photochemical oxidants	1-Hour value: 0.06 ppm or less	To maintain or attain limit as early as possible		1-Hour value: 0.4 ppm or more	1-Hour value: 0.12 ppm or more
Where applicable	Exclusive industrial area, except roadways and non-residential areas		Roads and peripheral areas		
Remarks	Desirable standard for protection of health and conservation of living environment under Paragraph 1, Article 9 of the Basic Law for Environmental Pollution		Prefectural Governor requests traffic control to Prefectural Public Safety Commission when air pollution due to automobile exhaust exceeds this limit	Should such a situation develop, the Prefectural Governor must request voluntary restrictions on automobile use	Should such a situation be considered due to automobile exhaust, the Prefectural Governor issues a request for traffic control to the Prefectural Public Safety Commission

(4) Vibration

The legal system pertaining to vibration is shown in Fig. 4.

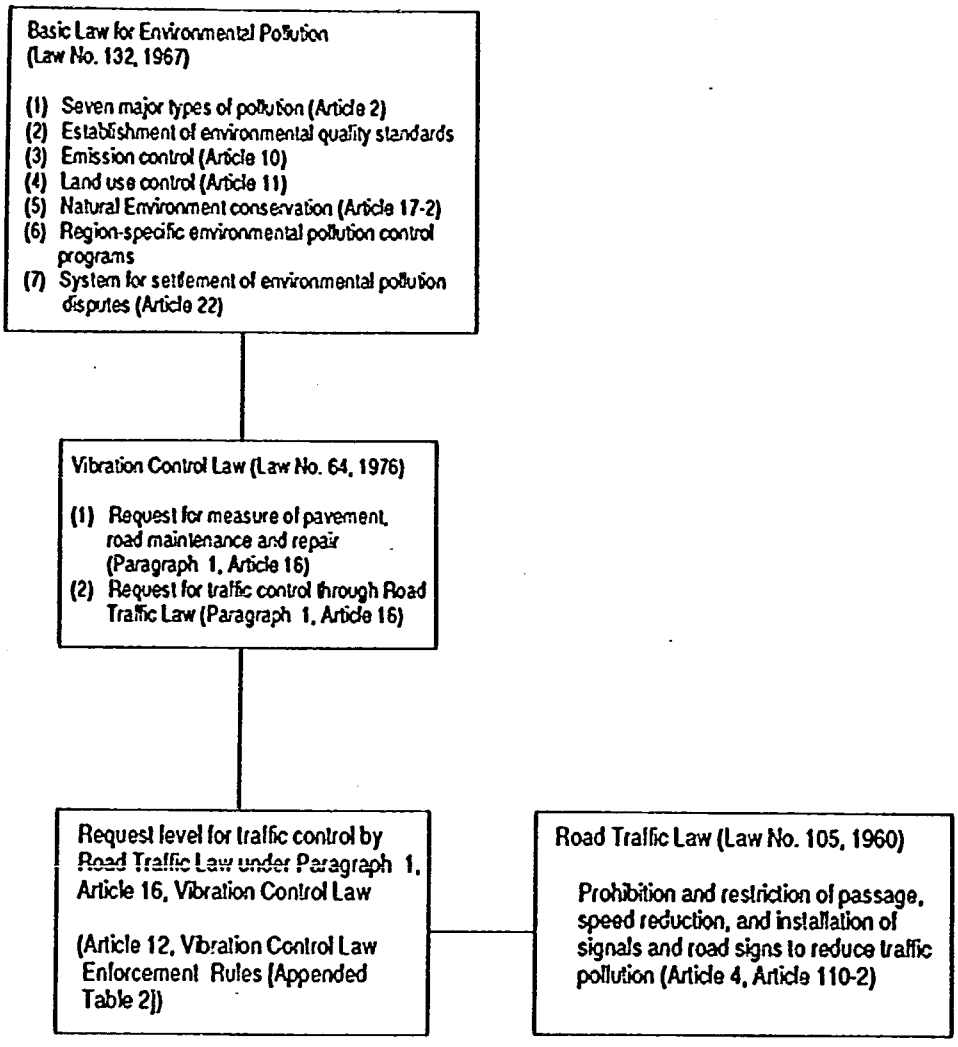


Fig. 4 Legal system for Vibration

1) Vibration Control Law (Law No. 64 of 1976): Environment Agency

This law provides control of vibration occurring over a wide range of activities from business to construction work, and that in certain cases the Prefectural Governor can issue a request to the road administrator if further action is considered necessary (Paragraph 1, Article 16) or to the Public Safety Commission for traffic control (Paragraph 1, Article 16).

2) Standards for Vibration : Environment Agency

Paragraph 1, Article 16 of the Vibration Control Law provides that when road traffic vibration exceeds a certain level (request level), significantly affecting the surrounding environment, a request can be made to the Public Safety Commission for traffic control according to the provisions of Road Traffic Law, this request level being stipulated in Article 12 of the Vibration Control Law Enforcement Guidelines (Prime Minister's Office Ordinance No. 58 of 1976) shown in Table 4.

Article 12 includes the following proviso.

The noise levels given below shall be determined by consultation between the governor, road administrator and public safety commission:

① On roads in the vicinity of facilities such as schools and hospitals where low noise levels are desirable: as shown in the table, reduced less up to 5 dB.
② In Class 1 areas at night in specially designated sections of existing trunk roads: night-time level for Class 2 areas.

The "Re-enforcement of Vibration Control Law" (Notice of the Environment Permanent Vice-Minister, December 1, 1976) stipulates that specially designated sections of existing trunk roads are those sections of national highway or major local roads with vehicle traffic volume of over 5000 cars/day, where the level at night of Class 1 area can barely be attained even when paving and other measures are adopted, due to softness of ground over all or part of the road, hindering traffic control.

Table 4 Request Limit of Road Traffic Vibration
(Article 12, Vibration Control Law Enforcement Rules
[Prime Minister's Office Ordinance No. 58,1976] - Appended Table 2)

Time classification / Area classification	Daytime	Nighttime
Class 1 area	65 dB	60 dB
Class 2 area	70 dB	65 dB
Remarks	When vibration exceeds the given level the Prefectural Governor issues a request to the road administrator or Public Safety Commission	

Note:
Class 1 and 2 areas correspond roughly to the following areas, and are determined by the relevant Prefectural Governor.
Class 1 area - Class 1 exclusive residential area,
Class 2 exclusive residential area and residential area.
Class 2 area - Neighboring commercial area, commercial area,
semi-industrial area and industrial area.

(5) Sunlight obstruction and radio interference

Part 3 of "Re-implementation of Criteria for Loss Compensation in the event of Acquisition of Land for Public Use" (Cabinet Understanding, June 29, 1962) describes procedures for advance payment of compensation for damage from shading.

Sunlight obstruction is covered by "Bearing expenses pertaining to suffering as a result of shade inflicted by construction of Public Facilities" (Construction Permanent Vice-Minister Notice, February 23, 1976).

Radio interference is described in "Bearing Expenses pertaining to suffering caused by interference to television reception due to construction of Public Facilities" (Construction Permanent Vice-Minister Notice, October 12, 1979).

The above notices were sent to all Directors of Regional Construction Bureaus and also circulated for reference to Directors of Public Corporations and Prefectural Governors.

1) Sunlight obstruction

In the event that suffering is caused to a person or persons living in a given area or district as a result of shade produced by the construction of public facilities under a project directly managed by the Ministry of Construction, and where the extent of suffering exceeds the limit considered acceptable in society, a fixed minimum level of compensation shall apply.

Dwellings eligible for compensation are defined as those with shaded hours (defined as the number of hours between 8 AM and 4 PM [or 9 AM and 3 PM in the Hokkaido region] during which the central part of the opening of the living room is in shade, measured according to the true solar time on the day of winter solstice) exceeding the value shown in Table 5. Compensation for damage is calculated as the sum of heating, lighting and other costs, and it is borne in a lump sum.

Table 5 Standards of Shaded Hours

	(a)	(b)	(c)	
	Area or district	Story	Shaded hours	
			Area other than Hokkaido	Hokkaido
(1)	Class 1 exclusive residential area	1st	4 hrs	3 hrs
(2)	Class 2 exclusive residential area	2nd	4 hrs	3 hrs
(3)	Residential area, neighboring commercial area, or semi-industrial area considered the same as a residential area in terms of land use is	2nd	5 hrs	4 hrs
(4)	In areas not designated for any specific use, a district where land use is recognized to be similar to an area or district listed in any of (1) to (3) above	Depending on the area, treated similarly to (1) to (3)		

Note : 1. Shaded hours listed in Column (c) are those pertaining to the living rooms facing true south; living rooms not facing true south should be corrected accordingly.
2. The shaded hours of Column (c) for any other stories than those listed in Column(b) should be determined in consideration of such conditions as the height of public facility and location of residence in relation to public facility, in line with shaded hours listed in Column (c).

2) Radio interference

In the event that suffering is caused to a person due to difficulty in receiving television waves as a result of construction of public facilities under a project directly managed by the Ministry of Construction, and where the extent of suffering exceeds the limit considered acceptable in society, a fixed minimum level of compensation shall apply.

The extent of the interference borne shall correspond to Grade 5~3 to Grade 2 or 1 in Table 6 for any one television channel. Compensation shall be sufficient to cover a technically and economically reasonable work which provides normal reception, for instance installation of joint or individual receivers, or relocation or upgrading of the existing receiver. Compensation is paid in a lump sum. In the event that a joint receiver is installed, a management association must be established.

Table 6 Evaluation of Reception Quality

Grade	Details
5	Excellent
4	Good reception with little noise or interference
3	Some noise or interference but still view able
2	Reception possible but not usable due to noise or interference
1	Reception impossible due to noise and/or interference, or very poor to the point of being unview able

(Note) According to "Procedural Rules Concerning Inspection of Broadcasting Stations and Measures Accompanying Inspection" (Notice 5-7 of the Director of Radio Regulatory Bureau, Ministry of Posts and Telecommunications, dated March 28, 1958.

WATER QUALITY LEGISLATION

1. Evolution of the legal system

As mentioned in Chapter 1, water pollution in Japan dates back to a mine poisoning controversy in 1877. There were also incidents of damage to agriculture and fisheries stocks from textile and pulp manufacturing liquid wastes. After World War II river, lake and sea water rapidly became polluted due to the transition from manure to chemical fertilizer use in agriculture, advances in the chemical production industry, and greater pollution by domestic effluents.

Previously water conservation was administered by individual regulation of only certain industrial effluents under specific laws such as the Fisheries Law. Although disputes over water pollution were common, there was no overall system regulating water quality conservation, and pollution levels rose virtually unchecked. This is explained by the fact that except for the 1877 mine poisoning incident, water pollution was not a major social issue. There was a general belief that a certain level of environmental disruption had to be accepted as part of the modernization process. Furthermore there was little awareness of a sense of resident rights, and Japan was also in the buildup to wartime mode.

Although the situation in the post-war period of rehabilitation did not differ greatly, during this time a number of water pollution laws were enacted, including the Mine Safety Law, Fisheries Resources Protection Law and Public Cleanliness Law. Tokyo and a few other autonomous regions formed their own environmental pollution control ordinances. In 1958 the Water Quality Conservation Law and the Factory Effluent Regulation Law were enacted following the 'Urayasu incident', in which fishermen operating in Tokyo Bay broke into a local paper mill to protest against damage by liquid waste from the factory.

The previous legal set-up based on the Water Quality Conservation Law was one of cure rather than prevention: regulation was carried out only in waters designated as already damaged or under threat of pollution. Although quality standards for discharge water had been integrated, enforcement was left to a number of different laws, including the Factory Effluent Regulation Law and the Mine Safety Law, and in usually entailed little more than issuing orders to correct waste water disposal methods and conducting checkups during installation.

Due to this highly ineffective system and Japan's rapid economic growth, water pollution continued to escalate even after 1958.

Laws enacted between 1955 and 1964 to regulate air pollution and ground settlement besides water pollution were only makeshift, temporary measures designed to treat specific cases of environmental pollution and quite unable to deal with worsening pollution levels. Public demand for systematic and comprehensive anti-pollution laws was growing.

1967 saw the enactment of the Environmental Pollution Law. The Air Pollution Law and Noise Regulation Law were enacted the following year, finally creating a complete system of environmental pollution control. In the meantime however the number of different types of pollution was rising due to rapid growth of the industry and economy, and the incidence of unregulated forms of pollution such as photochemical smog spread throughout the country. These laws were found to be lacking in many respects, particularly in that they were applicable in specific areas only. A complete overhaul was necessary in order to prevent environmental pollution before it occurred.

In 1970, at the 64th extraordinary Diet session (the 'pollution session'), some fourteen laws including the Water Pollution Law were either enacted or amended, and in 1971 the Environment Agency was established in an effort to unify pollution administration. Japan could then boast one of the most advanced systems of legal institutions and administrative organizations for environmental (and particularly water) pollution in the world.

Related legal systems were gradually upgraded, for instance the 1978 amendment of the Water Pollution Law to introduce total emission regulation, the 1984 enactment of Law on Special Measures for Conservation of Water Quality in Lakes and Marshes, and the 1993 review of environmental standards for health with respect to water pollution (see Table 1).

Table 1 A summarized history of water quality administration

a = law b = rule or regulation c = incident d = pertaining to Kinki Region Construction Bureau e = other

1878	c	Mineral poisoning from Ashio Copper Mine in Watarase River, Tochigi Prefecture
1891	c	Shozo Tanaka questioned in House of Representatives over Ashio mine poisoning incident (first case of Diet questioning over environmental pollution)
1896	a	River law (former law)
1900	a	Sewerage law (former law)
1901	c	Dispute between Mitsubishi Paper Manufacturing Co. (Takasago, Hyogo Prefecture) and farmers and fishermen on Kako River (Takasago poisoning case)
1910	a	Fisheries Law (Article 34: Proper disposal of harmful substances)
1918	c	Damage to agriculture and fisheries on Arata River (Gifu Prefecture) by effluents from spinning, paper manufacturing, food processing and other factories
1922	c	Outbreak of unknown disease ('ouch-ouch' syndrome) in Jinzu river basin (Toyama Prefecture)
1925	d	Drought in Yodo River. Lowest water level in history of Lake Biwa (-104 cm on December 4)
1934	c	Total extinction of ayu (sweetfish) in Nagara River (Gifu Prefecture) due to factory effluents
1941	c	Water pollution in Ishikari River intensifies due to effluents from Kokusaku Pulp mill (Asahikawa, Hokkaido)
1949	a b e	Mine Safety Law. Tokyo enacts Japan's first ever environmental pollution control ordinance Ministry of Construction inaugurated (June 1)
1951	e a a e	Recommendations on water pollution by Resources Investigation Council Economic Stabilization Board Fishery Resources Protection Law Port and Harbor Law Factory pollution control ordinance in Kanagawa Prefecture
1954	a e	Public Cleanliness Law Ordinance on pollution control in the workplace in Osaka Prefecture
1955	c c	Medical Association issues pronouncement on 'ouch-ouch' disease Outbreak of unknown infant disease in Western Japan (Morinaga arsenic milk incident)
1956	c	Minamata disease develops into major social problem; Kumamoto University sets up Minamata disease research team
1957	a	Waterworks law
1958	d e c d	Kinki Region Construction Bureau makes first water quality assessment of aquatic organisms in urban Osaka rivers Ministry of Construction subsidizes sludge dredging work in the Sumida River (first instance of water purification work) Fishermen from Urayasu and surrounding areas break into Honshu Paper Manufacturing Co. Edogawa plant and battle with police (Urayasu incident) Japan's first water pollution control liaison council created for Yodo River
1958	a a a	Factory Effluents Regulation Law Water Quality Conservation Law Sewerage Law
1959	b c	Water Quality Council inaugurated. Minamata disease research team at Kumamoto University claims organic mercury probable cause of Minamata disease

1960	c	Foul smell discovered in fish in Ise Bay (Yokkaichi)
1961	c	Foul smell in fish linked with Mizushima industrial complex, Okayama Prefecture
1963	b	Government releases quality standards and list of designated water bodies including Yodo River (under the jurisdiction of this bureau) in Water Quality Conservation Law
	d	First directly managed water quality analysis under bureau jurisdiction begins as part of Yodo River project
	c	Outbreak of unknown disease (Minamata No. 2) in basin of Agano River (Niigata Prefecture)
1964	a	River Law (new)
1967	d	Neya River purification work begins (water conveyance begun March 1970)
	c	Ministry of Health and Welfare research team concludes organic mercury poisoning in Agano river basin caused by effluents from Showa Denko factory
	a	Emergency Measures for Sewerage Development
	a	Environmental Pollution Law
1968	d	Directly-managed water quality analysis at Kinki Technical Office begins
	b	Ministry of Health and Welfare issues provisional notification of mercury countermeasures
	c	Ministry of Health and Welfare announces 'ouch-ouch' disease caused by cadmium discharge from Mitsui Mining & Smelting Co. Kamioka mine
	c	Spate of Kanemi rice oil poisoning (PCB poisoning) incidents across northern Kyushu
1969	e	Government submits first environmental pollution White Paper to National Diet in accordance with Environmental Pollution Law
	b	Ministry of Health and Welfare issues notification on control of cadmium-based environmental pollution
1970	d	First ever water quality conference at this bureau
	b	Cabinet sets environmental standards for water pollution
	e	Ministry of Construction releases five-year sewerage plan (1971 - 1975)
	c	Foul smell at waterworks in Tone River system
	c	Major sludge problem at Tagonoura
	e	Ministry of Agriculture, Forestry and Fisheries imposes total ban on agricultural chemicals DDT and BHC
	a	Fourteen environmental pollution bills deliberated and passed by 64th extraordinary Diet session ('environmental pollution session'), including Water Pollution Law, Marine Pollution Law and partial amendment to Environmental Pollution Law
1971	d	First automatic water quality monitoring equipment in this bureau installed at Hirakata on Yodo River
	b	Government ordinance on environmental standards (enforced June 24)
	c	Tokyo District Public Prosecutors Office names a private electroplating company for discharging poisonous liquid waste in excess of standards into public sewer system (first case of environmental pollution)
	b	Kyoto public health research institute finds PCB in fish from Lake Biwa and Uji River
	e	Environment Agency inaugurated
	b	Environment Agency promulgates environmental standards
1973	d	First ever intake restrictions on Yodo River due to drought (July 31)
	d	Water testing section set up in Kinki Technical Office
	a	Provisional Measures for Environmental Conservation in Seto Inland Sea
1974	b	Environment Agency promulgates provisional guidelines for treatment and disposal of bottom deposits (1975 standards for removal of PCB and Hg)
1977	c	Red tide in Lake Biwa; subsequently observed every year until 1993 with the sole exception of 1986
1978	a	Total emission regulation introduced by updating Seto Inland Sea provision measures to status of Special Measures Law and amending Water Pollution Law
1979	b	Government designates Seto Inland Sea and other waters for total emission regulation, and formulates general policy on COD reduction
	d	Kinki Region Construction Bureau issues list of water pollution countermeasures
	b	Shiga Prefecture issues ordinance to control eutrophication in Lake Biwa
1982	b	Environment Agency promulgates environmental standards for nitrogen and phosphorus in lakes and marshes

1983	d	Kinki Region Construction Bureau introduces water testing vehicles
	b	Ministry of Health and Welfare sets provision water quality standards for city water with respect to trichloroethylene and other levels
	c	National fact-finding groundwater survey by Environment Agency reveals trichloroethylene and other forms of pollution
1984	d	Kinki Region Construction Bureau begins simplified water quality survey by aquatic organisms for river protection month
	b	Environment Agency issues provisional policy guidelines on trichloroethylene and other effluents
	a	Special Measures for Water Quality Conservation in Lakes and Marshes (Lake and Marsh Law)
1985	b	Nitrogen and phosphorous added to effluent standards regulated by Water Pollution Law
	b	Lake Biwa designated in Lake and Marsh Law
1989	a	Water Pollution Law amended to cover groundwater monitoring; trichloroethylene and tetrachloroethylene added to list of poisonous substances
	a	Transparency of Lake Biwa water declines due to rapid multiplication of picoplanktons (July)
1990	b	Environment Agency issues provisional policy guidelines on water pollution by agricultural chemicals used at golf courses (21 items)
	b	Ministry of Health and Welfare issues provisional city water quality targets with respect to agricultural chemicals used at golf courses (21 items)
	b	Legislation on domestic effluent countermeasures
1991	b	Environment Agency and Ministry of Health and Welfare make nine additions each to provisional guidelines and water quality targets (respectively) with respect to agricultural chemicals used at golf courses
	b	Environment Agency promulgates environmental standards on soil pollution
	b	Tertiary water quality total emission regulations and general policy on total emission reduction released
1992	b	Completion of Phase 2 lake water quality conservation plan covering five lakes and marshes including Kasumigaura, regulating total emission of nitrogen and phosphorous
	b	Ministry of Health and Welfare amends quality standards for city water, adding 20 new items to original 26
1993	b	Environment Agency promulgates partial amendment of environmental water pollution standards, reviewing health items and making 15 additions
	b	Completion of Phase 2 lake water quality conservation plan for Lake Suwa and Lake Kamafusa Dam, regulating total emission of nitrogen and phosphorous

2. Environment Pollution Law (Basic Law for Environment Pollution Control, BLEPC)

This law, which is like a constitution for environmental pollution control, complements water quality legislation such as the Water Pollution Law and provides a foundation for control of environmental pollution. It gives definitions of environmental pollution, the responsibilities with respect to environmental pollution of private enterprise, the Government, residents and local public entities, and guidelines for fulfilling these responsibilities, for instance emission regulation and pollution control.

The protection of nature is at present covered by a legal system based on the Nature Conservation Law. However due to the increasing complexity of global and other environmental issues, the enactment of a general law for the environment, integrating pollution and conservation legislation, is now under consideration.

3. River Law

Although the River Law does not control water pollution as such, it provides the foundation for investigation and regulation of water quality by the Ministry of Construction, the administrator of A class rivers. Article 1 (Objectives) requires an general administration system to maintain the normal functioning of river water, and Article 29 prohibits by government ordinance any acts that may hinder administration of the river.

4. Water Pollution Law (or Control Law)

The Water Pollution Law was enacted during the 1970 'environmental pollution' Diet session by making major amendments and combining the former Water Quality Conservation and Factory Effluent Regulation Laws. The resulting legislation covers water pollution in general and is used to enforce the Environmental Pollution Law.

Facilities discharging polluted water or liquid wastes containing more than a given level of pollutants are designated by government ordinance and required to give advanced notice to the Prefectural Governor if planning construction of certain types of facilities or changes to the existing set-up. A factory or workplace with a designated facility is called a designated workplace, and water discharged from such a facility into public waters is called effluent. Effluents may include water discharged from other facilities.

It is the responsibility of the facility to assess the quality level of effluent to see that it meets the required standard. In the event that a private industry has failed to meet the standards the prefectural governor may order alterations to planned facilities or modifications to existing ones. If discharged water does not comply with the effluent standards the governor may impose an immediate penalty. Under the immediate penalty system total emission may be regulated in addition to effluent concentration.

With the partial amendment in April 1989 (enacted October 1989), the law could prohibit the underground infiltration of harmful substances, while new clauses provided for a system to monitor and determine the quality of groundwater and associated emergency measures. Regulatory legislation similar to that for effluent discharge into public waters was thus enforced for underground infiltration of effluents.

* Stepped-up prefectural standards (effluent standards according to Item 3, Article 3, Water Pollution Law).

If the prefecture deems that in a specific body of water the national standards are insufficient for controlling pollution due to natural or social conditions, it can issue an ordinance for a designated area, and set stricter levels for the items covered by the national standards. Known as stepped-up prefectural standards, these can be applied to specific workplaces with effluent discharge of less than 50 m^3/day.

* Total emission regulation

This formula regulates the actual quantity of pollutants contained in effluents rather than the concentration of effluents.

Traditional concentration-based standards can be met merely by diluting discharged effluent, and thus do not deal with increase in quantity due to an increase in total effluents from new facilities. To conserve water quality in a given area it is necessary to reduce the total amount of pollutants released from all prefectures related to that area.

Total emission regulation, introduced in 1978 via a partial amendment of the Water Pollution Law, designates pollution types, bodies of water and related areas. Total COD emission has been regulated twice in the past, in 1984 and in 1989 in Tokyo Bay, Ise Bay and the Seto Inland sea. However water quality has not yet improved sufficiently in these areas, and red tide and green tide are still seen on occasions. Total emissions are still being regulated, with the deadline set at 1994.

The introduction of total emission regulation is provided for in the Lake and Marsh Law as well as the Water Pollution Law. 1991 and 1992 amendments to the Enforcement of Lake and Marsh Act called for regulation of nitrogen and phosphorous in

addition to COD in designated lakes and marshes. (See the section dealing with the Lake and Marsh Law.)

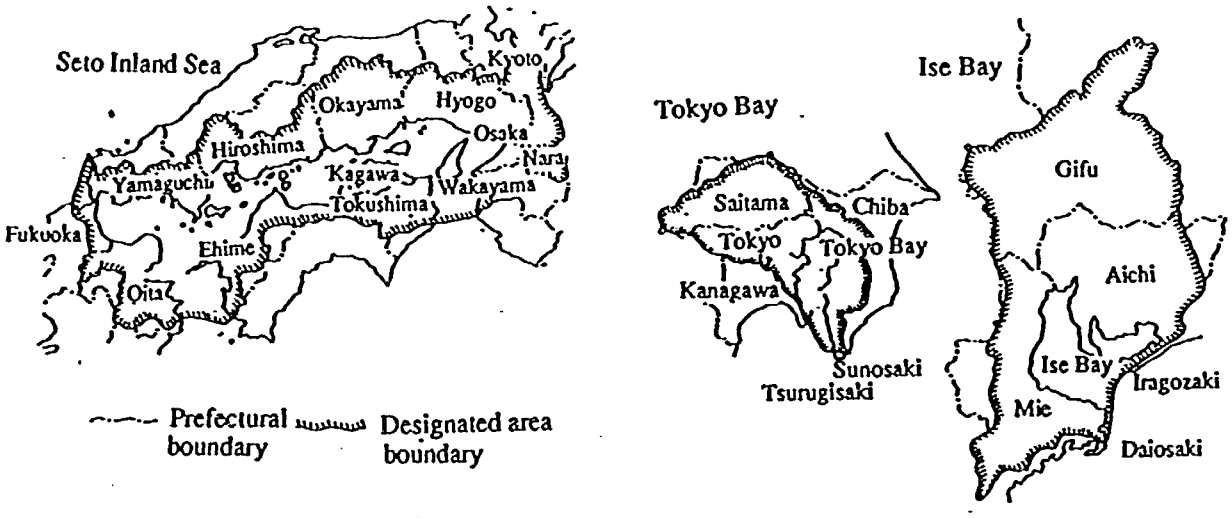


Fig. 6.1 Areas designated for COD total emission regulation

Total emission regulation, which targets sulphur oxides (SOx) and nitrogen oxides (NOx), was adopted by the Air Pollution Law earlier than the Water Pollution Law.

* Total emission regulation standards

Standards for COD total emission regulation are given by the following equation:

$$L = C \times Q \times 10^{-3}$$

where
L = allowable effluent load (kg/day)
Q = quantity of specified effluents (m^3/day)
C = COD value set by prefectural governor for each industry (mg/l)

'Specified effluents' refers to effluents other than rainwater and indirect cooling water, resulting mainly from industrial processes.

Standards for total emission regulation are applied to specific workplaces discharging on average in more than 50 m^3 of effluents per day. The workplace is obliged to assess the quantity and composition of effluents.

5. Special measures for the conservation of the Seto Inland Sea environment (Seto-uchi Conservation Law)

This law, previously a limited-period law enacted in 1973 called the Provisional Measures for Conservation of the Seto Inland Sea Environment, was made permanent in 1978 via a series of amendments including the introduction of total emission regulation to reflect the wishes of local fishermen and residents who opposed the pollution of the sea and disruption to the natural environment.

The law provides for total emission regulation according to the Water Pollution Law, and was used in designating COD total emission regulation areas on the coast of the Seto Inland Sea.

The Director-General of the Environment Agency can, if he deems it necessary to prevent eutrophication damage, direct the governor of a prefecture to formulate guidelines for reducing the discharge of phosphorus and other substances designated by government ordinance (designated substances) into public waters. At present only phosphorous and phosphorous compounds have been designated. The designated prefectures are upgrading sewer systems and human waste processing plants and working to replace phosphorous-based detergents with non-phosphoric varieties.

6. Special measures for conservation of water quality in lakes and marshes (Lake and Marsh Law)

The national government enacted this law in 1984 in view of the importance of water quality lakes and marshes. In Lake Biwa, the largest lake in Japan, pollution and eutrophication has become a serious problem, as exemplified by the annual red tides. Shiga prefecture has enacted its own eutrophication ordinance.

Under the law, the State first forms an overall policy on water quality in lakes and marshes, then the Cabinet designates lakes and marshes requiring emergency measures and other related areas at the request of prefectural governors (called designated lakes and marshes and designated areas). The prefectural governors then draw up water quality conservation plans for the designated lakes, marshes and other areas (called lake/marsh water quality conservation plans) every five years in accordance with the overall policy.

Special regulatory measures for designated areas include regulation of pollution load in newly built or expanded factories and workplaces, effluent regulation for designated specific facilities (for example small hospitals and septic tanks), and regulation of structure and usage of designated facilities and semi-designated facilities (for example fish nurseries and smaller livestock sheds). For lakes and marshes where these measures alone are inadequate, the law further requires pollutant total emission regulation under a lake/marsh total emission reduction plan.

At the end of fiscal 1992 there were nine designated lake and marsh areas: Kasumigaura, Imbanuma,Tegamuma, Lake Biwa, Lake Kojima, Lake Suwa, Lake Kamafusa Dam, Nakanoumi and Lake Shinji. Pollution load regulation was extended from COD to include nitrogen and phosphorous for the first five of these (and phosphorous for Lake Kamafusa Dam) in an October 1991 amendment, and to Lake Kamafusa Dam and Lake Suwa in an October 1992 amendment of the Ordinance for Enforcing the Lake and Marsh Law. The State then formed a Phase 2 Lake/Marsh Water Quality Conservation Plan incorporating general measures for nitrogen and phosphorous that included water quality targets for these two chemicals and advanced sewage treatment.

7. Sewerage law

The Sewerage Law, a project law designed to improve sewer systems, is similar to an environmental conservation law requiring general plans for sewerage work in individual river basins to attain environmental standards. The purpose of sewerage is initially defined as 'maintaining the cleanliness of land' when the legislation was enacted in 1890. The words 'improvement of cities' and 'maintaining water quality' were added in 1958 and 1970 respectively.

Sewerage is a general term comprising not only sewers but all sewage removal and treatment facilities, including treatment plants and pumping stations.

Farming village drainage effluent treatment facilities (village sewers) and joint septic tanks are also treated as sewage treatment facilities, but distinguished from sewers as defined under the Sewerage Law.

8. Waterworks Law

This law is designed to ensure plentiful supplies of cheap, clean water, thereby contributing to public health and a better living environment. It sets quality standards for water supplied by waterworks and requires water utilities to continuously check water quality.

Water purification plants must make periodic quality measurements of source water where water is taken from surface flows.

9. Mine Safety Law

This law is designed to prevent harm to mine workers, prevent mine pollution and promote sound development of mineral resources. Holders of mining rights are required to prevent damage associated with the disposal of gas, dust, ore refuse, sludge, mine water, drainage and smoke or mine pollution.

With respect to mines the other pollution regulations (including the Water Pollution Law) defer to the Mine Safety Law, since a system of licensing under the law had been in effect long before the current pollution control legislation came into being. Thus for instance it was decided that there was no need to implement the system under the Water Pollution Law of notifying prefectural governors.

The Mine Safety Law uses exactly the same standards for effluents as the Water Pollution Law.

10. Prevention of Marine pollution and maritime disasters (Marine Pollution Law)

This law is designed to prevent marine pollution and maritime disasters by restricting oil and waste discharges and providing for specific actions which may be taken.

11. Waste disposal and public cleanliness (Waste Disposal Law)

This general law was enacted in 1970 via a thorough overhaul of the 1954 Public Cleanliness Law, which was insufficient in the face of the expansion in quantity and number of new types of waste. 'Waste' as defined by this law refers to refuse, bulky refuse, cinders, sludge, excreta and similar unusable products in either solid or liquid form, excluding radioactive substances.

Waste is classified as either general or industrial. The latter is further broken down into general industrial and harmful industrial waste.

Treatment and disposal techniques are defined separately for each waste type.

12. Water quality legislation currently in force

Table 2 Water quality legislation

Type	Name	Abbreviated name	Purpose	Remarks
General	Basic Law On Environmental Pollution Control (Environment Agency)	Basic law or basic pollution law	To define the duties of the State, local public bodies and industry with respect to pollution control and set out definitions related to pollution control, thereby enabling the implementation of environmental strategies	
Enforce-ment	Water Pollution Law (Environment Agency)	Water pollution law	To prevent pollution of public waters through regulation of discharge from factories and workplaces into public waterways and to protect victims by defining the responsibility of industry for compensation	Comprehensive coverage of water pollution control
	Pollution Control Councils In Designated Factories Law	Control council law	To establish pollution control organizations at designated factories by nominating pollution control supervisors	Upgrade pollution control at factories
	Financial Burden Of Private Industry In Public Pollution Control Facilities	Burden of cost law	To define the scope of public pollution control facilities, the cost borne by private industry, and other matters related to the financial burden of private industry with respect to public pollution control facilities.	Costs borne by private industry
	Environmental Pollution Control Service Corporation Law	Service corporation law	To help maintain and improve living standards and promote the sound development of industry by working to reduce pollution in areas where industrial activity has reduced air and water quality significantly	Accelerates pollution control
Related laws	River Law (Ministry Of Construction)	River law	To ensure public safety and health through comprehensive river management to enable their proper utilization and normal functioning	
	Special Conservation Measures For Seto Inland Sea	Seto-uchi conservation law	To conserve the Seto Inland Sea environment by setting out definitions related to environment conservation planning and implementing specific measures to regulate construction and prevent eutrophication	Related to water pollution law
	Conservation Of Water Quality In Lakes And Marshes (Environment Agency)	Lake and marsh law	To help provide a healthy and rich cultural life for people by setting out a basic policy on conservation of water quality in lakes and marshes, and by implementing specific measures designed to maintain environmental standards	Related to water pollution law
	Special Measures For The Development Of Lake Biwa	Lake Biwa development law	To promote healthy development in the Kinki region by enhancing water utilization and the well-being of local residents of Lake Biwa, at the same time conserving the environment and preventing water pollution	
	Sewerage Law (Ministry Of Construction)	Sewerage Law	To develop sewer routes through independent planning for each river basin, set standards for sewer system,management and related areas, and help conserve bodies of water	Development of water pollution control facilities
	Waste Disposal And Public Cleanliness Law	Waste disposal law	To conserve the natural environment and promote public health by ensuring waste is disposed of cleanly and properly	Related to water quality through waste disposal facilities such as septic tanks
	Agricultural Land Soil Pollution Law	Soil law	To prevent adverse effects on crop growth through prevention and elimination of farmland soil pollution from specific agents, protect people and conserve the environment	Related to water pollution in terms of soil pollution by irrigation water
	Agricultural Chemical Regulation Law (Ministry Of Agriculture, Forestry And Fisheries)	Agricultural chemicals regulation law	To ensure that agricultural chemicals are of appropriate quality, and to ensure their safe and proper use by establishing systems for registration, sale and utilization, thus contributing to environmental conservation	Related to water quality through designation of polluting chemicals
	Mine Safety Law (Ministry Of International Trade And Industry)	Mine safety law	Obliges holders of mining rights to prevent dangers associated with disposal of gas, dust, ore refuse, slag, mine water, drainage and smoke or mine pollution (Paragraph 2, Article 4)	Related to water pollution law via regulation of mine water discharge and drainage
	Public Finance For Pollution Control Projects	Public finance law	Provides for government defrayments and other special government financial measures for costs of local public entities in pollution control projects	Upgrades pollution control by the Pollution Control Service Corporation Law
	Natural Parks Law	Natural parks law	Protection of designated areas (Article 17)	Regulation of drainage into lakes, marshes and moor lands
	National Land Use Planning Law	National land use planning law	Regulation of land use (Article 10)	
	Kinki Region Improvement Law	Kinki law	Kinki Region Improvement Plan (Conservation and development of land, water and other resources under the basic improvement plan) (Article 8)	Similar to Tokyo Metropolis and Chubu Region Improvement Laws
	Regulations On Factories In Urban Districts Of Kinki Region	Kinki factories law	Standards for granting permits to factories and similar industries (Article 7) Designation of restricted areas for factories and similar industries (Article 3)	Similar restrictions exist for Tokyo metropolitan region
	Development Of Conservation Areas In Kinki Region		Designation of designated suburban conservation areas (Article 5) Town planning for designated suburban conservation areas (Article 6) Reporting of acts in designated suburban conservation areas (Article 9)	
	Development Of Designated Suburban Areas And Urban Development Areas In Kinki Region		Suburban area construction plan (Matters related to sewerage and sewerage treatment facilities, which must take pollution control into account) (Article 4)	
	Development Of Special Industry Improvement Areas	Industry improvement promotion law	Details of improvement plan (Waterworks and sewerage) (Article 4)	Related law on government finance exists
	Town Planning Law	Town planning law	Development permit standards (Article 33) Town planning standards (Article 13) Designation of areas and districts (Article 8)	
	Building Standard Law	Building law	Regulation of construction in use areas (Article 48)	
	Plants For Processing Slaughtered Animals	Slaughtered animals law	Cases where permits not granted (where drinking water may be polluted) (Paragraph 2, Article 4)	
	Emergency Sewerage Measures	Emergency sewerage measures	To improve urban environments through urgent development of sewerage systems, thus helping to conserve water quality	Five year plan for sewerage improvement
	Emergency Measures For Waste Disposal Facilities	Waste emergency measures law	To improve living environments and promote public health through urgent development of waste disposal facilities	
	Waterworks Law (Ministry Of Health And Welfare)	Waterworks law	To ensure a plentiful supply of cheap, clean water through construction and maintenance of water pipes and systematic development of waterworks, thus contributing to public health and conservation of the environment	Related since water is drawn from public water sources
	Water Resources Development Law	Water resources law	To promote growth of the national economy and improve living standards by developing and rationalizing the use of water resources in river systems	
	Special Taxation Measures Law	Special taxation law	Depreciation of designated equipment (equipment which prevents pollution and other damage) (Article 43) Use of reserve funds to prevent mineral pollution in metals and other industries (Article 56-3)	
	Factory Location Law	Factory location law	Survey on factory location (also on pollution control) (Article 2) Reporting (Table of maximum discharge levels of Ministry-designated water pollutants; construction of pollution-control facilities and other measures) (Article 6)	
	Poisonous And Deleterious Substances Control Law	Poisonous and deleterious substances law	To exercise control of poisonous and deleterious substances as required for public health reasons	Related to water quality standards included in environmental and effluent standards

I. PRINCIPAL WATER QUALITY STANDARDS

1. Environmental Water Pollution Standards
(1971 Environment Agency Bulletin No. 59; last amendment in Bulletin No. 16, 1993)

Environmental standards on environmental conservation

(1) Rivers

(a) Rivers (excluding lakes and marshes)

	Applies to:	Standard values				
Type		Hydrogen ion concentration (pH)	Biochemical oxygen demand (BOD) (mg/l)	Suspended solids (SS) (mg/l)	Dissolved oxygen (DO) (mg/l)	Number of coliform groups (MPN/100 ml)
AA	Class 1 waterworks, natural environment conservation and all sections below	6.5 - 8.5	Under 1	Under25	Under 7.5	Under 50
A	Class 2 waterworks, Class 1 fisheries, bathing and all sections below	6.5 - 8.5	Under2	Under25	Under7.5	Under 1000
B	Class 3 waterworks, Class 2 fisheries and all sections listed below	6.5 - 8.5	Under 3	Under 25	Under 5	Under 5000
C	Class 3 fisheries, Class 1 industrial water and all sections listed below	6.5 - 8.5	Under5	Under 50	Under 5	--
D	Class 2 industrial water, agricultural water and section E below	6.0 - 8.5	Under 8	Under 100	Under 2	--
E	Class 3 industrial water and environmental conservation	6.0 - 8.5	Under 10	no refuse or other suspended solids	Under 2	--

Notes:
1. Standard values are daily averages (applicable also to lakes and marshes).
2. Where water is used for agricultural purposes, hydrogen ion concentration should be within the range 6.0 - 7.5 and volume of dissolved oxygen more than 5 mg/l (applicable also to lakes and marshes).
3. omitted
4. 'Natural environment conservation' is for sight-seeing and similar recreational purposes.
5. Class 1 waterworks handle water purification by simple methods such as filtering; class 2 purify standard water by sedimentation and filtering; class 3 handle advanced water purification including pretreatment techniques.
6. Class 1 fisheries: for yamame (trout), iwana (charr) and other oligosaprobic water species and Class 2 and 3 species. Class 2 fisheries: salmon species, ayu (sweetfish) and other oligosaprobic water species, and Class 3 species. Class 3 fisheries: koi (carp), funa (crucian) and other ß-mezzosaprobic water species.
7. Class 1 industrial water: ordinary water purification via methods such as sedimentation. Class 2 industrial water: advanced water purification e.g. by chemical injection. Class 3 industrial water: special water purification.
8. Environment conservation: limits to prevent discomfort in ordinary daily lives of the public (including walking along beach shores)

(b) Lakes and marshes -- natural lakes and marshes and artificial lakes with pondage of over 10 million m^3

A

Type	Applies to:	Standard values				
		Hydrogen ion concentration (pH)	Biochemical oxygen demand (BOD) (mg/l)	Suspended solids (SS) (mg/l)	Dissolved oxygen (DO) (mg/l)	Number of coliform groups (MPN/100 ml)
AA	Class 1 waterworks, class 1 fisheries, natural environment conservation and all sections below	6.5 - 8.5	Under 1	Under 1	Above 7.5	50
A	Class 2 and 3 waterworks, class 2 fisheries, bathing and all sections listed below	6.5 - 8.5	Under 3	Under 5	Above 7.5	1000
B	Class 3 fisheries, class 1 industrial water and section C below	6.5 - 8.5	Under 5	Under 15	Above 5	--
C	Class 2 industrial water and environmental conservation	6.0 - 8.5	Under 8	no refuse or suspended solids	Above 2	--

Notes:

1. At present standard values for suspended solids do not apply for Class 1, 2 or 3 fisheries.
2. Natural environment conservation is for purposes such as sight-seeing, and similar recreational purposes
3. Class 1 waterworks: simple water purification by filtering; class 2 and 3 waterworks: standard water purification by sedimentation and filtering or advanced purification including pretreatment.
4. Class 1 fisheries: himemasu (kokanee) and other oligosaprobic water species as well as Class 2 and 3 species. Class 2 fisheries: salmon species, ayu and other oligosaprobic species and Class 3 species. Class 3 fisheries: koi (carp), funa (crucian) and other eutrophicated lake species.
5. Class 1 industrial water: ordinary water purification by sedimentation; class 2: advanced water purification by chemical injection and special purification
6. Environmental conservation: limits to prevent discomfort in ordinary daily lives of the public (including walking along beach shores)

B

Type	Applicable in:	Standard values	
		Nitrogen (mg/l)	Phosphorous (mg/l)
I	Natural environment conservation and all sections below	Under 0.1	Under 0.005
II	Class 1, 2 and 3 waterworks (excluding special cases), Class 1 fisheries, bathing and all sections below	Under 0.2	Under 0.01
III	Class 3 (special) waterworks and all sections below	Under 0.4	Under 0.03
IV	Class 2 fisheries and section V below	Under 0.6	Under 0.05
V	Class 3 fisheries, industrial and agricultural water, environmental conservation	Under 1	Under 0.1

Notes:

1. Standard values are annual averages.
2. omitted
3. Standard values for phosphorous not applicable to agricultural water.
4. Natural environment conservation is for purposes such as natural sightseeing.
5. Class 1 waterworks: simple water purification by filtering. Class 2 waterworks: standard water purification by sedimentation and filtering. Class 3 waterworks: advanced water purification including pretreatment. 'Special' refers to special methods for removing odorous substances.
6. Class 1 fisheries: includes salmon species, ayu (sweetfish) and Class 2 and 3 species. Class 2 fisheries: includes wakasagi (smelt) and Class 3 species. Class 3 fisheries: includes koi (carp) and funa (crucian).
7. Environmental conservation: limits to prevent discomfort in ordinary daily lives of the public (including walking along beach shores)

(2) Coastal areas

Type	Applies to:	Standard values				
		Hydrogen ion concentration (pH)	Biochemical oxygen demand (BOD) (mg/l)	Dissolved oxygen (DO) (mg/l)	Number of coliform groups (MPN/100 ml)	n-hexane extracting substance (oils etc)
A	Class 1 fisheries, bathing, natural environment conservation and all sections below	7.8 - 8.3	2	7.5	1000	not detected
B	Class 2 fisheries, industrial water and section C below	7.8 - 8.3	3	5	--	not detected
C	Environmental conservation	7.0 - 8.3	8	2	--	--

Notes:
1. Where raw oysters are cultured the number of coliform groups must be no more than 70 MPN/100 ml.
2. omitted
3. Natural environment conservation is for purposes such as natural sightseeing.
4. Class 1 fisheries: includes madai (red sea bream), buri (yellowtail), wakame seaweed and Class 2 species. Class 2 fisheries: includes bora (mullet) nori seaweed.
5. Environmental conservation: limits to prevent discomfort in ordinary daily lives of the public (including walking along beach shores)

Reference table

Environmental soil pollution standards (Environment Agency Bulletin No. 46, August 23 1991)

Substance	Volume	For measurement techniques refer to:
Cadmium	No more than 0.01 mg/l in test solution. For farmlands, under 1 mg per kg rice.	Test solution: JIS Specifications K0102 (hereunder referred to as 'Specifications'), 61. Farmlands: Ministry of Agriculture and Forestry Ordinance No. 47, 1971.
Cyanogen	Not detected from test solution	Specifications, 38 (excluding techniques described in 38.1.1)
Organic phosphorous	Not detected from test solution	Appendix Table 1, Environment Agency Bulletin No. 59, Dec 1971 (hereunder referred to as 'Bulletin'), or Specifications 31.1 except gas chromatography. (Methyl dimetone: Appendix Table 2 of Bulletin)
Lead	No more than 0.1 mg per litre of test solution	Specifications, 54
Hexavalent chromium	No more than 0.05 mg per litre of test solution	Specifications, 65.2
Arsenic	No more than 0.05 mg per litre of test solution For rice paddied, no more than 15 mg per kg soil	Test solution: Specifications, 61. Farmland: Ordinance 31 of Prime Minister's Office, April 1974
Mercury	No more than 0.0005 mg per litre of test solution	Appendix Table 3, Bulletin
Alkyl mercury	Not detected from test solution	Nos. 1 & 2 in Appendix Table 4, Bulletin
PCB	Not detected from test solution	Appendix Table 5, Bulletin
Copper	No more than 125 mg per kg soil in rice paddies only	Ordinance 66 of Prime Minister's Office, October 1972

Notes:
1. Test solutions used for measurement must be prepared according to methods prescribed in Appendix tables.
2. Where polluted soil is apart from groundwater with concentrations below cadmium 0.01 mg, lead 0.1 mg, hexavalent chromium 0.05 mg, arsenic 0.05 mg and mercury 0.005 mg, the concentrations per litre of test solution should be 0.03 mg, 0.3 mg, 0.15 mg, 0.15 mg and 0.0015 mg respectively.
3. omitted
4. omitted
5. omitted

Appendix Table

The test solution should be prepared by filtering a sample solution via a glass fiber filter paper with 1μm diameter holes, centrifugally separating the filtrate by about 3000 r.p.m. for 20 minutes and then extracting the required quantity quantitative assessment from the supernatant.

1. Preparation of sample
   Soil is air-dried, small and medium pieces of gravel, wood etc removed and clods and lumps gently broken up. Soil obtained after passing through non-metallic 2-mm mesh screen is mixed thoroughly.
2. Preparing sample solution
   The sample (units: gram) is mixed with a solvent (unit: ml) obtained by adding hydrochloric acid to pure water and adjusting to pH 5.8 - 6.3 at 10% weight/volume ratio to produce at least 500 ml of solution.
3. Elution
   The sample solution is then shaken continuously for six hours at 200 per minute with a width of 4-5 cm, at room temperature (about 20°C) and atmospheric pressure (about 1 atm).

2. Effluent Standards

National standards (from Ordinance 35 of Prime Minister's Office, June 21 1971. Most recent amendment: Ordinance 29, 1991)

(1) Effluent standards for harmful substances

Substance	Upper limit (mg/l)
Cadmium and compounds	0.1
Cyanogen compounds	1
Organic phosphorous compounds (parathion, methyl parathion, methyl dimetone and EPN only)	1
Lead and lead compounds	1
Hexavalent chromium compounds	0.5
Arsenic and arsenic compounds	0.5
Mercury, alkyl mercury and other mercury compounds	0.005
Alkyl mercury compounds	not detected
PCB	0.003
Trichloroethylene	0.3
Tetrachloroethylene	0.1

Notes:
1. 'Not detected' means that the testing technique specified by the Director-General of the Environment Agency is not capable of determining the level of this particular substance.
2. omitted (a statement to the effect that effluent standards for arsenic do not apply to hotels with hot springs)
3. Article 12-3 of the Water Pollution Law prohibits underground permeation of water containing harmful substances, so the allowable limit in the above table will be 'not detected' for effluents permeating underground.

(2) Effluent standards for natural environment

	Upper limit
Hydrogen ion concentration (pH)	into the sea: 5.0 - 9.0 into other public waters: 5.8 - 8.6
Biochemical oxygen demand (BOD)	160 mg/l (daily average 120 mg/l)
Chemical oxygen demand (COD)	160 mg/l (daily average 120 mg/l)
Volume of suspended solids (SS)	200 mg/l (daily average (150 mg/l)
n-hexane extracted substances: mineral oils animal and vegetable oils and fats	 5 30
Phenols content	5
Copper content	3
Zinc content	5
Soluble iron	10
Soluble manganese	10
Chromium	2
Flourine	15
Number of coliform groups	daily average 3000/cm^3
Nitrogen content	120 mg/l (daily average 60 mg/l)
Phosphorous content	16 mg/l (daily average 8 mg/l)

Notes:

1. Upper 'daily average' limits are for daily average levels of effluent pollution.
2. This table applies to effluents from factories or workplaces with a daily average effluent of over 50 cm^3.

3 & 4. omitted (statements to the effect that pH and other effluent standards to not apply to sulphur mines or hotels with hot springs)

5. COD standards apply only to effluents discharged into lakes, marshes and the sea; BOD standards apply only to effluents discharged into public waters other than these.

6 & 7. Nitrogen and phosphorous content standards apply only to effluents discharged into lakes and marshes designated by the Director-General of the Environment Agency as vulnerable to growth of lacustrine plants and plankton, and to public waters flowing into such designated bodies of water.

Reference table

Administrative target values for maximum 1,1,1-trichloroethane and carbon tetrachloride levels in discharged effluents

Notification from Director of Water Quality Bureau, Environment Agency: Kan-Sui-Kan No. 127, August 22 1984 and No. 103, April 20 1989

	into public waters	permeating underground
1,1,1-trichloroethane	3 mg/l	3 mg/l
Carbon tetrachloride	0.03 mg/l	prohibited

3. Water Quality Standards for removal of sewage from designated workplaces -- reception standards (from Government Ordinance for Enforcing Sewerage Law No. 147, April 22 1959; most recent amendment No. 209, 1991)

	Substance	Standard	Remarks
1	Cadmium and cadmium compounds	0.1	Maximum values in mg/l units
2	Cyanogen compounds	1	
3	Organic phosphorous compounds	1	
4	Lead and lead compounds	1	
5	Hexavalent chromium compounds	0.5	
6	Arsenic and arsenic compounds	0.5	
7	Mercury, alkyl mercury and other mercury compounds	0.005	
8	Alkyl mercury compounds	not detected	
9	PCB	0.003	
10	Trichloroethylene	0.3	
11	Tetrachloroethylene	0.1	
12	Phenols	5	
13	Copper and copper compounds	3	
14	Zinc and zinc compounds	5	
15	Iron and iron compounds (soluble)	10	
16	Manganese and manganese compounds (soluble)	10	
17	Chromium and chromium compounds	2	
18	Flourine compounds	15	
19	Hydrogen ion concentration (pH)	5<pH<9	standards set by prefectural ordinance may not fall below these values
20	Biochemical oxygen demand (BOD)	< 600 mg/l	
21	Suspended solids (SS)	< 600 mg/l	
22	n-hexane extracted substance a. mineral oils content b. animal and vegetable fats and oils content	 < 5 mg/l < 30 mg/l	
24	Nitrogen content (T-N)	< 240 mg/l	
25	Phosphorous content (T-P)	< 32 mg/l	

Notes:

1. Nitrogen and phosphorous standards apply only where effluent standards in force on sewer. Should stepped-up prefectural standards also apply the above standards should be twice these.
2. Standards stricter than the above (although with limitations and only for extenuating reasons) may be applied to manufacturing sewage and the gas industry with respect to substances 19, 20, 21, 24 and 25 above.
3. Standarts must not be more severe in the event that effluent standards more relaxed than the above apply to sewage discharged directly into public waters.

4. Water quality standards for sewer effluents -- treatment plant effluents (Government Ordinance for Enforcing Sewerage Law No. 147, April 22 1959; most recent amendment No. 209, 1991)

Sewerage treatment method	Hydrogen ion concentration (pH)	Maximum biochemical oxygen demand (BOD) (mg/l)	Maximum volume of suspended solids (mg/l)	Maximum number of coliform groups per cm^3
Activated sludge, standard trickling filter or similar	5.8 - 8.6	20	70	3000
Fast trickling, modified aeration or similar	5.8 - 8.6	60	120	3000
Sedimentation	5.8 - 8.6	120	150	3000
Other	5.8 - 8.6	150	200	3000

• Modified aeration is a variant on the active sludge method, intended primarily to treat large quantities of sewage at low cost. The matrix is converted into sludge so it can be separated and removed, and air consumption minimized by keeping activated sludge in a logarithmic growth phrase.

Appendix

Table 1 Additional environment quality standard and the value

	Type	Value
1	Trichlorocthylene	less than 0.03 mg/l
2	Tetrachloroethlene	less than 0.01 mg/l
3	Carbon tetrachloride	less than 0.002 mg/l
4	Dichloromethane	less than 0.02 mg/l
5	1,2 dichloroethane	less than 0.004 mg/l
6	1,1,1-trichoethane	less than 1 mg/l
7	1,1,2-trichlorethane	less than 0.006 mg/l
8	1,1-dichloroethylene	less than 0.02 mg/l
9	Cis-1,2 dichloroethylene	less than 0.04 mg/l
10	1,3-dichloropropane	less than 0.002 mg/l
11	Thiram	less than 0.006 mg/l
12	Simazine (CAT)	less than 0.003 mg/l
13	Thiobencarb	less than 0.02 mg/l
14	Benzene	less than 0.01 mg/l
15	Selenium	less than 0.01 mg/l

Table 2 Amendment of item

	Item	Value after amendment	Current value
1	Cadmium	less than 0.01 mg/l	less than 0.01 mg/l
2	Total cyahongen*	Not detectable	Not detectable
3	Organic Phosphoruos	Delete from environment quality standard**	Not detectable
4	Lead	less than 0.01 mg/l	less than 0.01 mg/l
5	Chromium	less than 0.05 mg/l	less than 0.05 mg/l
6	Arsenic	less than 0.01 mg/l	less than 0.05 mg/l
7	Total mercury	less than 0.0005 mg/l	Not detectable
8	Alkylmercury	Not detectable	Not detectable
9	PCB	Not detectable	Not detectable

Note: * Cyahogen at present

** EPN included organic phosphorous has desirable to monitor

*** " not detectable" indicates the value is less than the quantitative evaluation in the other test

Table 3 Desirable monitoring item and standard value

	Item	Standard value
1	Chloroform	less than 0.06 mg/l
2	Trans-1,2 dichloroethylene	less than 0.04 mg/l
3	1,2-dichloroethylene	less than 0.06 mg/l
4	P-dichlorobenzene	less than 0.3 mg/l
5	Isoxathion	less than 0.008 mg/l
6	Diazinon	less than 0.005 mg/l
7	Fenitrothion	less than 0.003 mg/l
8	Isoprothiolene	less than 0.04 mg/l
9	Oxinic copper	less than 0.04 mg/l
10	Chlorothanlonil	less than 0.04 mg/l
11	Propyzamide	less than 0.008 mg/l
12	EPN	less than 0.006 mg/l
13	Dichloevos(DDVP)	less than 0.01 mg/l
14	Fenobucarb (BPMC)	less than 0.02 mg/l
15	Iprobentos (IBP)	less than 0.008 mg/l
16	Chlornitrofen (CNP)	less than 0.005 mg/l
17	Toluene	less than 0.6 mg/l
18	Xylene	less than 0.4 mg/l
19	Diethylexylphthalate	less than 0.6 mg/l
20	Boron	less than 0.2 mg/l
21	Flourine	less than 0.8 mg/l
22	Nickel	less than 0.01 mg/l
23	Molybdenum	less than 0.07 mg/l
24	Antimony	less than 0.002 mg/l
25	Nitrate and nitrite nitrogen	less than 10 mg/l

(E) STUDY TOUR

I. Study Tour

1. Study Tour

Outline

The program of "The Second Conference on Public Works Research and Development in Asia" included a one-week tour from November 20 (Sat) through November 26 (Fri) to inspect and study the development of major infrastructure in Shikoku-Chyugoku, Kyushu and Kanto Area.

The itinerary is as follows:

20 (Sat) : Move [Tsukuba→Tokyo→Takamatsu→Okayama]
Inspection on Seto-Ohashi

21 (Sun) : Move [Okayama→Fukuoka]
Inspection in Fukuoka City
Umino-Nakamichi Seaside Park
Fukuoka Tower
Fukuoka Dome

22 (Mon) : Inspection on PC Factory of Oriental Construction Ltd.
The Second Symposium on Public Infrastructure and Civil Engineering in Asia

23 (Tue) : Move [Fukuoka→Saga→Nagasaki]
Inspection in North Kyushu
Yoshinogari Historical Park
Rokkaku River
Nagasaki City

24 (Wed) : Move [Nagasaki→Tokyo→Tsukuba]
Inspection on Mt.Unzen

26 (Fri) : Move [Tsukuba → Tokyo]
Courtesy call on Minister of Construction
Inspection on Trans-Tokyo Bay Highway

Acknowledgement

The tour was made possible through the dedicated efforts and kind cooperation of Honshu-Shikoku Bridge Authority, Kyushu Regional Construction Bureau of MOC, Umino-Nakamichi Seaside Park Work Office, Saga Highway Work Office, Takeo Construction Work Office, Nagasaki Construction Work Office, Unzen Work Office, Japan Highway Public Corporation, Trans-Tokyo Bay Highway Corporation. We'd like to express our sincere thanks to them all.

November 20 (Sat) Seto-Ohashi

Leaving Tsukuba Dai-ichi Hotel by bus at 8:30 and by taking JR trains and Monorail. The party arrived at Haneda Airport in time for lunch and for the 13:00 Flight JAS #393 for Takamatsu Airport.

Leaving by bus from Takamatsu Airport to Sakaide Interchange, where the party was met by Mr. Harasaki, Director of Sakaide Management Office of Honshu-Shikoku Bridge Authority, who led us to Seto-Ohashi (Sakaide-Kojima Route), which started public on April 1, 1988. Mr. Harasaki explained, among others, the background of bridge construction, economy effect of bridge, future plan of Honshu-Shikoku bridges. On the way to Okayama, at Yoshima Parking Area, the party got on the ship of "Kanrin-maru".

After the inspection of the bridges, the bus took us to Okayama Terminal Hotel around 18:00.

November 21 (Sun) Inspection in Fukuoka City

At 9:30 the party left by Shinkansen Hikari #153 to Hakata St. from Okayama St. Upon arrival at Hakata St. around 12:00 was met by Mr. Naoe, Deputy Director of Planning Department and Mr. Ozawa, Head of Planning Div., and other members from Kyushu Regional Construction Bureau, MOC. And having lunch, then the party inspected on Umino-Nakamichi Sea Side Park. Outline of park improvement work, effect of improvement were explained. Then the party inspected on Fukuoka Tower and Fukuoka Dome.

The bus took us to the Hyatt Regency Fukuoka around 18:00.

November 22 (Mon) The Second Symposium on Public Infrastructure and Civil Engineering in Asia

After leaving the Hotel at 8:00 the first stop was at Fukuoka Factory of Oriental Construction Ltd. The party inspected on manufacturing process and quality control of prestressed concrete production.

Move to the Soralia Nishitetsu Hotel for the preparations of the Symposium and Lunch, starting at 14:00. "The Second Symposium on Public Infrastructure and Civil Engineering in Asia" was held under the Joint auspices of Public Works Research Institute and Kyushu Regional Construction Bureau of MOC supported by Fukuoka Prefecture Government, Fukuoka City Government and Western Branch of Japan Society of Civil Engineers. The Symposium attracted a large audience including the press of about 200 people from governmental and private organizations as well as

universities.

The Symposium consists of two sessions. One is Keynote Lecture "Regional Development and Civil Engineering Technology in Kyushu" by Prof. Takeshi Chishaki, Professor of Civil Engineering, Kyushu University. The other, Panel Discussion, is made with theme "Striving for a Better Environment - Regional Development Projects, Disaster Prevention, Environmental issue — " of coordinate by Mr.Sumiyoshi, Director-General of PWRI and 8 Panelists from 7 foreign participants and Mr. Aramaki, Director-General, Kyushu Regional Construction Bureau of MOC. Understanding of situation of each country was deepened through presentations and discussions on each projects for a better environment.

The Symposium session was concluded at 17:30 ending with the reception hosted by Kyushu Regional Construction Bureau of MOC.

November 23 (Tue) Inspection in North Kyushu (Fukuoka→Saga→Nagasaki)

Leaving the Hotel at 8:00 by bus, the first visit was Yoshinogari Historical Park Site. The manager of Yoshinogari Histrical Park explained the Yayoi culture of Japan, plan and effect of park work.

After the lunch, the tour took us to the construction site of Rokkaku River improvement site. The manager of Takeo Construction Work Office explained the office activities of flood control work and countermeasure of weak ground.

At Omura interchange of Kyushu express highway, the party was met Mr. Seto, Director, and Mr. Kiyasu, Head of Survey Div., Nagasaki Construction Work Office. Then the party visited to Graver Garden be shown history and development of Nagasaki City.

The bus arrived at Nagasaki Ground Hotel at 18:30.

November 24 (Wed) Mt.Unzen

Leaving the Hotel at 8:10 by bus, the party visited to Unzen Restoration Work Office. Mr. Matsui, Director of Unzen Restoration Work Office, explained the damage of roads, bridges, and living by debris flow and pyroclastic flow of Mt. Unzen-Fugen eruption from June, 1991. In addition, the party exchanged information and opinion through the site seeing of disaster prevention system.

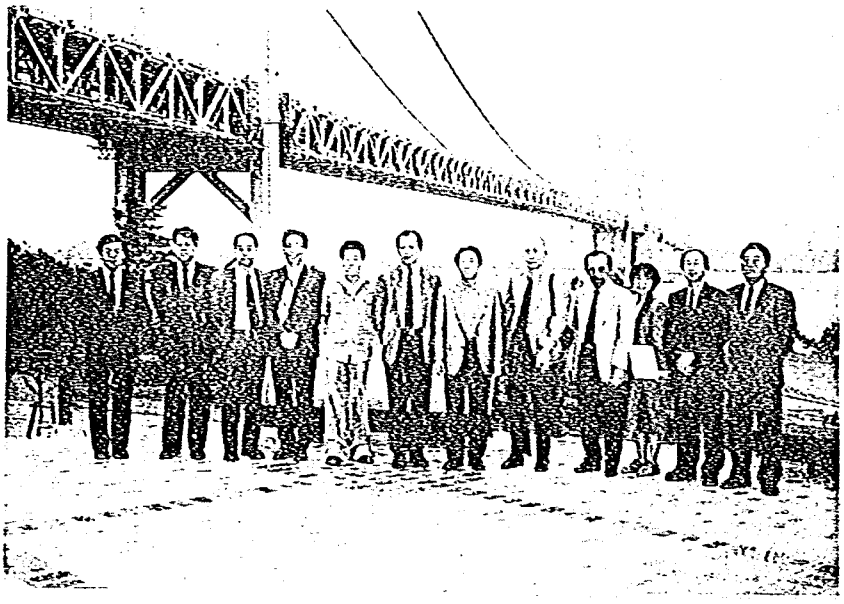
ANA Flight #666 left Nagasaki Airport at 15:20 for Haneda Airport, from where the party directly backed to Tsukuba.

November 26 (Fri) Courtesy Call on Minister of Construction / Trans-Tokyo Bay Highway

A report on the Second Conference was given to Mr. Igarashi, Minister of Construction at the occasion of Courtesy Call on Minister of Construction in the morning. The first, Mr. Sumiyoshi introduced the foreign participants and explained the summary & results of the Second Conference. Next, Mr. Igarashi gave the short speech that "The Conference on Public Works Research and Development in Asia" is growing as a good occasion for promoting of Public Works R&D and international research cooperation. Also, more expectation of technical cooperation for Asia is given to Japan Government from foreign participants. Talking was made in this mild atmosphere.

Later Mr.Takano, Deputy Director of Technology Department, and Mr. Dachiku, Assistant Head of Technology Div., Trans-Tokyo Bay Highway Corporation, was the guide to Kawasaki. During the boat ride from Kawasaki to Kawasaki, whole outline, Kawasaki Man-made Island, Kisarazu Man-made Island, and the bridge and tunnel construction work was presented by Mr.Dachiku.

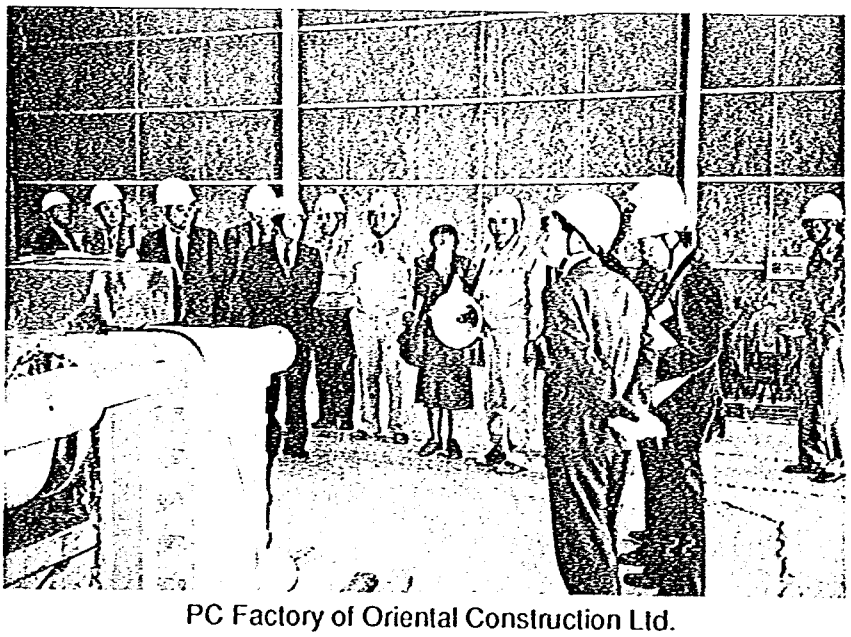
A Farewell party hosted by Mr.Sumiyoshi, Director-General of Public Works Research Institute, MOC, was held at Pastoral, Toranomon, with many attendance from Ministry of Construction, Ministry of Foreign Affairs, Science and Technology Agency, JICA, and each Asian country's Embassy at Tokyo, etc.



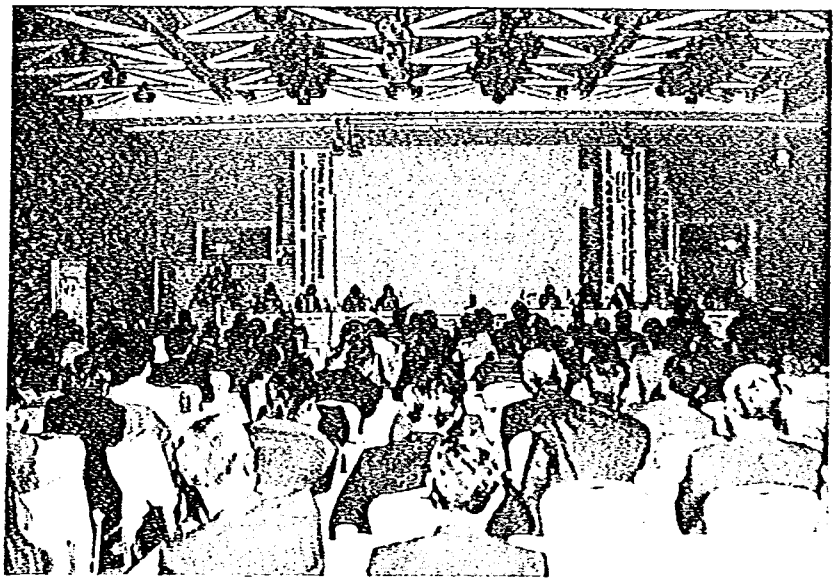
Seto-Ohashi (November 20, 1993)



Fukuoka-Dome (November 21, 1993)



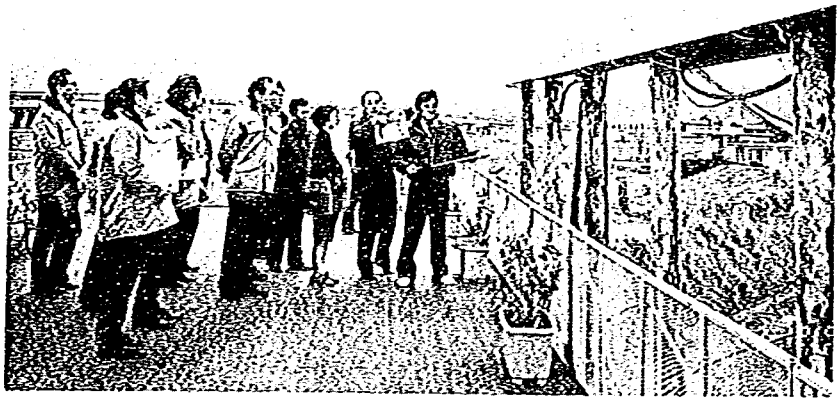
PC Factory of Oriental Construction Ltd.
(November 22, 1993)



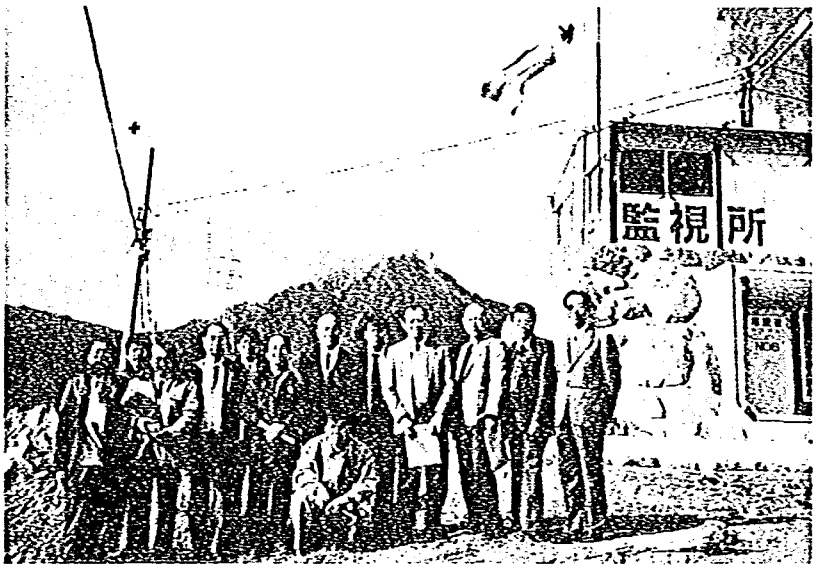
The Second Symposium on Public Infrastructure and Civil Engineering in Asia (November 22, 1993)



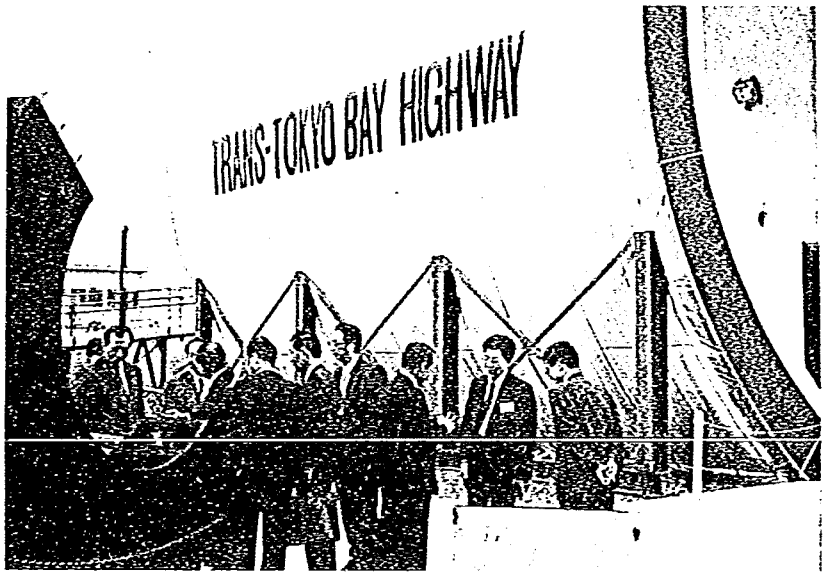
Yoshinogari Historical Park (November 23, 1993)



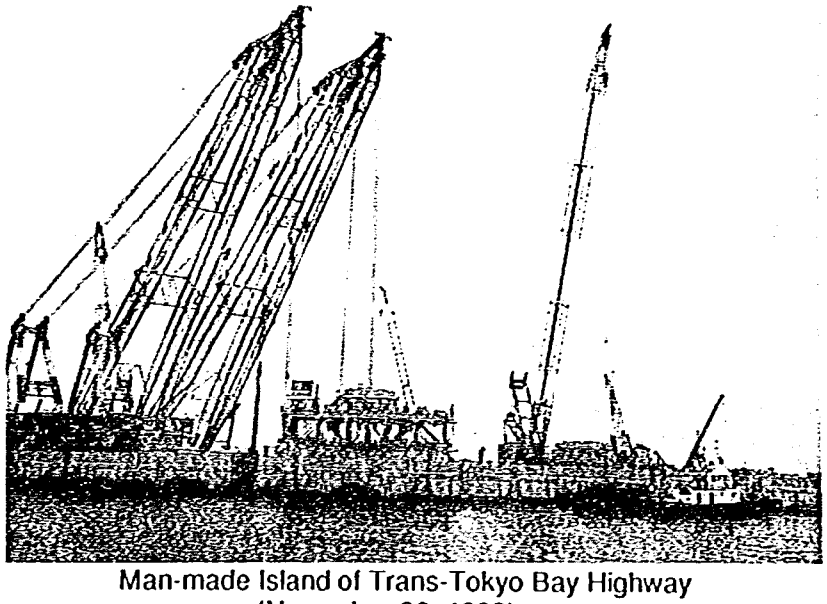
Rokkaku River Improvement Works (November 23, 1993)



Unzen Restoration Works (November 24, 1993)



Trans-Tokyo Bay Highway (November 26, 1993)



Man-made Island of Trans-Tokyo Bay Highway
(November 26, 1993)

II. The Second Symposium on Public Infrastructure and Civil Engineering in Asia

PROGRAM

14:00 Opening address

14:00～14:15 Address : Eiki Aramaki
Director-General, Kyushu Regional Construction Bureau, Ministry of Construction

: Yukihiko Sumiyoshi
Director-General, Public Works Research Institute, Ministry of Construction

14:15～15:05 **Keynote lecture** : "Regional Development and Civil Engineering Technology in Kyushu"
Takeshi Chishaki Professor, Faculty of Engineering, Kyushu University

15:05～15:15 ——— (recess) ———

15:15～17:00 **Panel Discussion**

Theme : "Striving for a Better Environment
—— Regional Development Projects, Disaster Prevention, Environmental Issue ——"

Coordinator : Yukihiko Sumiyoshi
Director-General, Public Works Research Institute Ministry of Construction

Panelist

‹ Japan ›
Eiki Aramaki, Director-General, Kyushu Regional Construction Bureau, Ministry of Construction
"Public Infrastructure in Kyushu Area"

‹ People's Republic of China ›
Wu Jishan, Director, The Institute of Mountain Hazards and Environment, Chinese Academy of Sciences
"The Comprehensive Debris Flows Control Works"

‹ Republic of Indonesia ›
Soedarmanto Darmonegoro, Secretary, Agency for Research and Development, Ministry of Public Works
"Water Pollution Control Project"

‹ Republic of Korea ›
Keung Hwan Kim, Director, Planning & Coordination Division, Korea Institute of Construction Technology
"Regional Flood Frequency Analysis for the Major Korean Rivers"

‹ Malaysia ›
Teh Siew Keat, Director of River Engineering, Department of Irrigation and Drainage, Ministry of Agriculture
"10 Year Programme on Cleaning Up of Klang River"

‹ Republic of the Philippines ›
Jose H. Espiritu, Director, Bureau of Research and Standards, Department of Public Works and Highways
"South Luzon Expressway Extention Project"

‹ Republic of Singapore ›
Khor Poh Hwa, Chief Civil Engineer, Public Works Department, Ministry of National Development
"Singapore Underground Road System"

‹ Kingdom of Thailand ›
Anusornant Mahavinichaimontri, Director of Materials and Research Division, Department of Public Works, Ministry of Interior
"Improvement Urban Air Quality"

17:00 Closing address

1. Keynote Lecture on Regional Development and Civil Engineering Technology in Kyushu

Prof. Takeshi Chishaki
Faculty of Engineering
Kyushu University

Regional Development and Civil Engineering in Kyushu



Prof. Takeshi Chishaki: Kyushu University

1. Introduction

The Kyushu area is located at the southwestern end of Japan and, from Tokyo, is in the opposite direction as Hokkaido, where the previous symposium was held. The Kyushu area, which is mainly composed of Kyushu and Ryukyu Islands, actually consists of approximately 2500 islands, or more than one third of all Japanese islands, which number a little less than 7000.

Kyushu accounts for only 12% of Japan's area, which is approximately one half that of Hokkaido. However, its population is 14 million, two and a half times that of Hokkaido. In Kyushu both inhabitable land and land with elevation under 100m total 14-15% of all such areas in Japan, showing higher percentages than its share of the total land area. Its shoreline amounts to twelve thousand kilometers, and its littoral area with depth under 20m, which may be considered as quasi territory, accounts for 20% of all such areas in Japan. The aforementioned numbers demonstrate that utilization of land in Kyushu is less difficult than in other regions.

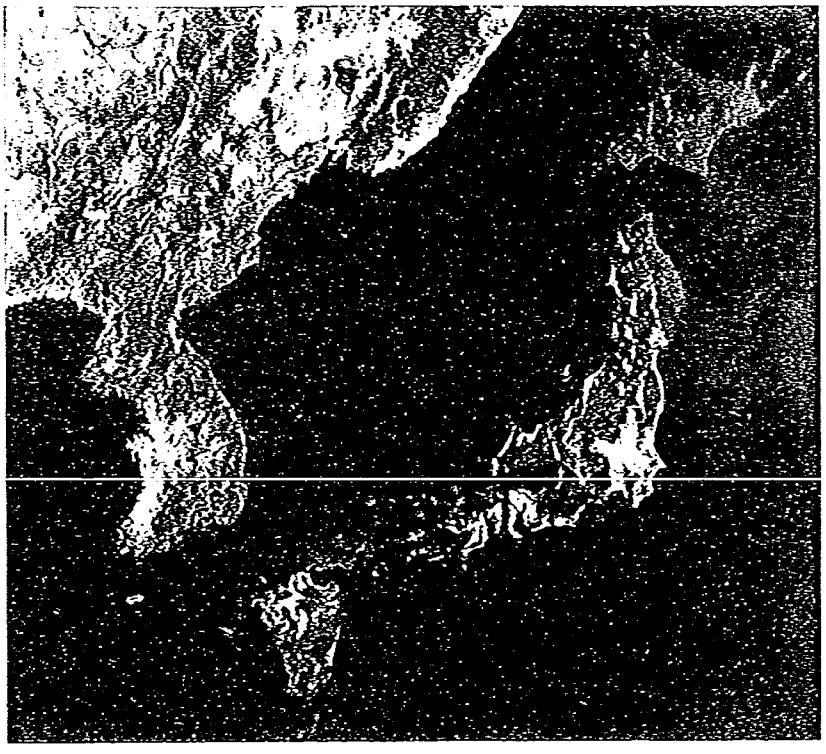


Fig.1 The Location of Kyushu

Kyushu is favored by a warm and diverse climate, varying from sub-tropical to temperate; has numerous natural features, such as active volcanoes, seas and mountains; and has played an important role in international cultural and economic exchange from ancient times since it is located near China and other Asian nations.

Favored by such conditions, people inhabited Kyushu, constructing villages and developing the region from the earliest times. It is natural that pubic works, or civil engineering, is deeply related with and has contributed much to these developments.

2. The ruins of Yoshinogari and civil engineering

Excavations of several ancient ruins are now being carried out in Kyushu, namely: at Yoshinogari in Saga Prefecture and Hiratsuka Kawazoe and Itazuke in Fukuoka. These ruins, which

date backs approximately 1700 years to the third century, attract wide public attention since they may have played important roles in the development of the old Japanese state. In particular, the ruins of Yoshinogari caught the public's attention and have attracted more than 7 million visitors since their discovery in 1989. This interest may result from the fact that these ruins may resemble the ancient village of "Yamataikoku" which appears in the "Gishiwajinden" section of the Chinese chronicle "Sangokushi". Nevertheless, the visitors can see a wide variety of ruins and remains. Circular moats, which are constructed around the village in twofold, and in some places three- or fourfold, and buildings such as watch towers and high-floor warehouses are of special interest to

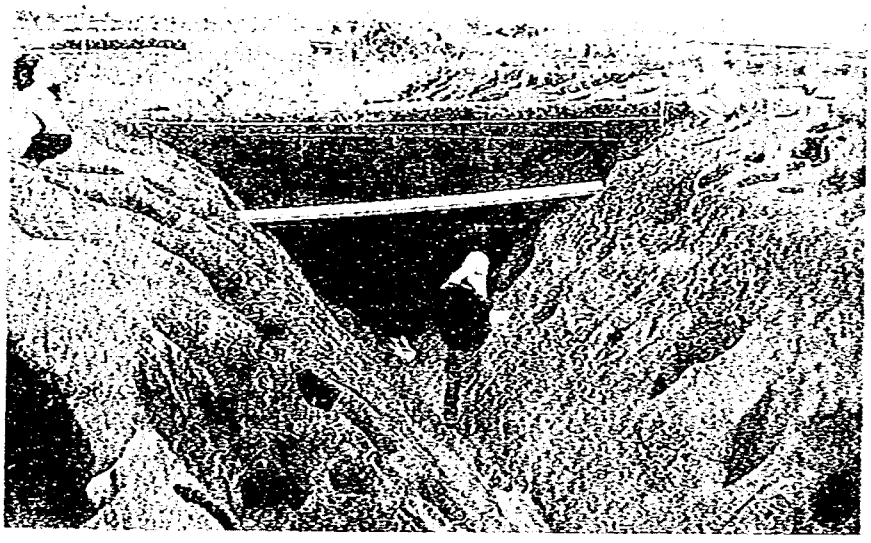


Fig.2 The Cross Section of the Outer Circular, and the Excavation

civil engineers.

The outer circular moat extends to 2.5 kilometers in length and has a triangular cross sectional shape 7 meters in width at the top and 4 meters deep. Hence, the calculated amount of earth which had to be removed is 35,000 cubic meters. The estimated population of the village at that time is 1000, of which only a limited proportion were able to do such workers. Considerable



Fig.3 The Ruins of Yoshinogari

time and labor must have been necessary to complete the moats, fences and surrounding earth moving work without developed tools such as excavators and transits.

Two ruins of watch towers were discovered within the inner moat. Each consisted of six pillars which had their ends buried in the ground. The form of the towers is portrayed by the ones reconstructed there: large buildings exceeding 10 meters in height. Horizontal members penetrated through the pillars, preventing sink age and reinforcing the structure. These "underground beams" arouse interest since the idea resembles underground beams used in designing today's viaduct.

Ancient ruins in Japan are new compared to those of Ancient Mesopotamia, Egypt or China. The levels of construction are much lower and smaller than the Great Wall of China and pyramids. However, the discoveries in the ruins of Yoshinogari have significance, proving public works were carried out and civil engineering existed even at the early times in Japan. Thus, public works and civil engineering in Kyushu developed over a long course of time beginning with the era of ancient villages or even earlier.

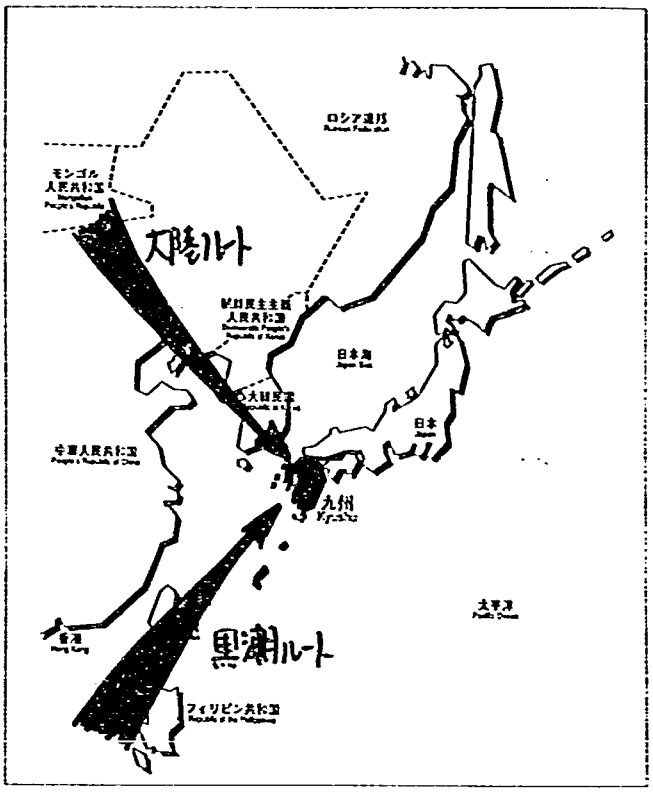


Fig.4 Two Routes of International Interchange

3. Bridge technologies supporting regional developments in Kyushu

The regional culture and economy of Kyushu has been developing since the era of ancient villages, sometimes playing principal roles and sometime side roles in Japanese history. The main difference between Kyushu and other regions of Japan is that Kyushu has developed its own regional culture, successfully incorporating knowledge accumulated through international cultural and economic exchanges with other nations, as a result of its unique location.

From the era of ancient villages, active international interchange brought elements of civilization to Kyushu through the route of Kyushu-Korea-China, mainly sending missions and tributes from Kyushu, and simultaneously inviting priests, students and engineers. Even the unfortunate wars between China and Japan and Korea and Japan may have stimulated the development of regional culture in Kyushu.

Besides such interchange with China and Korea, Kyushu has also been a key point in cultural exchange with nations to the south due to the geographical fact that Kyushu and Ryukyu Islands lie in a row or chain toward the south, and the Black Japan current runs from the South towards Kyushu.

Kyushu was located at an intersection point of two interchange routes, one with the Chinese continent and the other with nations to the south. The teachings of Confucius, Buddhism, Christianity and the study of Western sciences in the Edo era all entered Kyushu and then spread through Japan. Ceramics, which was brought into Kyushu by Korean potters, even now supports Japanese culture and industry. Sweet potatoes, which came from South into Kagoshima, and Portuguese sponge cake or "Kasutera", which was introduced into Nagasaki, still enrich the food culture in Kyushu.

(Technology of stone arch bridges spread from Kyushu to entire Japan)

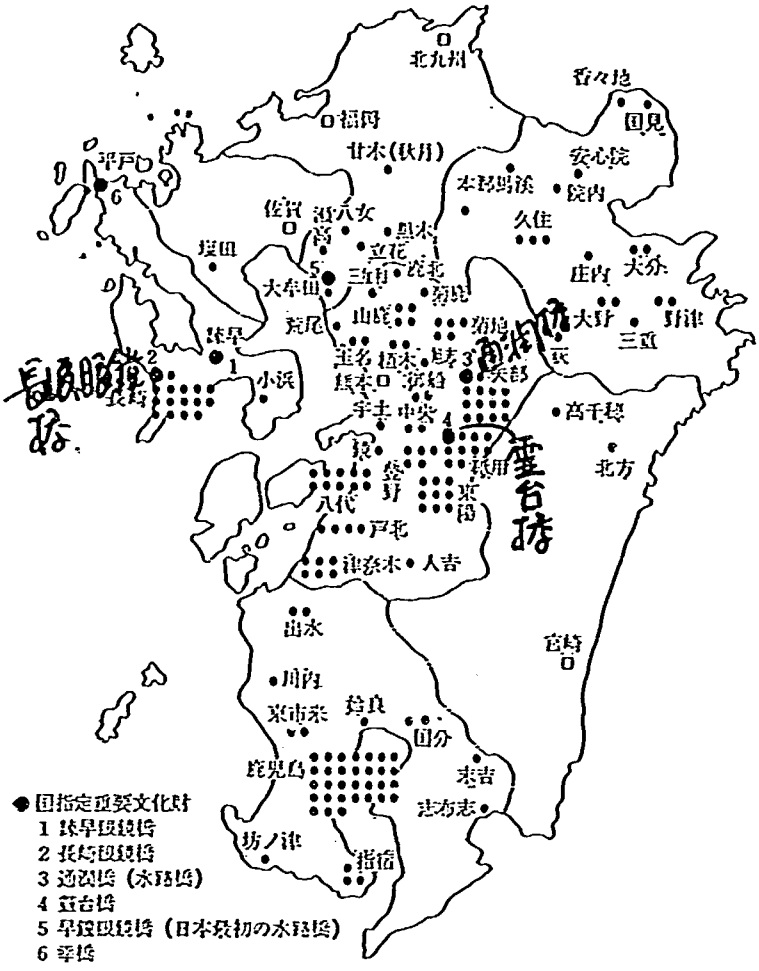


Fig.5 The Location of Stone Arch Bridges

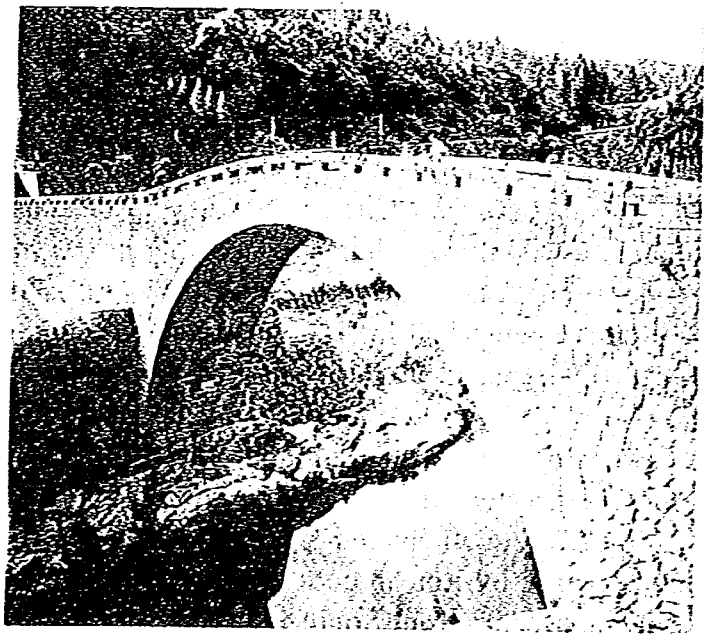


Fig.6 Reitaibashi in Kumamoto Pref

The technology of building stone arch bridges is a typical and representative example of civil engineering which was imported into and cultivated in Kyushu.

Bridges in Japan, and also in Kyushu, have in ancient times been built mainly with wood, which was abundant and easily processed and utilized for bridge construction. However, Kyushu has a nickname of "Taifu Ginza", due to the frequent typhoons and floods occurring there. Wooden bridges were carried away by floods and had to be rebuilt again and again, causing much sacrifice and burdening regional development. On the other hand, water for rice fields had to be secured for effective utilization of small flat or plateau areas and active agriculture in general. Hence, in the Kyushu Area, stone arch bridges were commonly built instead of wooden ones. Their number far exceeds those in other regions. These stone bridges are still used today for traffic bridges or water canals.

The technology of building stone arch bridges, which was first developed in ancient Rome, was transmitted to Japan and then developed as an original technology in Kyushu. Two routes of introduction are said to exist: in the first route the technology was introduced into Okinawa by the middle of the 15th century via the silk road and China, and then transmitted to Kagoshima. In the second route, it was introduced into Nagasaki by Shuin-sen, ships which sailed across the southern seas in the 17th century, 180 years after introduction via the first route. 'Meganebashi' in Nagasaki was the first bridge built using the technology introduced through the latter route. The technology of building stone arch bridges was hence introduced through the two routes previously identified, namely the continental and Black Japan current routes.

The Meganebashi in Nagasaki was built

in 1634 and became the starting point for other stone arch bridges in Kyushu. The first Japanese water-conducting arch bridge was built approximately 40 years later in Omuta, Fukuoka. Thirty years later, a stone arch bridge was also built in Hirado. However, it was after the 19th century that the imported technology was improved sufficiently and popularly utilized. The masons of Higo, who were the engineers of stone bridges in Kumamoto, were discharged Nagasaki Magistrate officers who moved to Kumamoto and improved the technology of building stone bridges. They transmitted it from generation to generation and successfully built stone bridges in Kumamoto and Kagoshima. 'Reitaibashi' on the the Midori River and 'Tsujunbashi' on its tributary in Kumamoto Prefecture along with five other stone bridges on the Koutsuki River in Kagoshima are the most famous ones. Tsujunbashi, especially, is unique in using the natural power of the inverted siphon, and is able to transmit 14 thousand tons of water a day, irrigating the Shiraito Plateau in southern Yabe and helping development of the region as a whole.

The technology of building stone bridges in Kyushu has thus been developed by the people of Kyushu. Its success is mainly attributable to the fact that Kyushu was the first to introduce the technology and had the climate which favored it. The technology in Kyushu spread to other regions,such as Tokyo, and by the end of the 19th century (the Meiji Era) led to constructing 'Nijubashi' and 'Nihonbashi'.

Kyushu was subsequently advanced in bridge construction. 'Kuroganebashi' in Nagasaki, which was completed in 1868, for example, was the first Japanese steel bridge. The second Japanese reinforced-concrete bridge was 'Sasebobashi' in Nagasaki Prefecture, which was completed in 1906.

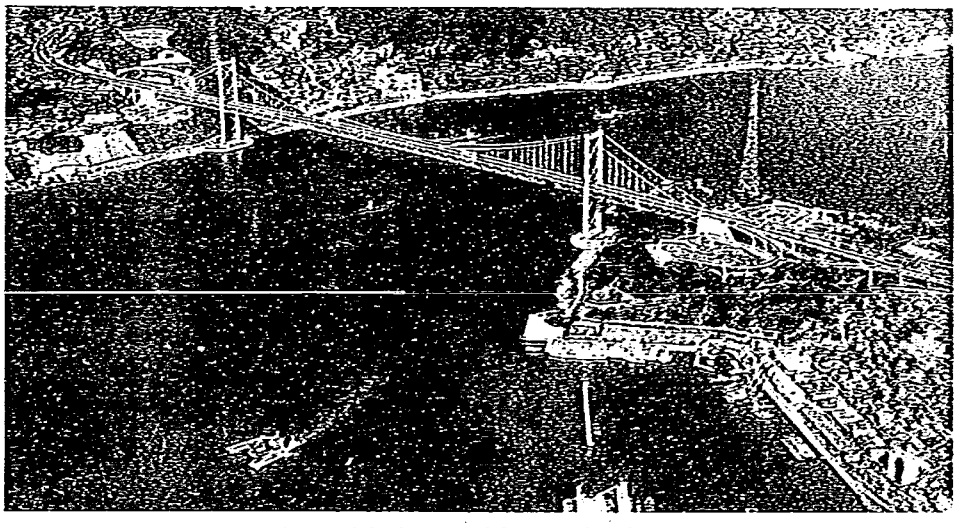


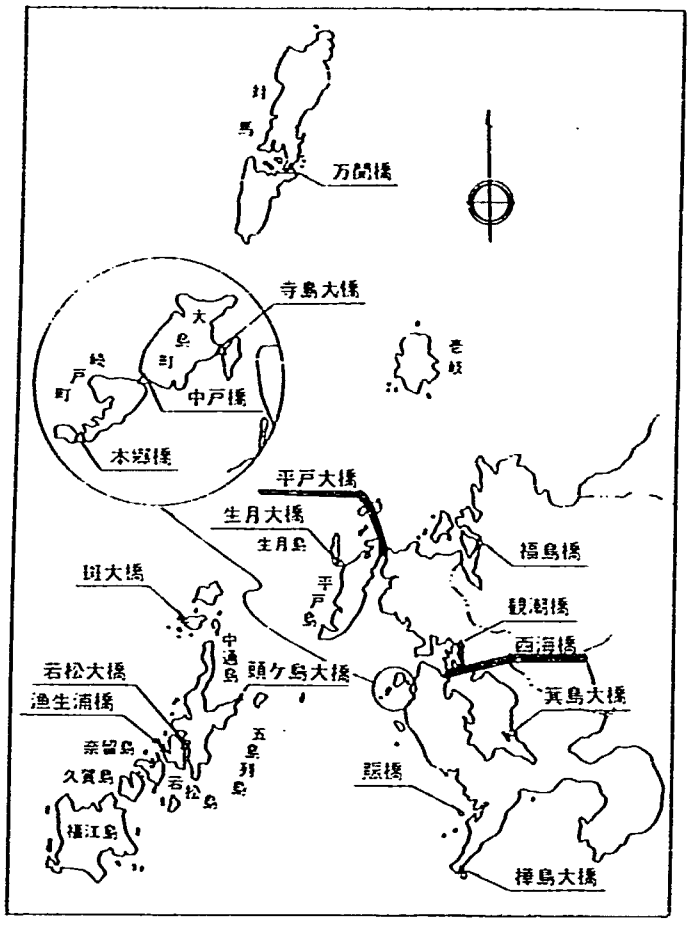
Fig.7 Modern Bridge Technology

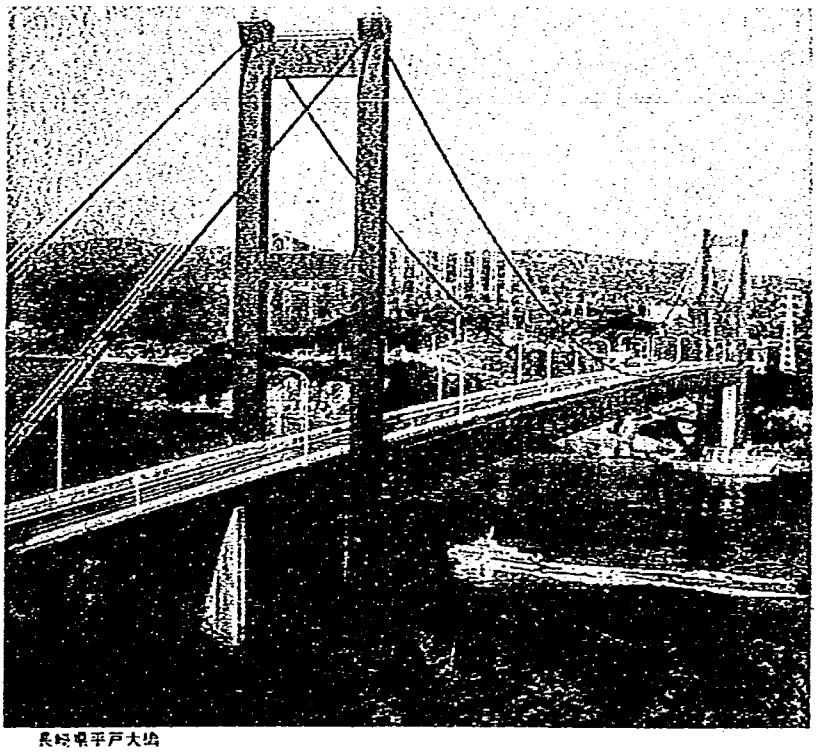
(Modern bridge technology after World War II developed along promotion of solitary islands)

As mentioned in the introduction, Kyushu consists of numerous islands including a number of islands and straits. Their existence is a primary factor for Kyushu having the most modern bridges in Japan, even today after Japan experienced the rapid economic growth after World War II. Solitary islands and peninsulas impose a severe restrain on people's lives and industries. Residents of such islands and peninsulas have wished and still wish to break free of this burden and develop a regional economy and culture. Building bridges to and connecting solitary islands with the main land promotes the economy, industries and standard of living, securing employment, enriching health, medical and educational services and so enriching every one's lives in the islands.

Demands for building bridges to solitary islands in Kyushu, although not certain, may be estimated to start at the beginning of the 20th century. The Solitary Islands Development Act enacted in 1943 led to concrete realization of the demands. The bridges shown in the figure were built thereafter in Nagasaki Prefecture, which has many solitary islands. For example; 16 bridges were built during the 48 years from 1944 to 1992.

The necessity and experience of building bridges to solitary islands in Kyushu helped to develop the technology of building modern and especially super long bridges, and pushed Japan to





長崎県平戸大橋

Fig.8 The Location of Bridges to Solitary Islands, Hirato Ohashi in Nagasaki Pref.

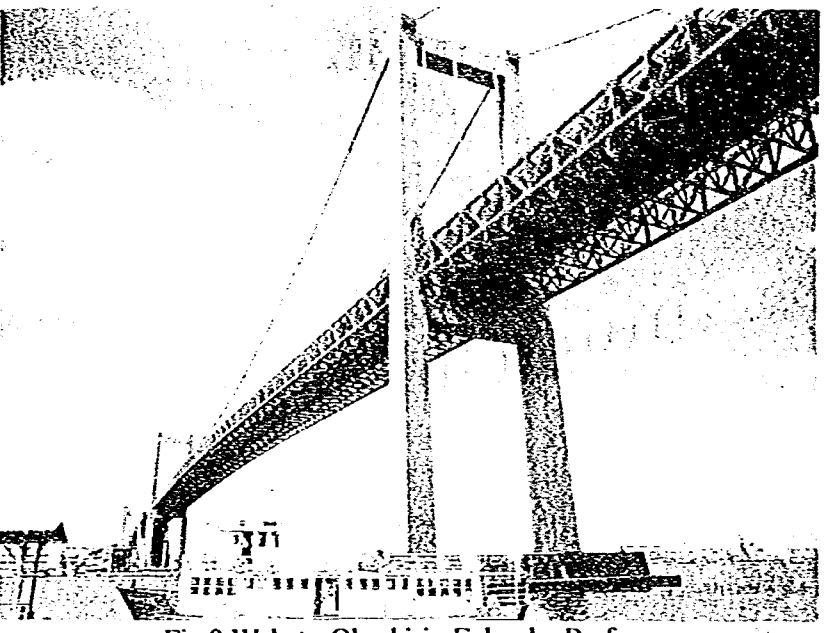


Fig.9 Wakato Ohashi in Fukuoka Pref.

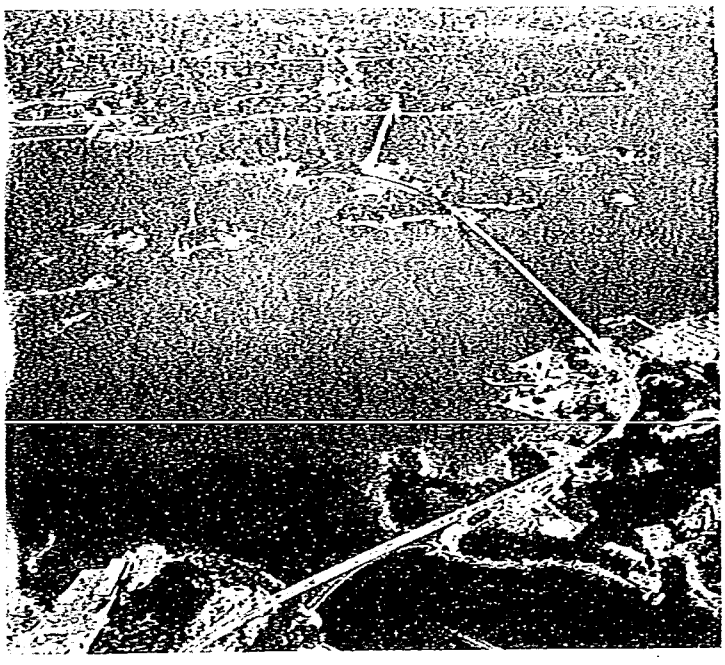


Fig.10 Amakusa Five Bridges in Kumamoto Pref.

the forefront of this field. Saikai Bridge in Nagasaki, completed in 1955 is the first arch bridge in Japan with a span exceeding 200 meters (216m) and was the third longest at the time of completion. 'Wakato Ohashi', with a span of 367 meters, which was the first modern suspension bridge in Japan, was built in Fukuoka in 1962.

Amakusa Five Bridges were completed in 1966, connecting Kyushu and Amakusa Islands. The bridges, which were built using all available bridge technologies, were truly effective in promoting the economy of the islands. Amakusa Islands, whose main industries are fishery and agriculture, were largely undeveloped, although they had a rich tourist potential. The bridges do not only promote fishery and agriculture on the islands, but also stimulate tourist development. Bridges themselves attract tourists, and 4.8 million people a year visit Amakusa Islands, a popular sight-seeing place in Kyushu.

Thereafter in 1973, Kanmon Bridge connecting Shimonoseki and Kitakyushu was built, being the longest suspension bridge in Asia. Japan's technology of building long bridges may be said to have come to perfection and was used in constructing bridges connecting Shikoku and the main islands.

Besides bridges, various other civil engineering technologies were developed in Kyushu. Construction of tunnels, artificial islands and marine airports, storage of petroleum and the treatments of special soils such as Ariake clay and shirasu are all technologies developed in Kyushu. Bridge was discussed here only as a representative one.

4. Kyushu having difficult times developing regional economy within the scheme of metropolitan areas versus regions

The Kyushu Area has been at the forefront of Japan in the field of public works and civil engineering. These advanced technologies have helped develop its regional economy. However, Kyushu now confronts a difficulty. New problems arose in the social scheme of metropolitan areas versus other regions. The Japanese economy, especially in the heavy and chemical industries, has greatly expanded form 1955 to 1970. The Tokyo, Chubu and Kinki Metropolitan Areas and the

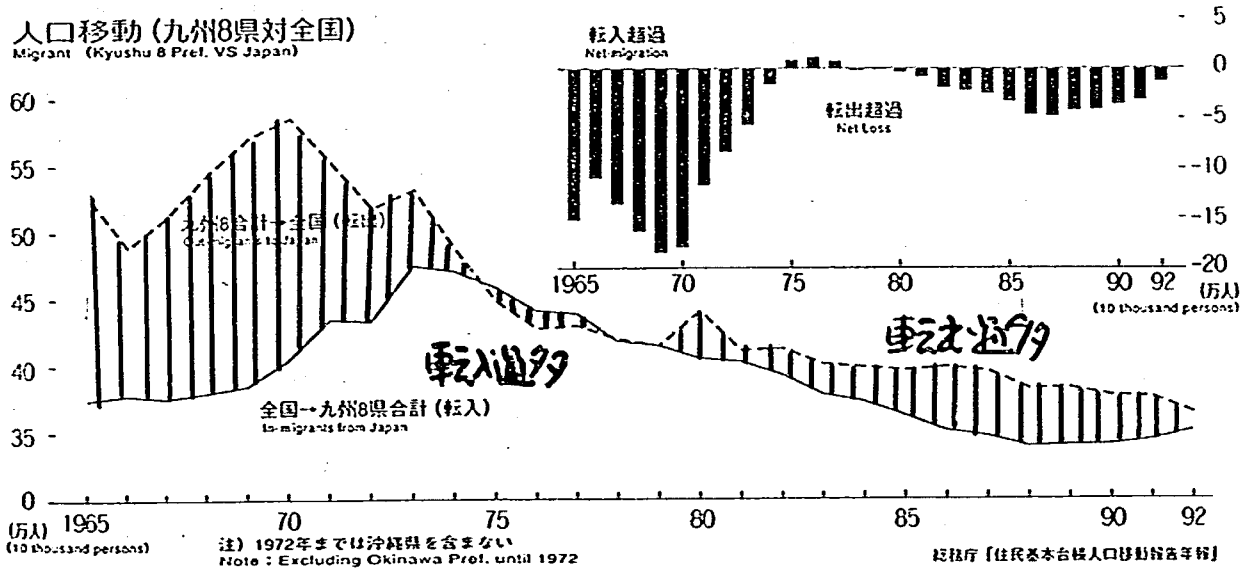


Fig.11 Migrant (Kyushu 8 Pref. VS Japan)

Tokai zone connecting them flourished. A number of workers moved into these metropolitan areas from undeveloped regions to support the expanding economy. Kyushu was no exception: its population decreased, and the percentage of elderly rose. Sixty percent of all villages in Kyushu were specified as 'depopulated regions' by the Urgent Anti-depopulation Act of 1970. The tendency still continues, although some temporary fluctuation was observed.

The Japanese government established "the First Comprehensive National Development Plan" in 1962 and the Second, Third and Fourth, successively aiming for developing regions to maintain a balance between the metropolitan areas and rural regions. Fundamental strategies in the plans were enrichment of social capital and promotion of public works. Two reasons may be proposed for the failure of the plans. First, establishment of social infrastructures was promoted in metropolitan areas first and in rural regions later since the amount of demand was primary evaluated. Indeed, advanced public works have been conducted and leading technologies have been developed in Kyushu. However, most such works were not systematic but sectional, sporadic and sometimes even experimental. Both Shinkansen railways and highways were constructed from metropolitan areas first and then to other regions. The difference in construction time caused a difference in degrees of development in the metropolitan areas and Kyushu and so the continuous outflow of population.

Secondly, social infrastructures continue to be established even in Kyushu, and is expected to stimulate a regional economy but is not yet actively utilized. In other words, establishing social infrastructures is indispensable in promoting a regional economy, but is not sufficient by itself. Skill to utilize the infrastructures, in addition to hardware and software, must be developed.

Hence, for planning projects, relationships between regional development and public works and civil engineering must be studied further. The following section gives a summary of future regional developments in Kyushu and the necessary civil engineering.

5. Regional developments demanded in Kyushu

Regional developments aim for creation of comprehensive communities, or environments in which people of all generations and occupations can enjoy a high standard of living. Social foundation facilities must be established, but their contents depend on regional development projects. Former regional development projects were mainly inviting manufacturing companies to

set up plants under administrative guidance, aiming for increasing employment opportunities, correcting income differences and preventing the outflow of population. The idea was that these companies would invite other related companies, which would secure employment, raise income levels, promote other regional industries and stimulate the region. However, as has already been mentioned, it was not a complete success.

On the other hand, future projects should reconsider old ones and aim for self-development, based on regional independency, and aim for creation of pleasant and comfortable environments. Planners search for synthetic and active development projects which may receive popular support, such as improving productivity of agricultural and fishery goods, supplementing value-added products, reforming industrial structures to highly advanced industries, intensifying the function of central cities, and utilizing rich tourist potentials.

(1) Promoting regional industries

Agriculture and fishery, which utilize nature - the largest resource in Kyushu, are the most suitable regional industries in Kyushu. However, the difference of income between rural communities and cities, difficult farm labor and basic inconveniences, and the lack of urban charm, all drive young people out of rural regions and cause a serious problem, the deficiency in successors to farms. Movements to revive villages, such as the "one speciality per village" and " best in Japan" movements, started and aimed at finding by themselves the charms of rural villages which may be as attractive as those of cities. The origin of these movements began in 1951 as the "Ume(Japanese apricot, and kuri(Japanese chestnut)" movement in Oyama-cho, Oita, and spread to the entire Oita Prefecture, catching the attention of all Japanese villages. The movement was distinctive in independently promoting the regional economy by utilizing produced were not only sold as primary products but were also processed there, adding supplementary value to the goods, securing employment and promoting settlement of people. The fact is Oyama-cho had invited three factories, such as garment factories, like the other villages. However, the factories only provided part-time employment for housewives and did not truly promote the regional economy. Expanding the industries in agricultural villages to both primary and secondary levels provides good quality employment, has far-reaching influences and effectively enhances the regional economy. Further promotion of the idea is expected.

(2) Responding to advanced industries

In the past, setting up plants, mainly of heavy industries, in rural regions was the central idea in developing the regional economy. Such intentions decreased, however, during the era of low economic growth. Instead, plants which needed cheap labor, such as the garment and metal-processing industries, and those which have problems operating in urban areas, such as food-processing plants, were built in rural regions of Kyushu. However, such plants employed mostly women or part-time workers and thus did not effectively promote the regional economy. Reflecting on these experiences, future plans for developing rural economies should focus on advanced industries, actively inviting IC and biotechnology industries, and reforming the existing raw-material-type plants to produce goods with supplementary values. Kyushu Technopolis, where the automobile and its related industries set up plants, may be evaluated as being at the starting point of this idea, and further development is expected.

(3) Tourist development utilizing natural beauty and historic cultural inheritance

Kyushu has a valuable tourist potential in its beautiful nature and numerous items of historic cultural inheritance, as mentioned in the introduction. The trends toward demanding comfortable and tasteful lives is expected to grow due to increasing free time and rising income levels. The tourist industry is one of the most effective methods to promote regional economies.

The tourist industry now grows in two opposing directions: far and wide sight-seeing which

visits overseas nations and famous picturesque spots and the more familiar recreational sight-seeing. Appropriate places for the former one are limited even in Kyushu, but the latter may be introduced in many regions. The quality of tourism will change from watch-and-see type to stay-and-act, from large groups to small group or families or individuals and from riding trains to driving their own cars. These transitions leave room for each region to develop and promote their own original tourist industry utilizing it to stimulate its economy, and thus regions now grope for the ways. Actual projects of developing Kyushu, such as constructing theme parks like 'Huis Ten Bosch' in Nagasaki and 'Sea Gaia' in Miyazaki, follow this line and are advisable.

(4) Responding to internationalization

Japan has had to establish deep economic relations with other nations since Japan is poor in natural resources. As a result, the Japanese economy has grown to the point where its gross national product amounts to approximately 10% of the world total although its population is less than 3% of the world total. On the other hand, serious trade friction problems and new rapidly advancing industrialized nations threaten the industries and economy of Kyushu. Confronting such difficulties, Kyushu is making cultural and economic exchanges with other nations on its own, thus promoting internationalization and utilizing it for development of regional economies.

(5) Strengthening functions of central cities

Each region does not exist as an isolated entity but rather as part of an organic relationship with surrounding regions and other organized zones, bearing and sharing the burdens with each other. Interaction among such zones stimulates the economy in the entire area. Cities serve as an index of development and as centers of such zones. Therefore, each central city must establish basic urban functions. The various urban functions demanded of the cities may be classified briefly as administration, economy, information, education and environment. Cities in Kyushu do not fall behind Kyushu's benchmark city, Fukuoka, concerning the environment but are weak in the other four functions, i.e. administration, economy, information and education. Their levels of strength are low compared to their population. Such functions must be strengthened in the central cities of each region.

These two diagrams show skeletons of regional evolution for all of Kyushu. The first diagram shows the axis structure proposed for Kyushu: the existing first axis traversing western Kyushu, a planned second axis crossing Kyushu, an east axis compensating for points missed by the first two and an international axis in response to internationalization. It is imperative that these four axes all are developed and strengthened.

The diagram of regional evolution is a result of respecting the unique characteristics of each region. Kyushu in brief has cities in the north and unspoiled nature in the south. Moreover, Kyushu does not exist alone, but interacts with neighbor nations, such as South and North Korea, China and Russia. It needs to consider itself as the vital point in the region surrounding the China Seas and the Sea of Japan and needs to make strategies for winning competition among blocks. It is hence desirable that the Fukuoka Metropolitan Area function sufficiently as the pivotal city, considering the present situation. The sketch is most realistic in that each region plans its own strategy and forms inter mutual networks.

Northern Kyushu is the 'head' of Kyushu, of which the skeleton is the Seikaido Megapolis ('Tokaido' is the Eastern highway, and 'Seikaido' is the western highway). Shimonoseki, Kitakyushu, Munakata, Fukuoka, Tikushi, Tosu, Kurume, Saga, Omuta, Arao and Kumamoto cities are all connected and can compete with the Tokyo and Kinki Metropolitan Areas, Pusan, Seoul, Shanghai, Taipei or Hongkong both in scale and in importance. This Seikaido Megapolis must have a determined face. It must act as the Asia Metropolis, or the center of commercial control and international functions which Fukuoka has. It must also act as the Super Technopolis using the

highly advanced technologies concentrated in the Kitakyushu triangle formed by Kitakyushu, Miyata and Kanda. Kumamoto City is expected to play the role of an interface city connecting northern Kyushu with the central and southern regions. Furthermore, bases for international transportation (international airports, harbors and merchant centers), communication systems (teleports and international communication), scientific research facilities and systems (North Kyushu Science City and System Supporting Research and Development), and cultural facilities (facilities for international conventions, national museums and international urban culture) must be established, developed and strengthened in the entire Kyushu Megapolis.

Nagasaki is Kyushu's 'hand'. The Marine Park concept may be constructed on the waterfront, based on Nagasaki's diversified marine industries, recreational activities, its exotic atmosphere and peculiar theme parks. Nagasaki City itself may be its center of focal point.

Central Kyushu is Kyushu's 'body', having wide forests, fertile land and active volcanoes. Its fundamental strategy is therefore the formation of Green Park and Agrizone. The conceptual central Kyushu rural-industrial city, Technopolis, may be constructed while developing a clean industrial zone of advanced technologies and adding urban amenities. Kumamoto City will serve as the center and Oita City as the east gate thus strengthening ties with Shikoku. The conceptual Marinovation area may also be formed, building bridges connecting Shimabara, Amakusa and Sendai and reforming Ariake and Shiranui Seas into inlets, and playing leading roles in developing the fishing industry and related technologies.

South Kyushu is Kyushu's 'leg' maintaining contact with the earth. Resort areas created mainly in Miyazaki, Kagoshima and Okinawa, utilizing the beautiful natural environment will form an Asian resort area which will not fall behind South France. Both Miyazaki and Kagoshima Cities will act as central cities, functioning as south gates to Kyushu.

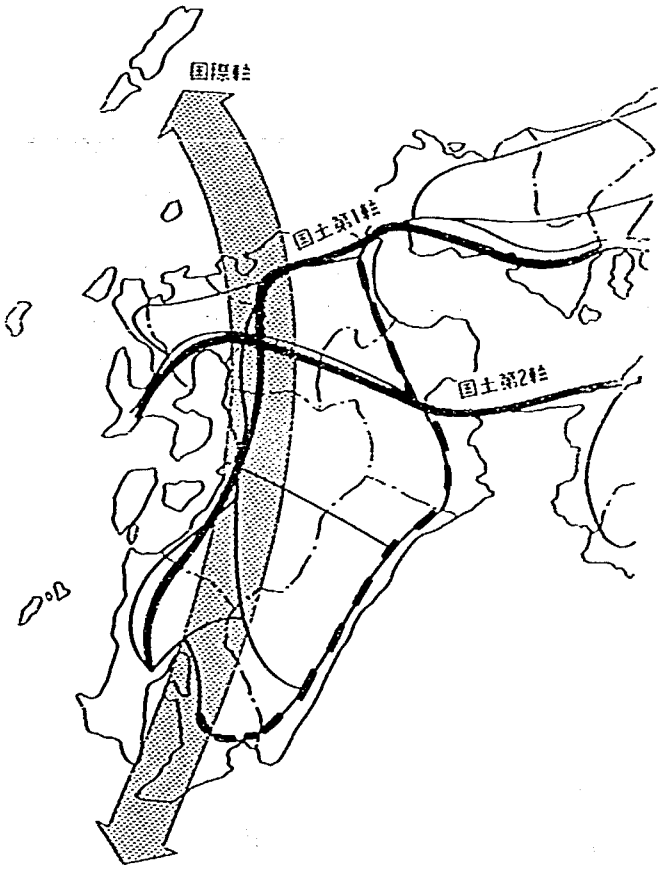


Fig.12 The Axis Structure for Kyushu

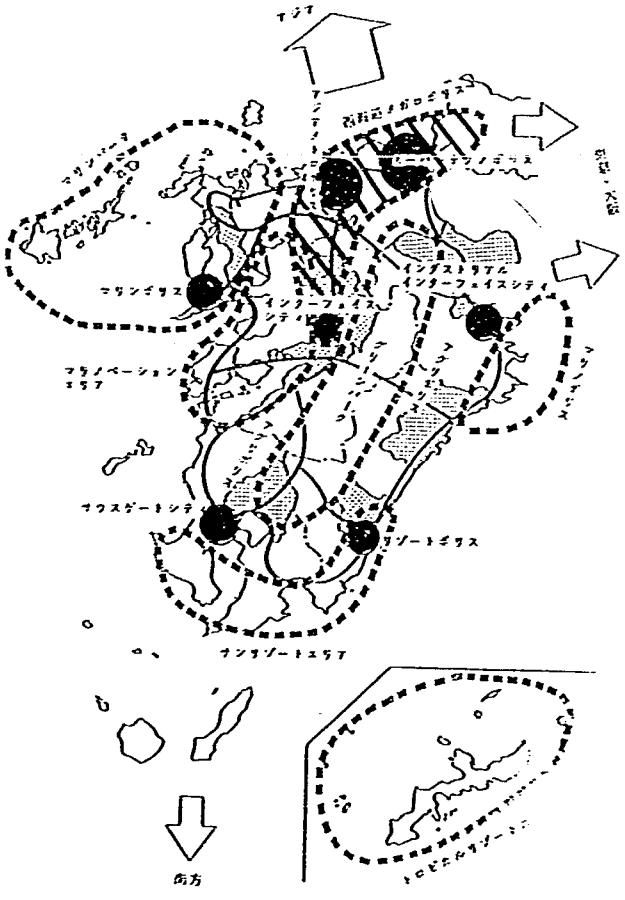


Fig.13 Regional Sketches of Kyushu

Such regional sketches are based on forming human cities which support integrated urban activities, effectively utilizing land and water for food production, developing rural-type industries, and creating places for recreation and wildlife habitat.

Networks must be established to allow interconnection and compensation of functions borne by all regions, such as city and green networks. The networks must be interconnected to and enhance their importance and solidarity. Functional networks for information, scientific study and culture must also be formed. Regions with various types of functions connected by networks are 'Kyushu in the twenty first century', or 'The Kyushu Planet shining in the Asian Universe'.

6. Expected directions of development in public works and civil engineering ---conclusion---

Strategies for the regional development of Kyushu toward the 21st century may be constructed as outlined above. The most important points for its realization are that development, occurs in appropriate scale and with contents utilizing the region's unique characteristics, and that planning and promoting projects is done with unassisted zeal. Networks must be constructed within Kyushu and between Kyushu and other areas and nations. Exchange of men, goods and information is also highly desirable.

Establishing social infrastructures and the skills sufficient to utilize them is a necessary condition for truly effective development of Kyushu. Civil engineering and public works are definitely the prime mover in propelling this establishment. Civil engineering must aim for the following two goals, considering the aforementioned regional developments.

(1) Carrying out public works with sensitivity to changing and diverse values by establishing civil engineering technologies

The first goal is to carry out public works flexibly with respect to a changing and diverse sense of values and to establish technologies to support such works. The five points on regional development in Kyushu given in the previous section are opinions of the author, who wishes Kyushu to be the leader, by making strategic changes in social structure, which are shown in this figure.

Social structures changed first from hunting society to agricultural, which initiated domiciliation and the formation of values for day-to-day living and for the relationship of masters to the ruled. Later, invention of the engine and the Industrial Revolution created industrial societies, which integrated labor and pursued efficiency and convenience. As a result, people gathered in cities and agricultural villages stopped playing the principal role, and the imbalance between cities and rural communities grew worse. Only limited regions, such as the three metropolitan areas previously mentioned, receive attention. All other regions suffer in their efforts to develop a regional economy. Rural communities in Kyushu have endeavored to aim for catching up to the advanced regions but have not always succeeded.

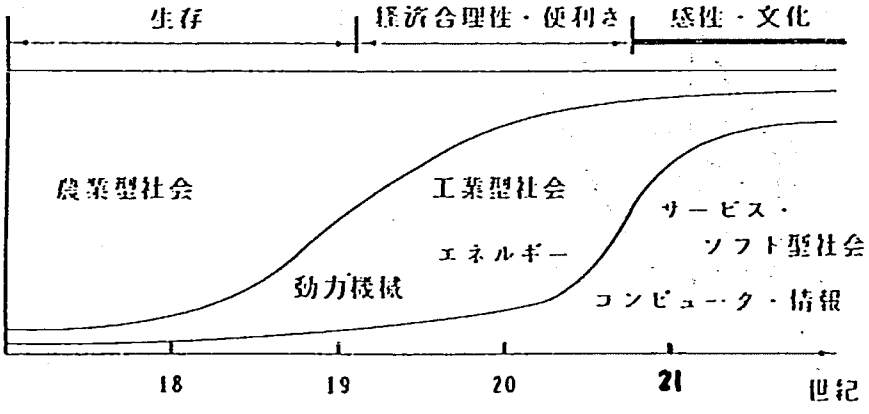


Fig.14 Changes in Social Structure

Many factors are attributable for their failures, but they all may be summarized quite simply: The communities only pursued the advanced cities, which had a merit in being large. It is impossible for Kyushu villages, which have less power and worse

conditions, to overtake the big cities, which underwent industrialization and then deindustrialization. The distance between the two always increased, resulting in serious depopulation, delays in information and services and a lack of conform and original culture.

Reflecting on these failures, projects to stimulate regional economies in Kyushu must aim for leading the era and not for pursuing larger, more advanced cities. Hence, public works are required to respond to various needs created by diverse human senses with the consideration that the society in the 21st century will be one which respects human senses. In other words, public works should not only be uniform, effective and economical, but contribute to the realization of a society in which people subjectively feel, touch and recognize, and such civil engineering technologies must be developed.

(2) Public works and technologies for enhancing the environment

The second goal is that public works must create pleasant surroundings. Public works, especially those on a large scale, increasingly cause complaints and environmental disputes on the part of local residents. Public works are originally carried out in order to contribute to various social activities and improve conditions. Two factors are attributable for the conflicts. One is the diverse priorities of society, and the uncertain standards for measuring and qualifying values. The other is that public works have aimed mainly for frugality and efficiency and have neglected other factors, such as culture, art, comfort, quality, response to diverse and flexible usage and harmony with nature, all of which may be graded useless for efficiency.

Having constructed the necessities, public works must from this point consider factors other than economy and efficiency. In doing so, public works must now enhance the social environment. Technologies to realize such works are strongly required to be developed.

I have discussed, possibly in a somewhat abstract way, the future directions of public works and civil engineering in developing the economy of the Kyushu Area. I hope my lecture may help you in some way. Thank you.

2. Panel Discussion on [Striving for a Better Environment – Regional Development Projects, Disaster Prevention, Environmental Issue -]

Coordinator : Yukihiko Sumiyoshi
Director-General, Public Works Research Institute Ministry of Construction

Panelist

<Japan>
Eiki Aramaki, Director-General, Kyushu Regional Construction Bureau, Ministry of Construction

<People's Republic of China>
Wu Jishan, Director, The Institute of Mountain Hazards and Environment, Chinese Academy of Sciences

<Republic of Indonesia>
Soedarmanto Darmonegoro, Secretary, Agency for Research and Development, Ministry of Public Works

<Republic of Korea>
Keung Hwan Kim, Director, Planning & Coordination Division, Korea Institute of Construction Technology

<Malaysia>
Teh Siew Keat, Director of River Engineering, Department of Irrigation and Drainage, Ministry of Agriculture

<Republic of the Philippines>
Jose H. Espiritu, Director, Bureau of Research and Standards, Department of Public Works and Highways

<Republic of Singapore>
Khor Poh Hwa, Chief Civil Engineer, Public Works Department, Ministry of National Development

<Kingdom of Thailand>
Anusornant Mahavinichaimontri, Director of Materials and Research Division, Department of Public Works, Ministry of Interior

Panel Discussion
Striving for a Better Environment



Coordinator: Yukihiko Sumiyoshi, Director-General,
the Public Works Research Institute,
the Ministry of Construction, Japan

Coordinator:

Firstly please allow me to introduce myself. My name is Yukihiko Sumiyoshi, and I am currently working as the Director-General of the Public Works Research Institute, Ministry of Construction. I will be chairing the panel discussion today. Before we begin I should like to introduce our eight guest panelists.

First of all we have Eiki Aramaki, Director-General of the Kyushu Regional Bureau, the Ministry of Construction; from China, the Institute of Mountain Hazards and Environment, the Chinese Academy of Sciences, we have Director Wu Jishan; from Indonesia, Agency for Research and Development, Ministry of Public Works, Secretary Soedarmanto Darmonegoro; from the Korea, Institute of Construction Technology, Director of Planning & Coordination Division Keung Hwan Kim ; from Malaysia, Department of Irrigation and Drainage, the Ministry of Agriculture, Director of River Engineering, Teh Siew Keat; from Philippine, Bureau of Research and Standards, Department of Public Works and Highways, Director Jose H. Espiritu; from Singapore, Public Works Department, Ministry of National Development, Chief Civil Engineer, Khor Poh Hwa; and from Thailand, Department of Public Works, Ministry of Interior, Director of Material and Research Division Anusornant Mahavinichaimontri.

As mentioned by Prof. Takeshi Chishaki in his keynote lecture, technological progress with respect to cultural development and social infrastructure in the Kyushu region has been greatly influenced since ancient times by other Asian countries. Furthermore, social infrastructure and supporting civil engineering technology has played a vital role in regional development and expansion, and will clearly continue to do so. Prof. Chishaki also spoke of the need to respond to increasing diversity of opinion and to environmental concerns issues in future development and civil engineering work in Kyushu. During the panel discussion today I look forward to hearing about a variety of issues and problems throughout Asia.

The primary aim of regional development, disaster prevention and environmental improvement in Japan is to create the lifestyle and surroundings of the people, specifically in terms of roads, bridges, rivers, dams, erosion control, sewerage systems, urban planning, housing and so on. I should now like to discuss specific examples of similar public works or projects elsewhere, beginning with a look at some of the differences in approaches to lifestyle and environment improvement and in the use of social capital.

I will ask each speaker to give an initial presentation of about six minutes duration, describing one or more plan or project undertaken in their country. We will then have a question and answer session, where speakers will have roughly three minutes each to talk about future improvement of infrastructure, related policies and guidelines, supporting civil engineering research and how these are reflected in current national policy in the field.

Let us now begin with Mr. Aramaki Director-General of Kyushu Regional Construction Bureau, who will speak on the use of social capital in the Kyushu region.

Refer to page 41 for summary of speeches

1)	Japan	Public Infrastructure in Kyushu Area
2)	China	Comprehensive Debris flow Control Works
3)	Indonesia	Water Pollution Control Project
4)	Korea	Regional flood Frequency Analysis for the Major Korean Rivers
5)	Malaysia	10 Year Program on Cleaning up of the Klang river
6)	The Philippines	South Luzon Expressway Extension Project
7)	Singapore	Singapore Underground Road System
8)	Thailand	Improvement Urban Air Quality

Coordinator:

To summarize these eight reports:

In Kyushu, Japan, we heard about the importance of expressway construction and other issues related to strategies for dealing with natural disasters, in particular typhoons, and the heavy rains and strong winds they bring, and volcanic eruptions.

In the city of Nanping, China, up till 1980 the victim of repeated debris flows, a variety of debris flow control works have successfully prevented further damage, and other issues for the future.

In the Sitaram River in Indonesia, at present heavily polluted with industrial and domestic waste fluids, water quality conservation work is centered on a pilot integrated sewerage collection and processing plant. We heard about the future of such integrated systems should proves successful.

In Korea, new techniques are being used in a bid to increase reliability and accuracy of flood prediction in regional rivers.

In the Klang river in Malaysia, where water quality has been deteriorating rapidly, an extended approach to purification is required. In formulating a Ten Year Plan for the river there have been more problems in developing 'soft' rather than 'hard' countermeasures (a problem shared by Japan).

From the Philippines we heard about environmental problems surrounding expressway construction in southern Luson, and efforts to utilize the very latest information when developing expressways in harmony with local surroundings.

The Singapore underground road system is being developed with a view to minimizing the effect on the environment and historical structures, while at the same time maintaining a vital element of a road transport system serving some four million in a confined area.

In Thailand, efforts are being made to reduce urban air pollution, a by-product of industrial progress and a problem shared by third world countries. A comprehensive approach including legislative measures is required, as in Japan.

If we analyze the range of issues covered (the Japanese report will be treated as having two parts -- disaster prevention and expressway development) we have: three reports concerning environmental issues, (two on rivers and the other on roadways); three on natural disasters (volcanic debris flows, flood prediction, etc.); and three on roadways. I believe this breakdown is most significant in that it reflects not only current thinking with respect to social capital, but also the general direction of society in Asia.

In Japan, research, policy guidelines and legislation are continually being reviewed and updated in a continuing effort to deal with traditional problems of river pollution and the

lack of proper sewerage facilities. China is making major efforts to deal with debris flows, combining a number of different technologies in a long-term approach, but further research and development into natural phenomena will be required.

Atmospheric pollution is a problem faced by a large number of cities in Asia, South America and in many developed countries. We have also heard about efforts to raise the quality of life and stimulate regional development, for instance via expressway construction in Japan and the Philippines, and underground road systems in Singapore. I believe that it would be most beneficial if more information regarding these projects, and related technical developments and research findings, should be circulated between our countries.

At this point I should like to ask our panelists if they have any questions, additional comments or questions to ask other speakers.

Comments from panelists:

Indonesia: Mr. Soedarmanto

Each of us has significant experiences to contribute. Indonesia faces the same problems as the rest of us, and I am keen to obtain more detailed information about work going on elsewhere in Asia. I should like to propose an organized setup whereby information could be circulated for use by other countries. I feel this would contribute a great deal to the individual efforts we are making to deal with these problems.

Korea: Dr. Kim

Each of us is working to alleviate suffering caused by natural disasters, and to improve the quality of life through infrastructure development. Japan provides us with some excellent examples of the importance of environmental considerations in sustainable development, while Malaysia's ten year program on river cleaning up has major significance in terms of river beautification. In Korea work is already underway on some 8% of the total river system in an effort to develop pleasant river areas for use by the general public. Although development is vital, at the same time we must not forget the importance of the natural environment.

Japan: Mr. Sumiyoshi

The Indonesian proposal has already been discussed at the Second Conference on Public Works Research and Development in Asia. The research and development information exchange setup is on the agenda for the future.

Coordinator:

Now I would like each panelist to give a three-minute talk, describing the current approach to and focus of government policy in their country with respect to social infrastructure development, as well as considerations for the future.

As before, we will begin with Mr. Aramaki representing Japan.

Refer to page 41 for summary of speeches

1)	Director-General, Kyushu Regional Construction Bureau, Ministry of Construction	Mr. Eiki Aramaki
2)	Director, Institute of Mountain hazards and Environment, Chinese Academy of Sciences	Mr. Wu Jishan,
3)	Secretary, Agency for Research and Development, Ministry if Public Works	Mr. Soedarmanto Darmonegoro
4)	Director of Planning & Coordination Division, Korea Institute of Construction Technology	Dr. Keung Hwan Kim
5)	Director of River Engineering, Department of Irrigation and Drainage, Ministry of Agriculture	Mr. Teh Siew Keat
6)	Director, Bureau of Research and Standards, Department of Public Works and Highways	Mr. Jose H. Espiritu
7)	Chief Civil Engineer, Public Works Department, Ministry of National Development	Mr. Khor Poh Hwa
8)	Director of Materials and Research Division, Department of Public Works, Ministry of Interior	Mr. Anusornant Mahavinichaimontri.

Coordinator:

We have heard about approaches to future improvement of infrastructure from each speaker, and in every case environmental considerations were an important feature. This issue can be split into two -- on the one hand, we talk of attempts to rectify a deteriorated or deteriorating environment, and on the other we have the idea of sustainable development, of utilizing infrastructure without affecting the present state of the environment.

Furthermore, there are two important aspects to the concept of the environment. A nation must have supporting technological development, as in Japan or Singapore, in order to be able to formulate and enforce standards, policies and regulations. It has taken Japan some 120 years to reach the present level of awareness in this field (and many measures have been taken retrospectively), whereas most Asian countries have accumulated the same experience in only three or four decades. It is encouraging indeed to see environmental issues being addressed simultaneously with development, rather than after problems arise, as has so often been the case in Japan.

Now I shall call for comments from our speakers.

Question and answer session:

The Philippines: Mr. Espiritu

Like other Asian countries Japan is working to improve environmental conditions. The difference is that it possesses advanced technology. However Japan does not exist independently of others. Now is the time to pass on the fruits of technological development to the rest of Asia. Furthermore, Japan must strive to use the very best technology in social infrastructure. The past ten years have given rise to some excellent examples of infrastructure in the Philippines, due to generous contributions from our neighbors. For instance, we have learned a great deal about strategies for dealing with volcanic eruptions and earthquakes. In the future we should like to learn more about sustainable development from countries like Japan who have had demonstrable success in this area. It should be noted however that favorable results in Japan alone do not constitute real success; nor does this constitute a truly 'industrialized nation'. Japan must show leadership by handing down the fruits of its labors to other Asian countries. Only then will the entire Asian region as a whole be able to create a significantly better environment and achieve sustainable development.

Japan: Mr. Aramaki

Kyushu was once proud of its seven-colored smoke; now we are gradually bringing back the blue skies. The same is true of Yotsuka-ichi. Japan is working together with China and a number other countries in its effort to reduce atmospheric pollution. I believe that joint effort at the national, municipal, and individual level is both possible and indispensable if we are to come to terms with environmental issues.

Japan: Mr. Kikuchi (from the floor)

I would be interested to know how the views of the general public are represented in Indonesian assessment guidelines, and whether public opposition can actually put a halt to construction.

Indonesia: Mr. Soedarmanto

The Indonesian government designates areas as either industrial or residential zones, although there is no mechanism for directly incorporating public opinion into the process. However we did for instance directly solicit comments over the construction of research laboratories in my own area. We recognize the importance of environmental work, and the role of culture and customs in creating such serious river pollution. We intend to employ every means available in order to boost public awareness of environmental issues.

From the floor:

I think there is one very important issue which should be taken into consideration in any discussion on the environment: the environmental destruction through air, water and noise pollution which accompanies development. Of course development is necessary for economic growth, but I think this has to be balanced with the toll on natural resources.

Coordinator: Mr. Sumiyoshi

The purpose of this very meeting is to debate the balance between natural resources, development and the environment. We are dealing with issues vital to the way in which infrastructure is utilized in the future.

Coordinator:

We've now reached the time to wind up this discussion, so I should like at this stage to make some concluding remarks. We have heard from our eight speakers about various projects underway at present, as well as infrastructure policy in the future.

We have seen that all of us are striving to tailor policies to natural, economic and social conditions, whether for everyday facilities like sewerage or regional planning of roads and river basins, specific environmental issues or major problems such as atmospheric pollution. Today the focus has been on environmental issues, but I should like to add that sharing and stockpiling of new information and technology within the Asian region is of enormous significance with respect to future developments in civil engineering technology and social infrastructure. We need to establish and expand information and contact networks, such as this symposium. I believe that today's discussion provides an excellent basis for exchanges of this kind.

Mr. Espiritu requested more technological cooperation from Japan for the Philippines and Asia in general. I think we should pause for a moment and reflect on the propriety of this suggestion. Asia is made up of a mosaic of countries, with widely differing customs, systems and cultures, and this diversity must be given due weight. At the same time, there are also a number of common themes and issues permeating the presentations we have heard today.

Our panelists today have demonstrated the complexity of issues in infrastructure development, and also the vital supporting role played by technology research and development. And I think we have all learned a little more about the types of problems faced by our neighbors.

Finally, in closing this panel discussion, I should like to express my thanks to all from the Branch of Western, Japan Society of the Civil Engineers, Fukuoka City, Fukuoka Prefecture, Kyushu Regional Construction Bureau of MOC, without whose efforts "The Second Symposium on Public Infrastructure and Civil Engineering in Asia "
would not have been such a resounding success. I also want to thank those who listened so attentively to the proceedings today.

Public Infrastructure in Kyushu Area



Mr. Eiki Aramaki, Director-General,
Kyushu Regional Construction Bureau,
MOC, Japan

I. Introduction of the Project for a Better Environment

Kyushu is separated from the East Asian Continent by only a strait, and historically has had direct exchanges with China and Korea. Up to 1854, Nagasaki was only one port which had been open to the world, the Netherlands and China for 250 years. Kyushu is said to share about 10% of Japanese national economy. Kyushu has about 12% of the land size and population of Japan. Other main indices such as GDP, annual retail sales or local public finance also occupy 9 to 12% of national figures. Yet some industries of Kyushu are national cores of



Fig. 1 Kyushu



Fig. 2 Severe Rainfall in Kagoshima (Aug. 1993)

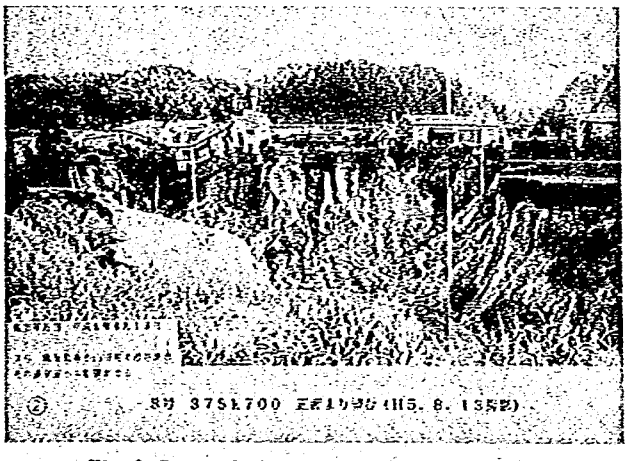


Fig. 3 Severe Rainfall in Kagoshima (Aug. 1993)

production, and supply well more than 10%; ship building (38%), integrated circuits (31%).
(In comparison with other countries, Kyushu has almost same size economy as Australia or the Netherlands in terms of GNP.)

Kyushu is endowed with an abundance of natural beauty, which attracts more and more tourists every year to many resort areas. Kyushu has 3 national parks featuring active volcanos and hot springs. On the other hand, topography, climate and other natural conditions make Kyushu an environment susceptible to natural disasters. We have severe natural conditions that include not only seasonal rains and typhoons, but also frequent volcanic disasters.

Last August, Kagoshima, southern-most prefecture was attacked by severe rainfall, and has got lots of damages on residents, houses or infrastructures. Slide shows a damaged section of National Highway No. 3 caused by flood of Kotsuki River along this Highway. Scale of this damage is 70 m in length and 26 m in height. They call it "Grand Canion in Kagoshima".

Lost of planted cedars which have been fallen by typhoon in 1991, 2 years ago, have come out with consecutive floods of this summer. They were all cleared away in dam lakes.

Mt. Fugen, the major mountain in Unzen National Park, has become active in 1990 after the last eruption of 200 years ago. Since then, it has been the sources of Debris Flow and Pyroclastic Flow accompanying heat gas (mixed flow of water, stones and earth) which force about 3,600 peoples to evacuate from their lands and houses.



Fig. 4 Planted Cedars (Sep. 1991)

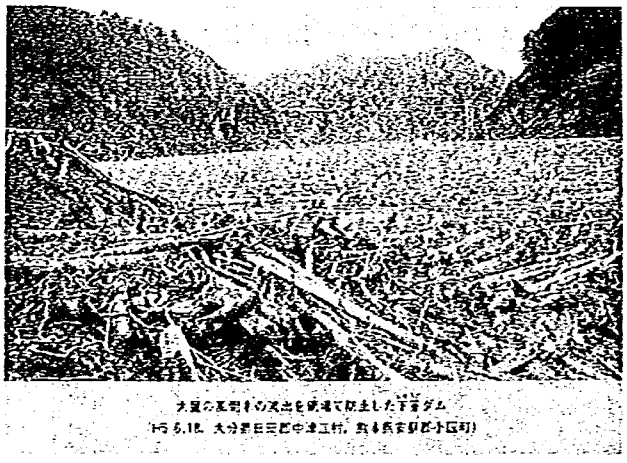


Fig. 5 Planted Cedars Outflow (Jun. 1993)

The Kyushu Regional Construction Bureau, as one of the 8 Regional Offices of the Ministry of Construction, carries out such works is water management, floor control, highways, parks and buildings.

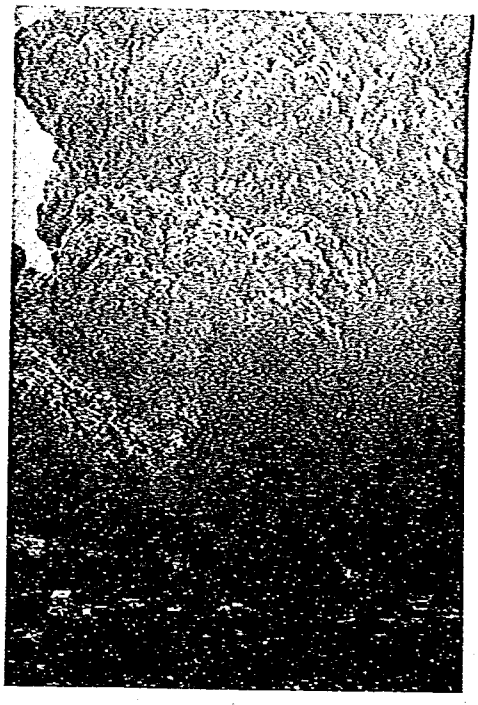


Fig. 6 Pyroclastic Flow

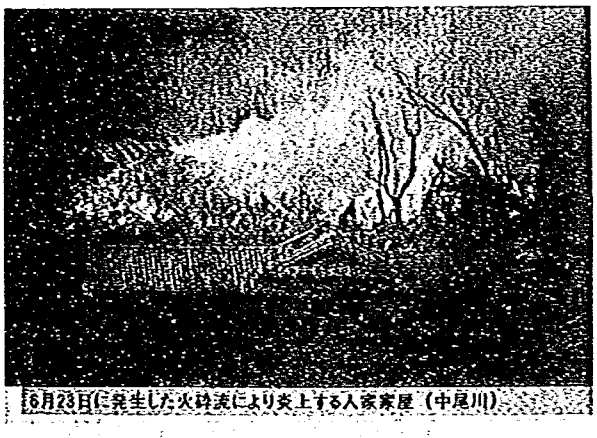


Fig. 7 Damages by Pyroclastic Flow (Jun. 1993)

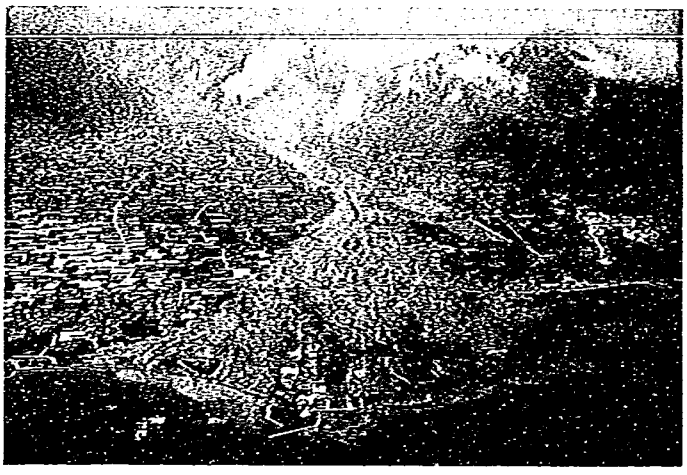


Fig. 8 Site around Mizunashi River (1993)

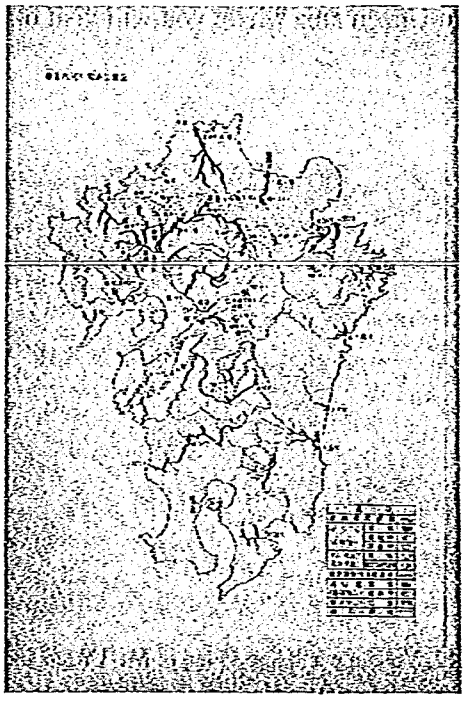


Fig. 9 Location of River in Kyushu

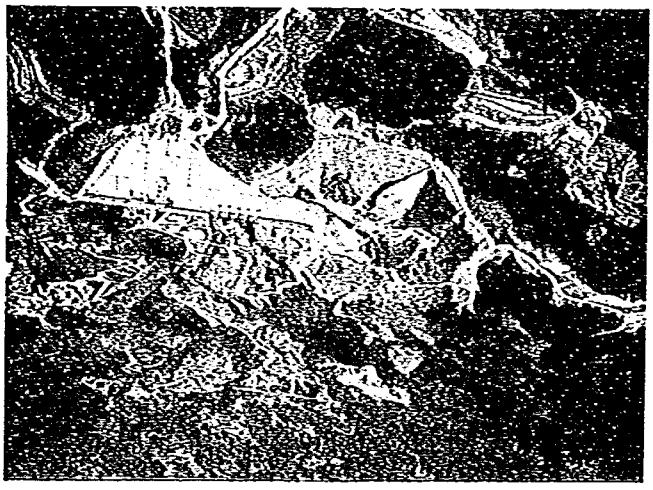


Fig. 10 Ryumon Daa

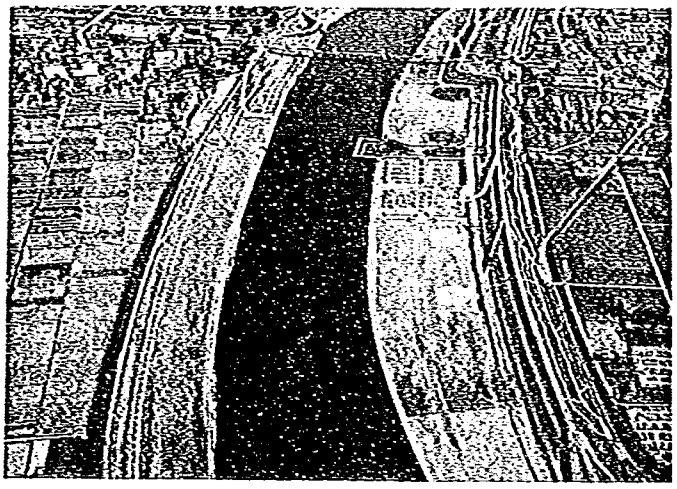


Fig. 11 Chikugo River

As for water management and flood control, we are conducting systematic improvement of flood control facilities such as dams or diversion channels and also maintenance works for 20 major riveers suchj as Chikugo River.

In order to protect residents from debris flow disasters, in the areas of volcanic activities, we are conducting sabo projects such as dams, training dikes and sand pockets. Slide shows the sabo projects in Unzen area where you will visit on Wednesday.

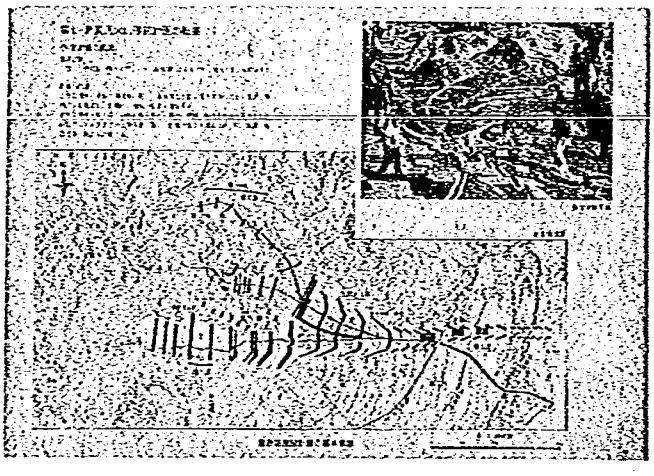


Fig. 12 Volcanic and Sabo Plan of Mt. Unzen and Fugen

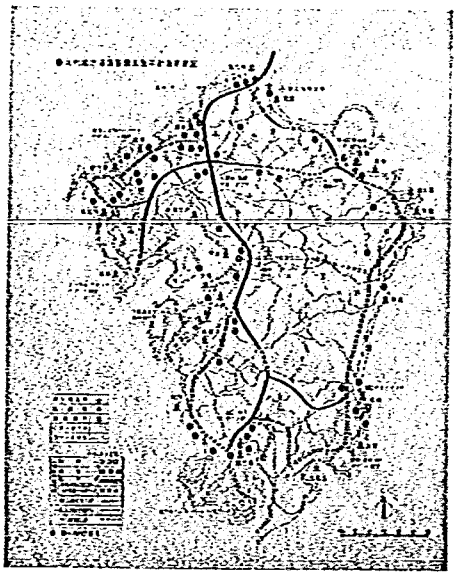


Fig. 13 5 Year Plan of Highway Works in Kyushu

Modern motorway system provides people with a high speed transportation network in Kyushu. Now, 680 km of motorways is in service, and 340 km, under construction out of 1500 km of total planned network in Kyushu. Our bureau is also in charge of improvement and maintenance works of 2,000 km trunk national highways in order to ease traffic jams or to ensure traffic safety.

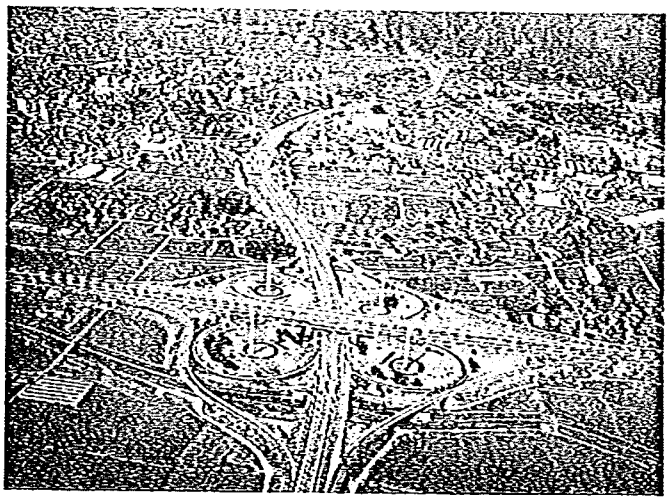


Fig. 14 Tosu Junction of Kyushu Express Highway

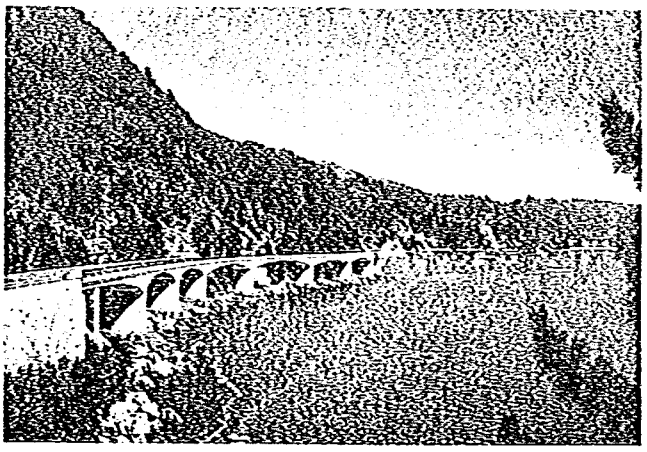


Fig. 15 Disaster Works of National Highway No.20

Apart from National Parks featuring natural beauty as I mentioned before, National Government, of Ministry is in charge of development of large scale urban parks like Umino-akamichi Seaside Park where you visited yesterday. We also have just started to develop another type of park, historical one in cooperation with the Saga Prefecture. Concept of this park stands on the view saying that this area is the origin of the first nation in Japan during 1st to 3rd century.

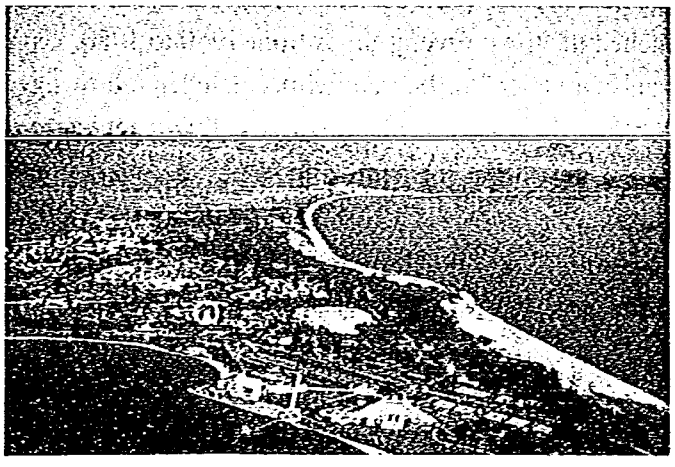


Fig. 16 Umino-Nakamichi Seaside Park

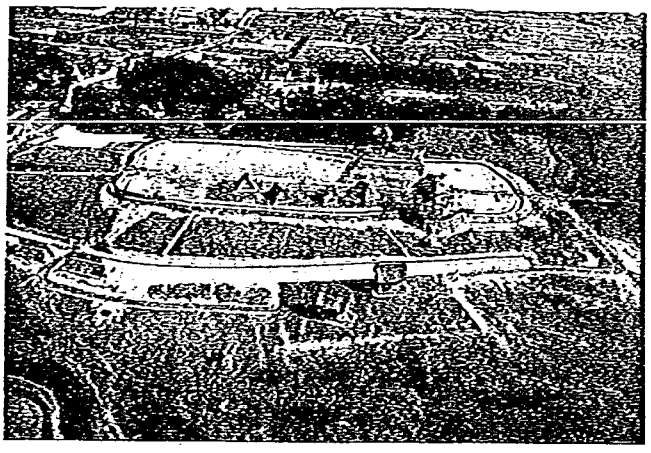


Fig. 17 Yoshinogari Histrical Park

The Comprehensive Debris Flows Control Works



Mr. Wu Jushan, Director, The Institute of Mountain Hazards and Environment, Chinese Academy of Sciences, China

I. Introduction of the Project for a Better Environment

1. Objective

Comprehensive measures have been adopted to control debris flow occurrences and to protect Nanping Country Town and highways from debris flows.

2. Outline

There are fifteen debris flow gullies on the mountain side behind Nanping Country Town. The watersheds of all gullies have an area of 2.62 km^2. Because the vegetation has been destroyed, debris flows in the gullies occurred frequently and damaged the town several times from 1950 to 1980. The debris flow control works started from 1980 and completed in 1983. The works included following measures: 1. revegetation of 135 ha wasteland by sowing gresse and planting trees; 2. One retaining wall at the mountain slope base and 53 check dams in the gullies for stabilizing slopes; 3. four debris flow storage grounds in the slope toe area for storing debris flows; 4. channel works with a total length 750 m in the low reaches of the gully for draining floods; 5. a debris flow warning system, setting up at the mouth of shuiquan Gully, which threatens the country town severely.

3. Problems of Technical Issue

Generally, the conteol works is very successful. But, the engineering part of the works has a few technical problems: 1. scourring foundations of check dam and channel works by debris flows and floods; 2. poor foundation for setting up check dams in the gullies because of the unstable slopes and active landslides at the dam sites.

4. Effects for a Better Environment

Since 1983, the debris flow have been controlled essentially and Nanping County Town and highways have been protected from debris flow disasters.

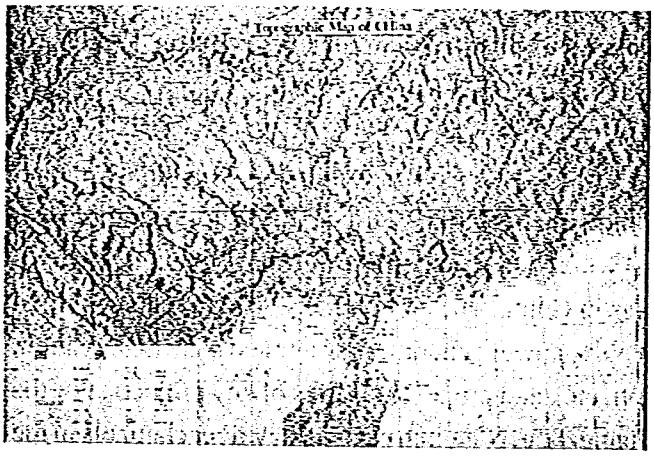


Fig. 1

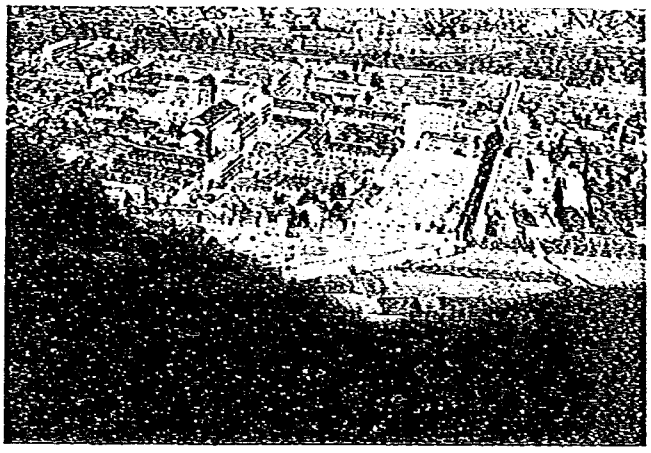


Fig. 2

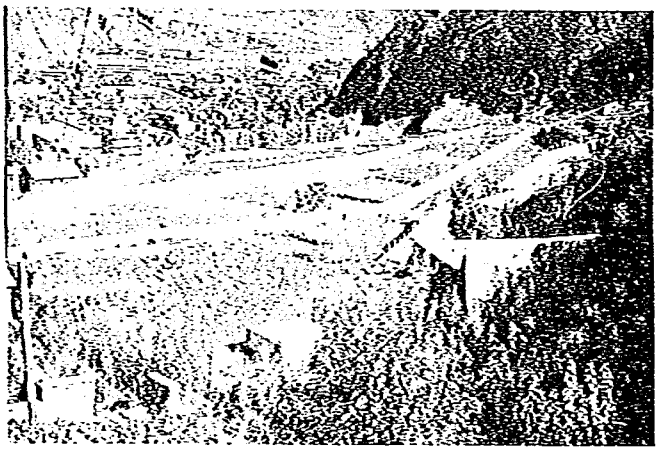


Fig. 3

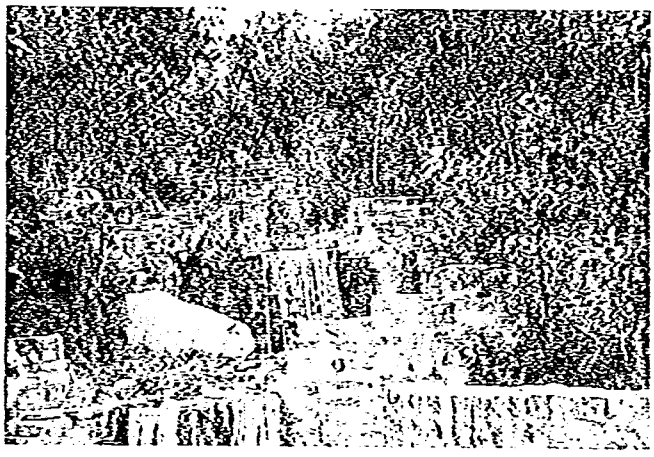


Fig. 4

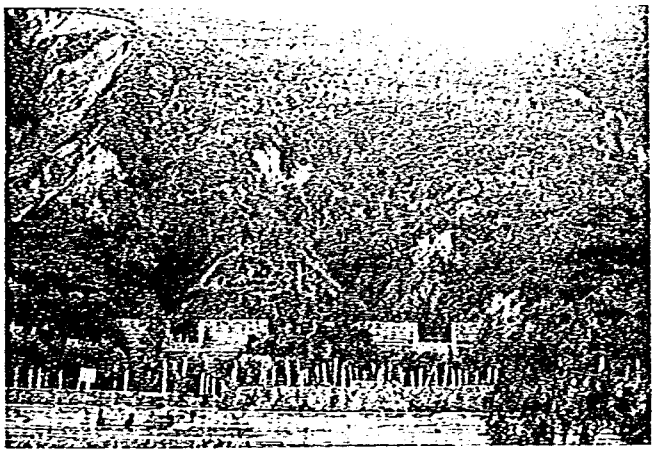
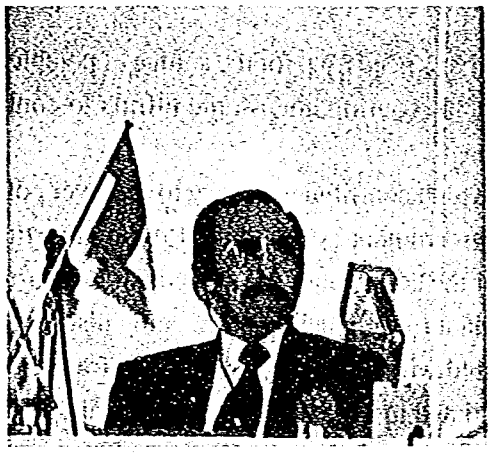


Fig. 5

II. National Plans, Conception or Laws for Improvement of Infrastructure for a Better Environment, also Public Works Research & Development to support them.

. The comprehensive plan of Zhujiang River Basin is an excellent example of combining natural resources exploitation with environment preservation in a big basin. Zhujiang River is the biggest river in South China, with a basin area of 442,000 km² within the boundaries of China. The mouth area of Zhujiang River is one of the most developed areas in China. The comprehensive plan includes flood prevention, water nagivation, irrigation, water supply, power generation, water and soil conservation, water quality preservation, river mouth renovation, etc., and proposes a series of key projects. For the flood prevention of the important cities such as Guangzhou, Nanning, etc. and key river channels in the basin, the plan gives the floods prevention standards, presents the countermeasures against the floods and selects several key water conservancy projects. This plan was approved by The State Council of China in May 23, 1993 and it provides a basis for the future natural resources exploitation, environment preservation and flood prevention in the basin.

Water Pollution Control Project



Mr. Soedarmanto Darmonegoro, Secretary,
Agency for Research and Development,
Ministry of Public Works, Indonesia

I. Introduction of the Project for a Better Environment

The last twenty years have seen a steady industrial growth in Indonesia. Industrial clusters in major cities of the country especially on Java islands such as Jakarta, Surabaya, Bandung, Semarang have been mushrooming. Consequently, major rivers in those cities become heavily polluted.

A study on industrial wastewater problems confirmed the pressing need for strengthening the control of industrial wastewater discharge to alleviate existing pollution in several major rivers in Java.
The study estimated that a total investment of $22,282 million would be required over the ten-year period from 1991 to 2000 for the construction of wastewater treatment facilities for about 9,473 pollutive industries in Java.

Of this total investment, $1,384 million would be needed for the construction of about 22 Centralized Wastewater Collection and Treatment Schemes (CWCTS) to serve 7,579 industries, $198 million for pre treatment facilities required for the construction of about 1,894 Industrial Wastewater Collection and Treatment Schemes (IWCTS) for industries not being covered by CWCTS.

1. Objectives

The objectives of the project are to:

(i) test and evaluate the viability of the CWCTS approach;
(ii) prepare priority projects for investment in industrial wastewater control; and
(iii) strengthen capabilities of the agencies concerned in various aspects of industrial wastewater control.

2. Outline

The Citarum River near Bandung has been polluted by both domestic as well as industrial wastewater. Approximately five million people live along the catchment area and around 300 industries with potential pollution since most of them do not have water treatment plant.

The effects of pollution from the Citarum River have been felt as many cases aroused like plenty of fish dying, the polluted of raw water and public groundwater wells.

Having in mind that the Citarum River serves people's needs, eg. for the source of potable water, irrigation, fishing, hydro-power, industry, recreation and scouring, then some efforts to control the pollution becomes imperative.

In South Bandung there are about 80 industries which contributes greatly to the river pollution. In 1982 initial effort was started in which the Local Government assigned the Research Institute for Water Resources in cooperation with industries. Under the cooperation all the industries' wastewater discharge were to be collectively aligned into a pilot plant for treatment before being discharged into the river. Since then, construction of culverts was started with financial contribution from industries side. Meanwhile, the construction of pilot plant was initiated in 1985/1986 with financial contribution from the Ministry of Public Works and State Ministry for Population and Environment.

3. Problem of Technical Issues

Most of the culverts constructed since 1982 have damaged in various places and need improvement qualitatively. Cooperation from industries played an important role.

However, earlier survey (1986) on wastewater discharge of each industry requiring the plant to treat 100 liter/second, but the second survey (1990) indicated the change of the design because they gave the more factual data. It should then be able to treat 160 liter/second, and is expected to expand to 230 liter/second in the year 2000.

Other problem is how much contribution should the industries pay and take part.

4. Effects for a Better Environment

When this project is operational in 1995, it is expected that this prototype plant could be applied in other part of Indonesia.

This cluster system which is affordable to the industries would help realise the Government's Clean River Program, badly needed by all living beings.

II. National Plans, Conception or Laws.

In July 1989 the State Minister for Population and Environment launched a National Campaign called Clean River Program (PROKASIH) which was intended to clean up rivers already heavily polluted. The program was first of all directed to clean the river from industrial wastewater, better known as B3 (Bahan Berbahaya Beracun or Disastrous and Poisonous Matters). Other sources of pollution such as domestic, agriculture and mudding wastewater (as a result of erosion) are not included in this program.

The first implementation of the program covered eight provinces, four in Java, three in Sumatera and one in Kalimantan. Following the evaluation of the program in September 1991, another 11 province would be included in the implementation program for 1991/1992.

Two Government Rulings with regard to Environmental Impact Analyses (PP No. 29/1986) and Water Pollution Control (PP No. 20/1990) have been issued by the Government. Both rulings clearly deal with the issues of environment and pollution which are getting popular along with the dynamics of industrial growth in Indonesia. In order to achieve these, the Government has established among others an Agency for Environmental Impact Control or BAPPEDAL and conducted an Environmental Impact Analysis (AMDAL) courses both in Jakarta and other provinces in Indonesia.

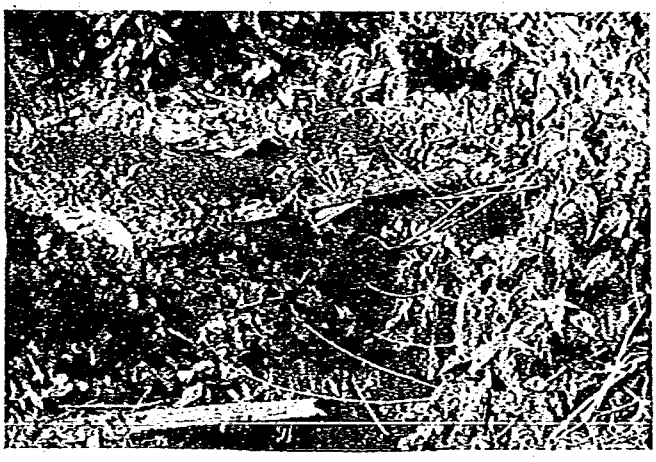


Fig. 1

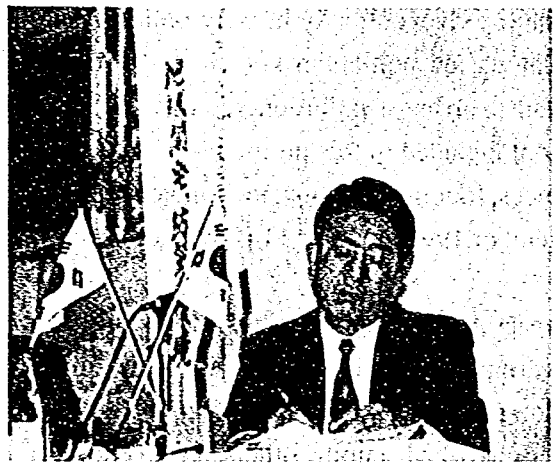


Fig. 2



Fig. 3

Regional Flood Frequency Analysis for the Major Korean Rivers



Dr. Keung Hwan Kim, Director,
Planning & Coordination Division,
Korea Institute of Construction Technology,
Korea

I. Introduction of the Project for a Better Environment

1. Objective

To establish a procedure and to analyze regional flood frequency for the major Korean rivers.

2. Outline

(a) Procedure is established for flood frequency analysis of annual maximum series data with consideration of screen of the data, identification of homogeneous regions and choice of a regional frequency distributions.

(b) Random samples from traditionally used distributions, which parameters are estimated by the traditional moment method, show the condition of separation of skewness. However, random samples from recently introduced "thick tailed" distributions with the L-moment method do not display the condition of separation. For Korean rivers, the index flood procedure with the general extreme value distribution and parameters estimated by the L-moment method could be appropriate for regional flood frequency analysis.

(c) There are about 6,000 station-years of daily river-stage records available for analysis. Among them, only one thirds can be converted into usable discharge records because of insufficient discharge measurements. Results of preliminary analysis indicate that Korean rivers could be classified into three groups in consideration of characteristics of regional flood frequencies, and quantiles estimated are about 3.0 for 100 years of return period and 2.5 for 50 years of return period.

3. Problems of Technical Issues

Although a robust result can be obtained from the project, implementation of the result would be a difficult process. Because, significant differences, which exist in design floods estimated by the old method and the new method, should be fixed by somehow.

4. Efects for a Better Environment

Since robust design floods can be estimated as a results of this project, a robust management of water resources would be possible. Under the global climate change circumstances, the robust design method, especially from outliers of data, would become one of the necessary tools to overcome the circumstances.

OUTLINE OF THIS RESEARCH PROJECT

- O Distribution Function with 3 or More Parameters
  - Conventional: EV1, 2, 3, LN2, 3, P3, LP3
  - This Project: GEV, Wakkeby, Pareto, GL
- O Parameter Estimation
  - Conventional: Ordinary Moment Method, Max. Likelyhood Method
  - This Project: Probability Weighted Moment Method (Linear Moment)
- O Frequency Analysis
  - Conventional: Point
  - This Project: Region

PRELIMINARY RESULTS

- O Increase Reliability of Flood Estimation for a Site with Insufficient Length of Measured Records.

DISASTER DAMAGE ASSESSMENT AND REHABILITATION PLAN IN KOREA.

PRINCIPLE

- O Restrict National Financial Aids at a Certain level.
  - Reduce National Financial Burden
  - Not to Weaken the Disaster Mitigation Efforts of the Local Governments and the Individuals

II. Damage Assessment and Rehabilitation Plan in Korea

The National Disaster Prevention and Countermeasures Headquarters sets up a guideline every year in order to support the local authorities in assessing damages at the national level so that informed estimates can be properly evaluated. When a disaster occurs, total damage is estimated by the relevant local government personnel in accordance with the guideline. The local government takes responsibility for disasters with relatively light casualties. In the case of the disaster with a serious damage, the national government takes part in the field survey for the restoration plan after the emergency actions are taken.

The field survey team, teamed with technical staffs from concerning ministries, finalizes damage assessments and sets up a restoration plan for each of the damaged area. After the survey completed, the costs needed to carry out the plan will be shared in accordance with the codes.

10 Year Programme on Cleaning Up of Klang River



Mr. Teh Siew Keat, Director of River Engineering,
Department of Irrigation and Drainage,
Ministry of Agriculture, Malaysia

I. Introduction of the Project for a Better Environment

1. Objectives

The objectives of the 10 years programme on cleaning up of Klang River which flows through the capital city of Kuala Lumpur are as follows:

- To clean up the Klang River and its major tributaries from rubbish and silt
- To improve the water quality of the Klang River and its major tributaries to a minimum of Class III standard (require extensive treatment if use for water supply and suitable for recreational use without body contact)
- To beautify the riverine environment with the view to upgrade recreational facilities especially within the city / town areas

2. Outline

The main sources of pollution are identified as follows:

- Riverine squatters – About 2,600 families living illegally along the river use the rivers/ treams as rubbish dumps and open sewers
- Land development – Housing development to meet the needs of increasing population and agriculture have contributed large amount of silt in the Klang River
- Unsewered premises – About 40% of all the premises in the whole basin are still unsewered, which has contributed to the high ammoniacal-nitrogen content in the river
- Factories – Factories especially the illegal ones are responsible for the discharge of oil, chemicals, toxic wastes etc. into the rivers
- Animal farms – 11 pig farms are contributing to the high ammoniacal nitrogen content in the river

In line with its commitment and aspiration to conserve the environment and to improve the urban living

surrounding, the Government has embarked on a 10-year programme to clean up the Klang River in 1992. The concept of this programme is based on an action plan with specific sub-programmes to clean, upgrade the channel capacity of the rivers and establish it as new recreational areas for the residents of the Klang Valley. There are a total of eight (8) sub-programmes being established, each to be implemented by different agencies and coordinated by a working committee. The sub-programmes are listed as below:

a) Cleaning of Klang River
b) Desilting
c) Beautification
d) Resettlement of squatters
e) Pig-waste treatment
f) Rehabilitation of fish life
g) Public education
h) Water pollution control

In Malaysia, the rivers are being looked after by various governmental departments/agencies in their own respective fields and responsibilities. The implementation of the program is based on a concerted, integrated and coordinated approach through an action plan with the participation and commitment of various ministries, departments, local authorities and the Selangor State Government.

3. Problems of Technical Issues

Limited river reserve and insufficient headroom for machinery below bridges always pose problems in the operation and maintenance works for the desilting of urban rivers.

4. Effects for a Better Environment

By the end of the programme in the year 2001, the river environment of Klang River will be greatly improved and the following effects are expected:

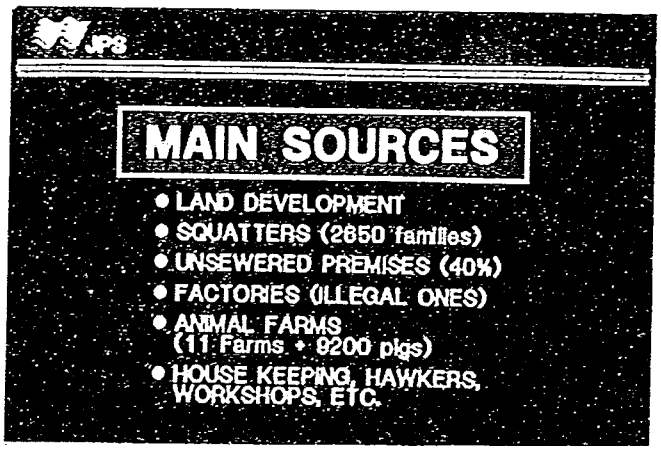


Fig. 1

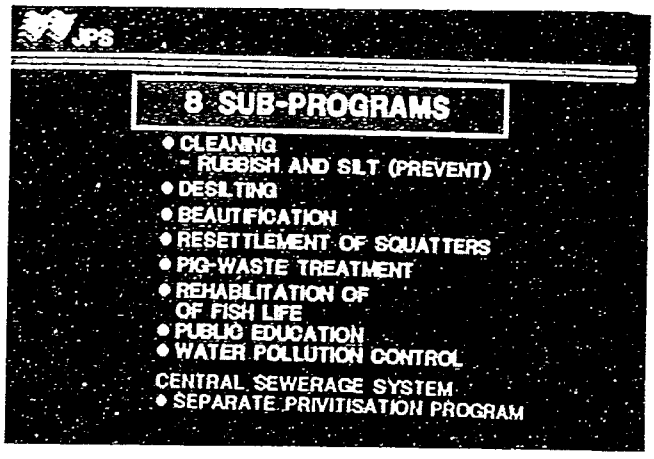


Fig. 2

a) Major portion of the pollution sources that were identified can be eliminated
b) River water quality could be improved to Class III.
c) More species of aquatic life could be found in the watercourses.
d) Riverbanks formerly cluttered with squatter premises and backyard trades can be transformed into beautiful walkways and landscaped parks.
e) The watercourses can be used for recreation like boating, canoeing, fishing, etc.


o clean
ip our rivers
A. Sahibullah

Fig. 3

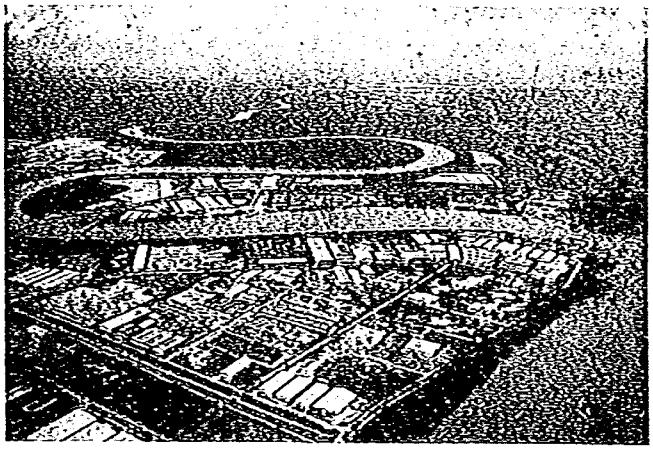


Fig. 4



Fig. 5

II. National Plans, Conception or Laws for Improvement of Infrastructure for a Better Environment, also Public Works Research & Development to support them.

Similar cleaning programme will be extended to other important rivers especially those passing through urban areas like Penang River, Temiang River and Malacca River. This effort will enhance the river environment and improve the living condition for the people.

South Luzon Expressway Extention Project



Mr. Jose H. Espiritu, Director, Bureau of Research and Standards, Department of Public Works and Highways, Philippines

I. Introduction of the Project for a Better Environment

● NAME OF PROJECT	:	South Luzon Expressway Extension (SLEE) project Sto. Tomas – Batangas City, Batangas
mplementing Office	:	Department of Public Works and Highways
Project Amount	:	P 1.707 Billion
Source of Funding	:	Overseas Economic Cooperation Fund (OECF) of Japan 16th Yen Credit Loan Agreement No. PH-P103
Length	:	47.746 km.

1. Objectives

- To improve infrastructure in the transport sector in order to support the national and regional economics, growth and development, and
- To predict and assess environmental impacts, propose countermeasures, environmental management and monitoring plan.

2. Outline

The following are measure on the protection of physical environment to minimize the adverse effects and to help speed recovery of the disturbed areas not only within the right-of-way, but also on adjacent land that may be affected:

SOIL EROSION and SLOPE PROTECTION

a. VEGETATION – Ground cover will be maintained, temporarily devegetated areas will be mulched and reseeded or sodded.

b. SLOPE PROTECTION – Soil removed during excavation will be minimized and stabilized by the use of vegetation cover, contouring and provision of drainage structures.
c. STREAM PROTECTION – Riprap or gabion baskets will be used to stabilize banks in areas subject to scouring.
d. DRAINAGE – Drainage structures including ditches, culverts, pipe drains will be installed to divert and disperse surface water flows in a matter to prevent erosion and to protect slopes. It will be periodically maintained to remove and ensure their proper functioning.
e. AIR QUALITY – Exposed surfaces will be melted or sprayed. Stored soils or borrow materials will be stabilized to minimized dusts.

HYDROLOGY

Different elements involved in SLEE project has no direct impact in the quality of both surface and underground waters. There could be some indirect impact due to anticipated industrial and commercial urban growth along the corridor of the expressway.

AIR QUALITY

Air will be temporarily affected by fugitive dust as a result of the construction activities. Stored materials and truck hauling materials will be covered.

NOISE POLLUTION

Reductions of the undesirable effects of expressway-generated noise involves a comprehensive approach which includes vehicle, noise reduction, improved expressway design and land-use control.

MATERIALS

Most of the material sources investigated are existing quarries at hillside or mountainsides.

FLOODING

Drainage structures will be lined and will employ energy disipators at discharge points to avoid erosion. Drainage facilities will be periodically maintained. Box culverts were based on flood discharge data for the last 50 years.

WASTE DISPOSAL

The contractor will develop and implement a solid waste management plan for the duration of the construction activity. Dumping site should be carefully selected to protect streams and vegetation. Environmentally hazardous materials should be stored in designated areas which have been improved to accept such storage.

3. Problems of Technical Issues

Construction of SLEE may cause some environmental problems. The high economic growth envisioned cannot be sustained without having the simultaneous proper management of the environment. The accelerated urbanization will put additional stress on the limited ground water resources. Over-pumping of ground water may result in salt-water intrusion unless alternate source of water are introduced. Drainage due to the increased urbanization will also utilize the river system as receiving water of industrial effluent and domestic waste. These anticipated indirect impacts require proper management in the urban planning of the area.

4. Effects for a Better Environment

The project has its high urbanization impact and will accelerate the development potential in the area specially in the industrial sector and will trigger the economic growth through the increase of trade between Metro Manila and the southern part of Luzon. It is hoped likewise that strict compliance and concern for the above will improve the condition of the following:

PHYSICAL ENVIRONMENT

1. Slope, vegetation and stream will be well protected.
2. Air quality will be improved.
3. Noise pollution will be minimized.
4. Ecosystems will be protected since it does not transverse or locate within the impact area of the SLEE.
5. Floods will be minimized minimized, through installation of drainage structures and ensure their proper functioning.
6. Waste will be disposed at designated areas during the duration of the construction activity.

SOCIO-ECONOMIC IMPACT

1. It will promote land-use and settlement.
2. It will generate employment and income.
3. Public services will improve.
4. Heavy traffic demand can be accommodated.
5. It will promote tourism, through preservation of archeological and historical sites.
6. It will provide linkage to the Batangas port which would eventually serve the transportation facilities requirement of the CALABARZON Program.

II. National Plans, Conception or Laws for Improvement of Infrastructure for a Better environment, also Public Works Research and Development to support them.

The Department of Environment and Natural Resources (DENR) initiated in 1987 the process of formulating a Philippine Strategy for Sustainable Development (PSSD).

After a series of consultations with different sectors of society, the concept, form and substance of the PSSD was presented to the central government on June 22, 1989. The Conceptual Framework of the PSSD was eventually approved on November 29, 1989.

As an offshoot to the DENR's efforts, the President of the Philippines issued on September 1, 1992, Executive Order No. 15 creating the Philippine Council for Sustainable Development. The Order sets the direction of a National Conservation Strategy as spelled out in the PSSD which was adopted in 1989. Likewise, it also oblige the Philippine government to translate its commitment adhering to the principle of sustainable development when it actively participated in the United Nations Conference on Environment and Development (UNCED) Summit held in Rio de Janeiro, which came out with the Rio Declaration, the Agenda 21, the Convention on Climate Change and Biodiversity.

NATIONAL PLANS, CONCEPTION OR LAWS FOR IMPROVEMENT OF INFRASTRUCTURE FOR A BETTER ENVIRONMENT, ALSO PUBLIC WORKS RESEARCH AND DEVELOPMENT TO SUPPORT THEM

★ Philippine Strategy for Sustainable Development (PSSD)
  - initiated in 1987 by the Department of Environment and Natural Resources and eventually approved by the central government on November 29, 1989

★ Philippine Council for Sustainable Development
  - created by the President of the Philippines through Executive Order No. 15 issued on September 1, 1992

★ active participation of the Philippine government in the United Nations Conference On Environment And Development (UNCED) Summit held in Rio de Janeiro, which came out with the Rio Declaration, the Agenda 21, the Convention On Climate Change And Biodiversity

★ various environment-related laws, proclamations and Executive Orders enacted:
  1. P.D. No. 856 (Dec. 23, 1975) – Establishing the Sanitation Code of the Philippines
  2. P.D. No. 1121 (Apr. 18, 1977) – Creation of the National Environmental Protection Council
  3. P.D. No. 1151 (June 6, 1977) – Formulation of the Philippine Environmental Policy
  4. P.D. No. 1152 (June 6, 1977) – Formulation of the Philippine Environmental Code
  5. P.D. No. 1586 (Dec. 14, 1981) – Establishing an Environmental Impact Statement System including other environmental management-related measures and for other purposes
  6. Proclamation No. 2146 (Dec. 14, 1981) – Proclaiming certain areas and types of projects as environmentally critical and within the scope of the Environmental Impact Statement System established under P.D. No. 1586
  7. DENR Administrative Order No. 21 (Series of 1992) – amending Revised Rules and Regulations implementing P.D. No. 1586 (Environmental Impact Statement System)

★ THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS IN RESPONSE, AMENDED ITS MINISTRY ORDER NO. 72 (SEPT. 24, 1982) – DPWH Guidelines on the Rules and Regulations Implementing P.D. No. 1586 in relation to P.D. No. 1151 and Proclamation No. 2146

Singapore Underground Road System



Mr. Khor Poh Hwa, Chief Civil Engineer,
Public Works Department,
Ministry of National Development, Singapore

I. Introduction of the Project for a Better Environment

1. Objectives

The proposed underground road network aims to:

Increase the road capacity by a minimum of 40% in the study area and relieve traffic congestion. No more than 20% of the roads in the traffic model network area will have a level of service less than D.

Minimise visual intrusion, noise and traffic emissions whist achieving the increase in road capacity.

Minimise the impact of the underground network on existing buildings of historic or architectural merit, and on existing surface routes, parks and communities.

2. Outline

A goal of the Underground Road System is to complement Singapore's strategic planning policies and be generally supportive of the urban design for a "tropical city of excellence". The lelvel of adverse impacts on the built environment and natural systems associated with the underground roads must be of an acceptable level. The issues examined include impacts to:

National Monuments
Conservation Areas
Land Use
Visual Quality
Air Quality
Noise/Vibration Impacts

3. Problems of Technical Issues

(1) As no national monuments are to be demolished, this requirement is considered a hard constraint in the design. Some proposed national monuments that are located close to or over the underground road networks require underpinning during construction. Underpinning of a national monument is considered a major impact. Some national monuments may require other levels of protection during construction such as compaction grouting, bracing or ground improvements.

(2) All buildings located within the boundary of a conservation area are to be preserved. For all such conservation areas, it is proposed to:

preserve as much as possible each area's architecture and ambience;
improve the physical environment by providing pedestrian walkways, plazas, landscaping and control of signages;
enhance the character of each area by introducing new activities while sustaining the old traditional activities of tourist value and
provide guidelines for the private sector to be actively involved in the conservation effort.

(3) The compatibility of the effects of the underground road system on the land use plans for 2000 and 2030 is an important element. The underground road system provides improvements in access in the study area and supports on-going development plans. It will create joint development and air right development opportunities.

The underground road system is basically located under existing roadways, thus improved vehicular access in the study area is provided with minimal impacts to surface land use plans, both existing and future. In cases where the underground roads do not follow the existing roads, the tunnels can be designed to accommodate future loads of new development thus valuable space in land-scare Singapore can be optimised.

Possible land use impacts are generally associated with the following surface elements of the tunnels:

Portals
Ventilation buildings
Electrical substations

Ventilation buildings can be combined with new developments to minimise the land use and visual impacts.

4. Effects for a Better Environment

(1) Visual Quality

Project elements associated with the underground roads that will change the character of the visualenvironment and alter the aesthetic experience for motorists, pedestrians and residents include:

Portals and ramps
Ventilation buildings
Electrical substations

Special attention will be given to the design and architecture of the above elements including form, structural materials, colours, textures, landscape and incorporation of complementary uses to enhance the overall visual effects of these elements.

(2) Air Quality

Air quality impacts of the underground road networks are caused by the emissions of vehicular traffic.

The underground road network will significantly reduce (by 4%) the areawide amount of carbon monoxide emissions generated within the project area compared to emissions generated under the base case. This reduction is achieved by changes in traffic patterns and equals to an approximate 40,000 kg per day reduction in CO emissions (or approximately 14,000 tones per year). The local analysis includes an estimate of the air quality impacts of each exit portal and ventilation building on surrounding sensitive land uses, referred to a receptors. Sensitive land uses for the portal point source analysis include hospitals, residences, churches, parks and heavily pedestrianised areas where the air quality impacts of vehicular emissions would be most readily noticed. For the ventilation buildings analysis, the critical receptor is the nearest building of equivalent height to the ventilation building exhaust stacks.

Some measures to reduce the potential air quality impacts include:

- The release point of ventilation building exhaust stacks can be raised to reduce air quality impacts on surrounding receptors
- The ventilation building exhaust ducts coming out of a single vent structure could be at different heights to minimise impacts at any single receptor
- exit portals can be relocated along the right-of-way so as to minimise impacts on heavily congested public areas
- future development immediately surrounding exit portals can be designed to minimise air quality impacts

(3) Noise and Vibration

The noise issues are temporary construction impacts and long term operational impacts of traffic entering and exiting portals, noise resulting from the operation of the ventilation buildings; and noise on surface roadways.

Ground vibration issues are usually of relevance during the construction phase.

Noise mitigation will be required at portals. The measures include:

Extensive noise barriers or vegetal screens
Sound reducing pavement surfaces on portal ramps
Portals extended or moved away from sensitive areas
Enclosure over ramps

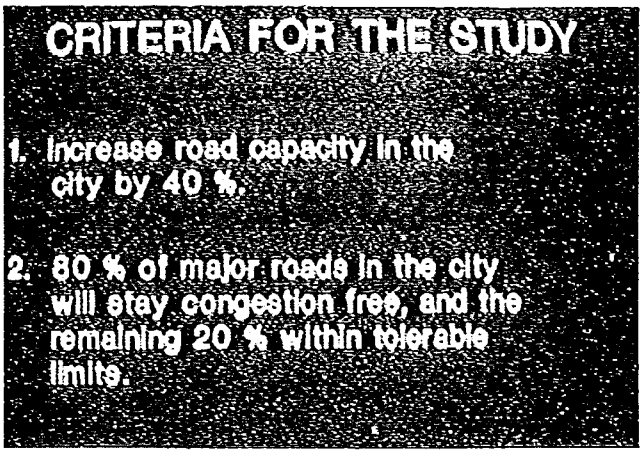


Fig. 1

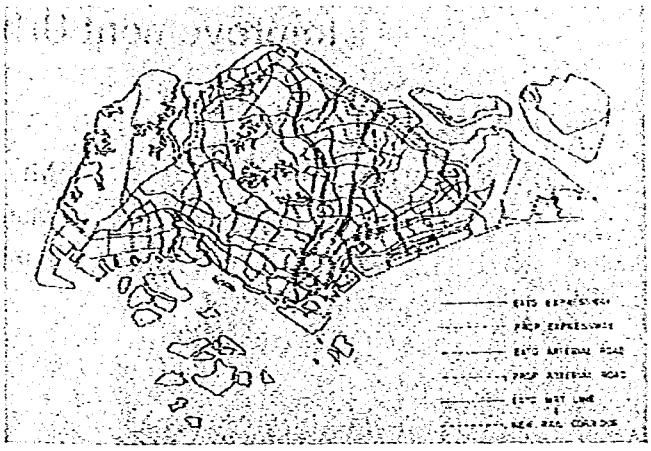


Fig. 2

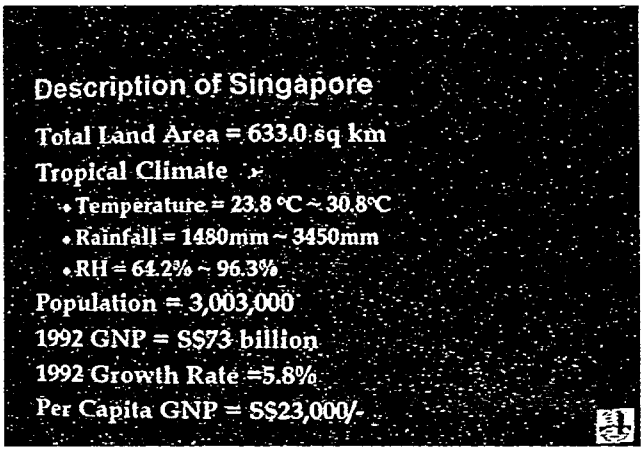


Fig. 3

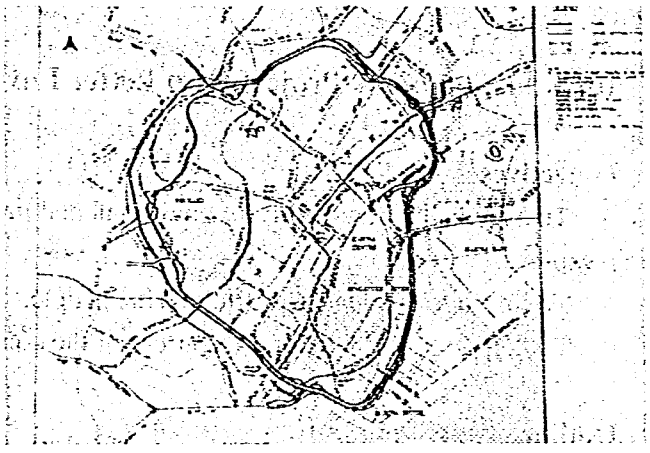


Fig. 4

II. National Plans, Conception or Laws for Improvement of Infrastructure for a better environment, also Public Works Research & Development to support them

The Green Plan

The Singapore Green Plan which has been developed by the Ministry of the Environment charts the strategic directions of balancing development and environment. It describes the policy directions Singapore will take towards realisation of the long term vision of a model green city. The Green Plan looks at all areas of environmental concern and describes what the Government has done for the environment and what it proposes to do to preserve, protect and enhance the environment for the future.

The Green Plan will guide Singapore towards a model Green City by the year 2000. It will be a city with high standards of public health and a quality environment.

Improvement Urban Air Quality



Mr. Anusomant Mahavinichaimontri, Director of Materials and Research Division, Department of Public Works, Ministry of Interior, Thailand

I. Introduction of the Project for a Better Environment

1. Objectives

– To establish a framework for environmental improvement and sustainable use of natural resources.
– To improve the quality of life of Thai people.
– To help protect the natural resources of the country for the benefit of future generations.

2. Outline

Air quality in Thailand's urban and industrial areas has deteriorated as a result of the concentration of energy-intensive activities, such as power generation, transportation and manufacturing. The Bangkok Metropolitan Region (BMR) alone contains almost 75 percent of the country's manufacturing industries and accounts for 58 percent of Thailand's total energy consumption. The city therefore faces air pollution problems typical of many other cities of the developing world.

The pollutants of concern are those resulting from the combustion of fuels: sulphur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), smoke and suspended particulate matter (SPM), and lead from vehicle engines. Prolonged exposure to high concentrations of these pollutants may cause problems for human health, such as irritation of the respiratory tract. National Ambient Air Quality standards (NAAQ) were established in 1981 and are updated and monitored by the Office of the National Environment Board (ONEB). Measurements of air quality taken in 1989 near major streets in Bangkok and compared with the NAAQ standards showed that, in most cases, concentrations of the pollutants measured (CO, lead and SPM) did not exceed the standard.

However the range of concentrations was quite wide and indicated that occasional breaches of the standards do occur, particularly in the case of suspended particulate matter.

3. Problems of Technical Issues

Air Pollution From Transport

Transport, as the largest consumer of energy, accounts for much of the air pollution problems seen in Thailand's cities. Some 51 percent of the total energy consumed by transport in 1990 was used in the Bangkok Metropolitan Area (BMA; the inner area of the BMR) alone. About 75 percent of the 1990 energy consumption by transport is attributable to land transport, the rest being accounted for by water and air transport. The energy consumption of land transport is made up almost entirely from road transport; rail transport consumes less than 1 percent of the energy used by transport. The number of vehicles in Bangkok has soared, from 600,000 in 1980 to 2.3 million in 1990.

Figure 1. shows the breakdown of energy consumption in the transport sector by fuel type. Diesel and gasoline are the most important fuels.

The main pollutants from the transport sector are lead, carbon monoxide, nitrogen oxides, hydrocarbons and smoke resulting from incomplete combustion in diesel and two stroke motorcycle engines. Transport is the single largest contributor of NO_x emissions (64 percent of total NO_x emissions), carbon monoxide (87 percent of the total) and hydrocarbons (41 percent of the total). Most of the atmospheric lead in Bangkok is due to the use of leaded fuel in vehicle engines. The transport sector contributes less to the total concentrations of SO_2 and SPM than industry or power generation.

Measures to mitigate air pollution problems caused by the transport sector should therefrom be aimed not only at exhaust emission controls but also at improvement of fuel and engine specifications and the improvement of the road network to maintain traffic flow.

Air Pollution from Industry

All manufacturing and production processes consume energy. Many industrial plants have their own boilers or generators on site which are direct consumers of fossil fuels. Figure 2. shows the fuel breakdown for the manufacturing sector. Biomass fuels and petroleum products are the principal sources of fuel; it can also be seen that in some 18 percent of manufacturing plants energy demand is met by purchasing electricity from the national grid.

Manufacturing alone accounts for 21 percent of total SO_2 emissions, 12 percent of NO_x emissions and 56 percent of SPM emissions (for which industry is the largest emitter of the three sectors). These figures do not include industry's indirect contribution to air pollution through its purchase of generated power. The industries which make the largest contribution to air pollution are the non-metallic mineral industries (e.g. cement manufacture, glass and ceramics) and food processing.

Air Pollution from Electricity Generation

The power sector emits 56 percent of the country's total SO_2 emissions and 16 percent of total NO_x emissions, but relatively small quantities of other pollutants. At present the principal fuels used in the generation of electricity are natural gas (40%), fuel oil (29%), and light (22%). Coal and lignite are expected to become much more significant fuel sources in electricity generation, as a result of the policy to make more use of domestic sources of energy. The proportion of coal and lignite used in power stations is estimated to rise from 22 percent in 1990 to 66 percent in 2006. Clearly, this fuel switch could have major implications for the quantities of pollutants emitted to the atmosphere.

4. Effects for a Better Environment

The high concentration of energy-intensive activities in bangkok and a small number of other cities in Thailand has created air pollution problems which are typical of such places. The Thai Government is committed to a comprehensive program of measures in the transport sector designed to reduce the environmental impact of vehicle movements. For the industrial and power sectors, the sulfur content of fuel oil is being reduced, emission standards will be introduced shortly for all industries, and restrictions have been introduced on the sitting of polluting industries in the BMA and other densely populated areas. Energy policy is being reviewed a number of measures to reduce demand for electricity and encourage the more efficient use of electricity are being introduced.

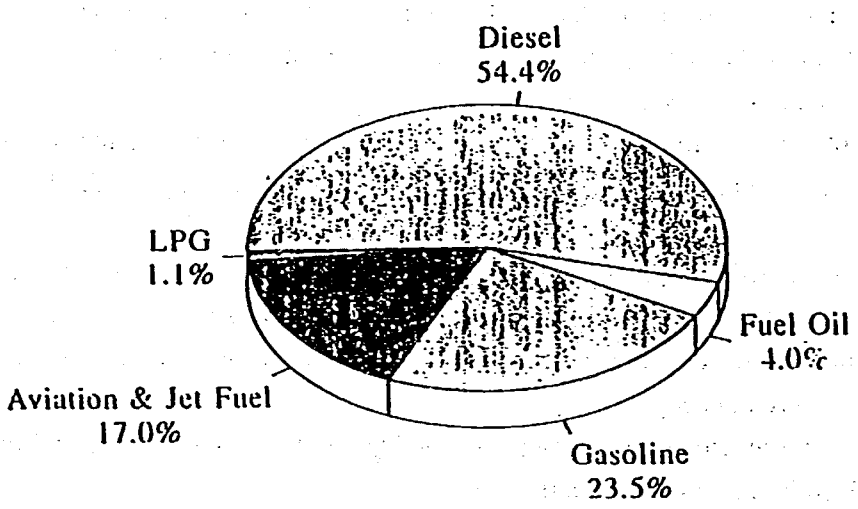


Fig. 1 Energy Consumption for the Transport Sector, 1990

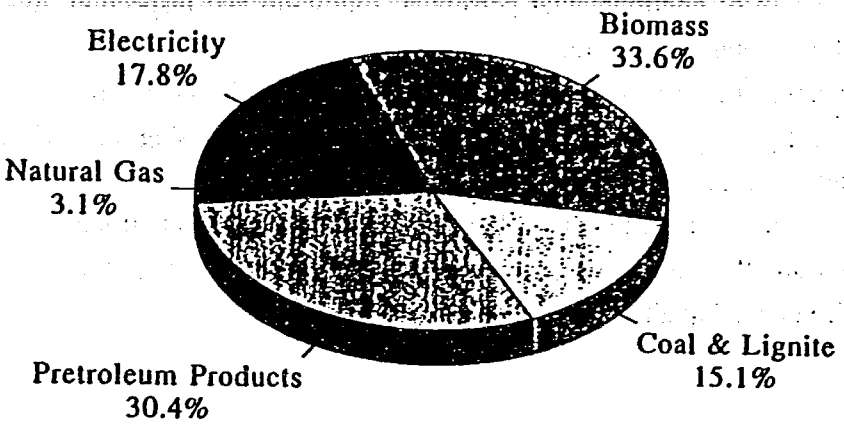


Fig. 2 Energy Consumption for the Manufacturing Sector, 1990

II. National Plans, Conception or Laws for Improvement of Infrastructure for a Better Environment. & Also Public Works Research & Development to Support them.

The National Plans and Conception to enhance of the infrastructure for a better environment and one of the most outstanding project regarding the Government's Sixth national Economic and Social Development plan are elaborated as follows:

(1) To clarify the plan for environmental development, and to make it more effective in practice, the guidelines for developing the environment during the Sixth Plan comprise the following 4 main principles:

(1.1) Environmental development should support create economic development as far as possible.

(1.2) A system should be created that will link the economic and social development plan with the environmental development plan, besides coordinating the government, private sector, local organizations and people.

(1.3) To ensure more effective implementation, guidelines for developing the environment should be defined in the form of operational plans.

(1.4) Preventive measures that anticipate environmental, problems should be emphasized, rather than waiting for the problems to arise before taking action.

(2) Policies on developing the environment during the Sixth Plan period will consist of the following:

(2.1) Coordinate the environmental development plan with economic development as a whole.

(2.2) Plan and manage the environment by geographical area: For example, plans will be formulated for defining categories of river basin quality, managing the environment on the Eastern Seaboard and in Songkhla Lake Basin, and so on.

(2.3) Amend laws, rules and regulation on the environment to make them more suitable and supportive of economic development in various sectors.

(2.4) Improve the basic administrative structure for environmental work, including organizations, production of environmental personnel, follow-up and inspection, research studies and environmental information systems.

(2.5) Encourage the use of modern technology which allows natural resources to be used efficiently and without damaging the environment or causing the environment or causing pollution problems.

(2.6) Encourage a correct understanding and awareness of the environment among the private sector and the general public, who should participate in the promotion and protection of environmental quality as much as possible.

第２回
アジア地域土木研究所長等会議
会 議 録

平成６年３月

建設省土木研究所

序　　文

第２回アジア地域土木研究所長等会議（土木技術研究開発幹部セミナー）が、平成５年１１月１５日から２６日にわたり、つくば市の建設省土木研究所を中心として開催されました。この会議はアジア諸国の自然条件や社会･経済条件にあった土木技術を生み出しかつ各国の天然資源、人的資源の活用を図るため、土木技術研究開発面からアジア諸国間の技術交流を進めることにあり、初回が平成４年度に発足したものであります。この会議には我が国と政治、経済、文化等の多くの面で深い関係にある中国、インドネシア、韓国、マレーシア、フィリピン、シンガポール及びタイの７ヶ国より会議の主旨にふさわしいそれぞれの国の土木技術研究開発に係わる責任ある地位にある７名の方々が参加下さいました。

本会議ではそれぞれの国が抱える土木技術研究開発の課題等について、基調講演、カントリー報告、「災害および防災」と「環境と社会資本整備の調和」をテーマとした特定課題討論、及び個別の土木技術専門分野に分かれた討論を通じ、お互いの理解を深めることができました。そして最終討論では、各国の一層の社会基盤整備のために関係国の蓄積された経験と研究成果の共有の重要性を認め、この会議の有効さと継続発展が重要であることについて、参加者全員の意見一致を見ました。今後、土木技術研究開発分野におけるアジア地域諸国間の本格的国際交流として、その発展が内外より期待されております。

また、会議中に行われた四国･中国、九州、関東地域での視察旅行を通じ、海外参加者に対し日本の代表的な社会基盤整備状況について理解を深めていただくことができました。特に本会議の一環として、土木研究所と九州地方建設局の主催により「第２回アジアにおける国土開発と土木技術に関する国際シンポジウム」を産・官・学の各界より約２００名の参加を得て開催し、相互の研究情報の交換や日本のアジア諸国に対する技術協力への一層の期待が表明されました。

本会議録は、第２回アジア地域土木研究所等会議に提出された参加各国からのカントリー報告書、討論のための資料、講演録、討議概要などをとりまとめたものです。貴重な海外情報として本会議の会議録を公表し、本会議の活動を広くお知らせすることはアジア地域の社会基盤整備の発展およびそのための技術開発の推進に大きく寄与するものと確信致します。

最後に、本会議の開催にあたり全面的な協力と支援を賜った関係各位に厚く御礼申し上げるとともに、本会議の活動をより発展させることにより皆様方の御期待に応えて参りたいと思っております。

第２回アジア地域土木研究所長等会議議長
建設省土木研究所長　住　吉　幸　彦

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中国科学院成都山地災害及び環境研究所長 呉 積善 Wu Jishan
インドネシア公共事業省研究開発庁次長 Soedarmanto Darmonegoro
韓国建設技術研究院企画調整室長 金 亘煥 Kim Keung Hwan
マレイシア農業省灌漑排水局河川部長 Teh Siew Keat
フィリピン公共事業道路省研究基準局長 Jose H. Espiritu
シンガポール国家開発省公共事業局土木技術担当課長 Khor Poh Hwa
タイ内務省公共事業局材料研究部長 Anusornant Mahavinichaimontri

（A）会議プログラム

Ⅰ．プ　ロ　グ　ラ　ム

Ⅰ．プログラム

１．会議の日程

11月 8日（月）	：来日	（つくば泊）
9日（火）～14日（日）	：JICAオリエンテーション、土木研究所見学	（　〃　）
15日（月）	：開会式	（　〃　）
	基調講演	
	建設省技監招待レセプション	
16日（火）	：カントリー報告	（　〃　）
17日（水）	：特定課題討論	（　〃　）
18日（木）	：分野別課題討論	（　〃　）
19日（金）	：プログラム調整会議「会議の将来計画」	（　〃　）
20日（土）	：視察旅行［移動（つくば→東京→高松→岡山）］	（岡 山 泊）
	瀬戸大橋	
21日（日）	：視察旅行［移動（岡山→福岡）］	（福 岡 泊）
	海の中道海浜公園、福岡タワー等	
22日（月）	：視察旅行	（　〃　）
	オリエンタル建設㈱福岡工場	
	第2回アジアにおける国土開発と土木技術に関する国際シンポジウム	
23日（火）	：視察旅行［移動（福岡→長崎）］	（長 崎 泊）
	吉野ヶ里、六角川改修・軟弱地盤対策、九州縦貫・横断自動車道	
	長崎市内	
24日（水）	：視察旅行［移動（長崎→東京→つくば）］	（つくば泊）
	雲仙防災	
25日（木）	：総合討議・結論採択	（　〃　）
	閉会式	
	国際協力事業団筑波インターナショナルセンター表敬訪問	
26日（金）	：［移動（つくば→東京）］	（東 京 泊）
	建設大臣表敬訪問	
	東京湾横断道路視察	
	建設省土木研究所長招待フェアウェルパーティー	
27日（土）	：帰国準備	（　〃　）
28日（日）	：帰国	

２．開会式

１．日　時　：　平成5年１１月１５日（月）１０：００～１０：５０

２．場　所　：　建設省土木研究所　８階会議室

３．式次第　：　（司会：　建設省土木研究所　企画部長　田村　正秀）

開会の辞

主催者挨拶	建設省土木研究所長	住吉　幸彦
来賓挨拶	建設省技監	藤井　治芳
	国際協力事業団筑波インターナショナルセンター所長	飯村　圭司
海外参加者挨拶	タイ内務省公共事業局材料研究部長 Anusornant Mahavinichaimontri	

日本側参加者の紹介

海外参加者の紹介

閉会の辞

記念撮影

3. 会議プログラム

第1日目　11月15日（月）：本会議

場　所：8階会議室
司　会：企画部長　田村 正秀

9:00～　受付
10:00～10:50　開会式
10:50～11:00　休憩
11:00～12:00　基調講演1「持続可能な開発のための土木技術者の役割」
日本海外コンサルタンツ㈱社長　濱守　厚

12:00～13:30　昼食

13:30～14:30　基調講演2「経済発展段階と建設技術の移転」
建設省土木研究所長　住吉　幸彦
14:30～14:40　休憩
14:40～15:40　基調講演3「日本における研究について　－土木工学を中心として－」
筑波大学構造工学系教授　椎貝　博美
15:40～15:50　休憩

15:50～16:30　（会議の進め方の打合せ）

17:00～18:00　移動

18:00～20:00　建設省技監招待レセプション（ホテル　サンルートつくば　Tel.0298-52-1151）

第2日目　11月16日（火）：本会議

場　所：8階国際会議室
議　長：所長　住吉 幸彦

9:20～ 9:30　第1回会議以降の活動報告
建設省土木研究所研究調整官　飯島　尚
9:30～10:10　カントリー報告（日本）
建設省土木研究所研究調整官　飯島　尚
10:10～10:50　カントリー報告（中国）
中国科学院成都山地災害及び環境研究所長　呉　積善　Wu Jishan
10:50～11:00　休憩
11:00～11:40　カントリー報告（インドネシア）
インドネシア公共事業省研究開発庁次長 Soedarmanto Darmonegoro
11:40～12:20　カントリー報告（韓国）
韓国建設技術研究院企画調整室長　金　亘煥　Kim Keung Hwan
12:20～13:20　昼食
13:20～14:00　カントリー報告（マレーシア）
マレーシア農業省灌漑排水局河川部長　Teh Siew Keat
14:00～14:40　カントリー報告（フィリピン）
フィリピン公共事業道路省研究基準局長　Jose H. Espiritu
14:40～14:50　休憩
14:50～15:30　カントリー報告（シンガポール）
シンガポール国家開発省公共事業局土木技術担当課長　Khor Poh Hwa
15:30～16:10　カントリー報告（タイ）
タイ内務省公共事業局材料研究部長　Anusornant Mahavinichaimontri
16:10～16:30　取りまとめ

第3日目　11月17日（水）：本会議　　場所：8階国際会議室

特定課題討論Ⅰ．「災害および防災に関する研究開発」

9:30～10:45　課題1「総合的な治水対策」
［議　長：建設省土木研究所河川部長　中尾　忠彦］
発表（日本）
建設省土木研究所河川部都市河川研究室長　栗城　稔
発表（韓国）
韓国建設技術研究院企画調整室長　金　亘煥　Kim Keung Hwan
発表（マレーシア）
マレーシア農業省灌漑排水局河川部長　Teh Siew Keat
討論及びまとめ

10:45～10:55　休憩

10:55～12:10　課題2「道路のり面災害対策」
［議　長：建設省土木研究所材料施工部長　池村　雅司］
発表（日本）
建設省土木研究所材料施工部土質研究室長　三木　博史
発表（中国）
中国科学院成都山地災害及び環境研究所長　呉　積善　Wu Jishan
発表（インドネシア）
インドネシア公共事業省研究開発庁次長　Soedarmanto Darmonegoro
討論及びまとめ

12:10～13:30　昼食

13:30～14:00　（議事録チェック）

特定課題討論Ⅱ．「環境と社会資本整備の調和に関する研究開発」
［議　長：建設省土木研究所環境部長　水谷　敏則］

14:00～15:15　課題1「ダム湖や河川の水質保全対策」
発表（日本）
建設省土木研究所環境部環境計画研究室長　丹羽　薫
発表（フィリピン）
フィリピン公共事業道路省研究基準局長　Jose H. Espiritu
発表（タイ）
タイ内務省公共事業局材料研究部長　Anusornant Mahavinichaimontri
討論及びまとめ

15:15～15:25　休憩

15:25～16:25　課題2「都市部における道路交通による大気汚染及び騒音への対策」
発表（日本）
建設省土木研究所環境部交通環境研究室長　石田　稔
発表（シンガポール）
シンガポール国家開発省公共事業局土木技術担当課長　Khor Poh Hwa
討論及びまとめ

18:00～20:00　国別夕食会（研修会館　Tel.0298-64-2844）

第4日目　11月18日（木）

9:30～12:00　分野別課題討論

（1）	土石流	（8F　会議室）
（2）	道路橋の材料－ｺﾝｸﾘｰﾄ－	（531会議室）
（3）	洪水防御	（532会議室）
（4）	河川緑地	（533会議室）
（5）	地下空間利用	（627会議室）
（6）	大気汚染対策	（526会議室）

12:00～13:30　昼食

13:30～14:00　（議事録チェック）

14:00～16:30　分野別課題討論

（1）	土石流	（8F　会議室）
（7）	舗装材料	（531会議室）
（8）	環境改善－下水道－	（532会議室）
（9）	河川環境の創造	（533会議室）
（10）	道路交通管理	（627会議室）

第5日目　11月19日（金）：本会議

場　所：8階国際会議室
議　長：所長　住吉　幸彦

10:30～12:00　プログラム調整会議「会議の将来計画」

12:00～13:30　昼食

13:30～14:00　（議事録チェック）

14:00～15:00　最終結論準備打合せ

15:00　移動（土木研究所→つくば第一ホテル：土研マイクロバス）

17:30　移動（つくば第一ホテル→土木研究所：土研マイクロバス）

18:00～20:00　会議終了パーティ（土木研究所1階会議室、Tel.0298-64-2211）

分野別課題討論スケジュール（11／18）

	中　国	インドネシア	韓　国	マレーシア	フィリピン	シンガポール	タ　イ	
9:30								
	（1）　8F会議室 土　石　流 （砂防研究室）	（2）　531 会議室 道路橋の材料 － コンクリート － （コンクリート研究室）	（3）　524 会議室 洪水防御 （河川研究室）	（4）　532 会議室 河川愛護 （都市河川研究室）	（1）　8F会議室 土　石　流 （砂防研究室）	（5）　627 会議室 地下空間利用 （トンネル研究室）	（6）　526 会議室 大気汚染対策 （交通環境研究室）	
12:00	12:00～13:30　昼食 13:30～14:00　議事録チェック							
14:00	（1）　8F会議室 土　石　流 （砂防研究室）	（7）　531 会議室 舗装材料 （舗装研究室）	（8）　526 会議室 環境改善 － 下水道 － （下水道研究室）	（9）　532 会議室 河川環境の創造 （河川環境研究室）	（1）　8F 会議室 土　石　流 （砂防研究室）	（10）　627 会議室 道路交通管理 （新交通研究室）	（8）　526 会議室 環境改善 － 下水道 － （下水道研究室）	
16:30								
C／P	砂防研究室	環境計画研究室	施工研究室	都市河川研究室	ダム新技術研究官	交通安全研究室	下水道研究室	

第6日目　11月20日（土）：視察旅行

8:20	つくば第一ホテル発（Tel.0298-52-1112）
	移動（ホテル→土浦駅　：　ＪＩＣＡバス）
9:14	土浦駅発（ひたち１０６号）
10:04	上野駅着
	移動（上野→浜松町→羽田空港　：　ＪＲ、ﾓﾉﾚｰﾙ）
11:00	羽田空港着
	昼食
13:00	羽田空港発（ＪＡＳ３９３便）
14:20	高松空港着
	移動（高松空港→坂出→岡山　：　マイクロバス）
15:00～17:00	瀬戸大橋視察　「案内：本州四国連絡橋公団第二管理局計画課」
18:00	岡山ターミナルホテル着
	岡山ターミナルホテル泊（Tel.086-233-3131、Fax.086-233-3144）

第7日目　11月21日（日）：視察旅行

9:00	岡山ターミナルホテル発（Tel.086-233-3131、Fax.086-233-3144）
9:30	岡山駅発（ひかり１５３号）
11:50	博多駅着
	昼食
13:00～17:00	福岡市内視察（海の中道海浜公園、福岡タワー等）「案内：九州地方建設局企画課」
18:00	ハイアット・リージェンシー・福岡着（Tel.092-412-1234、Fax.092-414-2490）
18:00～20:00	シンポジウムに関する打合せ
	ハイアット・リージェンシー・福岡泊（Tel.092-412-1234、Fax.092-414-2490）

第8日目　11月22日（月）：視察旅行

8:00	ハイアット・リージェンシー・福岡発（Tel.092-412-1234、Fax.092-414-2490）
	移動（地建マイクロバス）
9:10～10:20	オリエンタル建設㈱ＰＣ工場
	移動（地建マイクロバス）
11:30	シンポジウム会場（ソラリア西鉄ホテル）着
11:30～12:30	昼食
12:30～14:00	通訳との事前打合せ
14:00～17:00	第２回アジアにおける国土開発と土木技術に関する国際シンポジウム （ソラリア西鉄ホテル、Tel.092-752-5555、Fax.092-781-1211）
17:30～19:30	九州地方建設局長招待レセプション （ソラリア西鉄ホテル、Tel.092-752-5555、Fax.092-781-1211）
	ハイアット・リージェンシー・福岡泊（Tel.092-412-1234、Fax.092-414-2490）

第9日目　11月23日（火）：視察旅行

8:00	ハイアット・リージェンシー・福岡泊（Tel.092-412-1234、Fax.092-414-2490）
	移動（マイクロバス）
	九州縦貫・横断自動車道視察
9:10～10:30	吉野ヶ里視察
	移動（マイクロバス）
11:40～12:30	昼食
12:30～15:30	六角川改修・軟弱地盤対策視察
	移動（マイクロバス）
	九州横断自動車道視察
16:30～17:30	長崎市内視察
18:00～20:00	懇親会
	長崎グランドホテル泊（Tel.0958-23-1234、0958-22-1793）

第１０日目　１１月２４日（水）：視察旅行

8:00	長崎グランドホテル発（Tel.0958-23-1234、0958-22-1793）
	移動（事務所マイクロバス）
10:00～11:00	雲仙関係視察
	移動（事務所マイクロバス）
13:00	長崎空港着
	昼食
14:20	長崎空港発（ＡＮＡ６６６便）
15:50	羽田空港着
	移動（羽田空港→つくば　：　土研マイクロバス）
19:00	つくば第一ホテル着
	つくば第一ホテル泊（Tel.0298-52-1112、Fax.0298-52-5623）

第１１日目　１１月２５日（木）：本会議

場　所：８階国際会議室
議　長：所長　住吉　幸彦

10:00～11:40	総合討議、最終結論
11:40～12:00	閉会式
12:00～13:30	昼食
14:00	移動（土研→筑波第一ホテル　：　ＪＩＣＡバス）
16:00	移動（筑波第一ホテル→JICA筑波ｲﾝﾀｰﾅｼｮﾅﾙｾﾝﾀｰ　：　ＪＩＣＡバス）
16:30～17:00	国際協力事業団筑波ｲﾝﾀｰﾅｼｮﾅﾙｾﾝﾀｰ所長表敬訪問
17:00～18:00	国際協力事業団筑波ｲﾝﾀｰﾅｼｮﾅﾙｾﾝﾀｰ所長主催パーティ
	（筑波ｲﾝﾀｰﾅｼｮﾅﾙｾﾝﾀｰ、Tel.0298-38-1111）
	つくば第一ホテル泊（Tel.0298-52-1112、Fax.0298-52-5623）

第１２日目　１１月２６日（金）：視察旅行

8:30	つくば第一ホテル発（Tel.0298-52-1112、Fax.0298-52-5623）
	移動（ホテル→土浦駅　：　ＪＩＣＡバス）
9:14	土浦駅発（ひたち１０６号）
10:04	上野駅着
	移動（地下鉄）
11:00～11:30	建設大臣表敬訪問
12:00～13:30	昼食
13:30～16:00	東京湾横断道路視察「案内：東京湾横断道路㈱技術部」
18:00～20:00	建設省土木研究所長招待フェアウェルパーティ
	（虎ノ門ﾊﾄﾙ　Tel.03-3432-7261）
	ダイヤモンドホテル泊（Tel.03-3263-2211、Fax.03-3263-2222）

第１３日目　１１月２７日（土）

休日、帰国準備
ダイヤモンドホテル泊（Tel.03-3263-2211、Fax.03-3263-2222）

第１４日目　１１月２８日（日）

帰国

4. 閉会式

1. 日　時　：　平成5年11月25日(木) 11：40～12：00

2. 場　所　：　建設省土木研究所　8階　国際会議室

3. 式次第　：　(司会　建設省土木研究所　総務部長　　田口　　仁)

開会の辞

挨拶　　建設省土木研究所長　　住吉　幸彦

マレーシア農業省灌漑排水局河川部長　Teh Siew Keat

閉会の辞

5. 会議参加者一覧

海外参加者

中華人民共和国
呉　積善　Wu Jishan　　中国科学院成都山地災害及び環境研究所長

インドネシア共和国
Soedarmanto Darmonegoro　ｲﾝﾄﾞﾈｼｱ公共事業省研究開発庁次長

大韓民国
金　亘煥　Kim Keung Hwan　韓国建設技術研究院企画調整室長

マレーシア
Teh Siew Keat　　ﾏﾚｰｼｱ農業省灌漑排水局河川部長

フィリピン共和国
Jose H. Espiritu　　ﾌｨﾘﾋﾟﾝ公共事業道路省研究基準局長

シンガポール共和国
Khor Poh Hwa　　ｼﾝｶﾞﾎﾟｰﾙ国家開発省公共事業局土木技術担当課長

タイ王国
Anusornant Mahavinichaimontri　タイ内務省公共事業局材料研究部長

日本側参加者

住吉　幸彦	建設省土木研究所長	
都丸　徳治	〃	次長
飯島　　尚	〃	研究調整官
市川　　慧	〃	地質官
田村　正秀	〃	企画部長
水谷　敏則	〃	環境部長
中尾　忠彦	〃	河川部長
市村　訓男	〃	下水道部長
竹林　征三	〃	ダム部長
矢沢　昭夫	〃	砂防部長
神崎　紘郎	〃	道路部長
池村　雅司	〃	材料施工部長
藤原　　稔	〃	構造橋梁部長
飯田　　裕	〃	地震防災部長
藤沢　侃彦	〃	企画部先端技術開発研究官
古賀　泰之	〃	〃　地下開発研究官
山本　晃一	〃	河川部河川管理総括研究官
○西田　穂積	〃	ダム部ダム新技術研究官（フィリピンC／P）
安崎　　裕	〃	道路部道路交通総括研究官
福田　昌史	〃	積算技術研究ｾﾝﾀｰ積算技術研究官
大石　龍太郎	〃	企画部国際研究協力官
山下　武宣	〃	〃　ダム計画官
谷口　信彦	〃	〃　橋梁計画官
堀内　浩三郎	〃	〃　トンネル計画官
○丹羽　　薫	〃	環境部環境計画研究室長（ｲﾝﾄﾞﾈｼｱC／P）

島谷　幸宏	建設省土木研究所環境部河川環境研究室長	
石田　　稔	〃	〃　交通環境研究室長
○栗城　　稔	〃	河川部都市河川研究室長（マレーシアC／P）
○田中　修司	〃	下水道部下水道研究室長（タイC／P）
○石川　芳治	〃	砂防部砂防研究室長　　（中国C／P）
山田　晴利	〃	道路部新交通研究室長
○瀬尾　卓也	〃	〃　交通安全研究室長（ｼﾝｶﾞﾎﾟｰﾙC／P）
中村　俊行	〃	〃　舗装研究室長
猪熊　　明	〃	〃　トンネル研究室長
○苗村　正三	〃	材料施工部施工研究室長（韓国C／P）
三木　博史	〃	〃　土質研究室長
河野　広隆	〃	〃　コンクリート研究室長
中野　正則	〃	構造橋梁部基礎研究室長
松尾　　修	〃	地震防災部動土質研究室長

注）○：カウンターパート

II. 目 的 ・ 経 緯

II. 目的・経緯

1．目　　的：　アジア地域諸国の土木技術研究開発及びこれに係る監理を担当する土木研究所長、技術開発担当部局の局長等の上級幹部技術者が一堂に会し、各国での社会基盤整備の現状、将来についての情報交換、討論等を行うことにより、社会基盤整備の必要性及びそれを推進するための土木技術研究開発の重要性についての認識を深め、参加国間での共同研究テーマの発掘、研究者の育成、研究体制の整備等を図る。さらにこれらの活動を通じ、恒常的なアジア地域の技術交流ネットワークを構築し、アジア地域における社会基盤整備事業の安定的な発展に資する。

2．開催経緯：　平成4年度に第1回会議を開催して以来、毎年1回日本において開催している。またこの会議の活動の一環として、開催期間中に地方建設局等と共催により国際シンポジウムを開催し、官・民・学の専門家を交えて広く本活動を紹介している。

第１回アジア地域土木研究所長等会議

期　　間	平成５年　２月１５日～２６日
場　　所	建設省土木研究所
ﾌﾟﾛｸﾞﾗﾑ	基調講演 1)アジア地域諸国の経済社会開発のための社会基盤整備の方向 東京大学工学部土木工学科教授 西野 文雄 2)近代日本における土木工学の進歩と経済･社会の発展への貢献 － 土木研究所７０年の活動と今後の展望 － 建設省土木研究所長　住吉 幸彦 3)技術協力における研究･技術開発の役割 (財)全国建設研修センター副理事長　玉光 弘明
	カントリー報告 1)国の概要 2)公共事業の現状 3)研究機関・技術開発担当部局の概要 4)　〃　の研究開発 5)　〃　の国際研究交流 6)　〃　の「災害・防災」に関する取り組み 7)　〃　の「環境と社会資本整備の調和」に関する取り組み
	特定課題討論「降雨災害防除に関する研究開発の現状と今後の方向」 1)河川災害 2)土砂災害
	分野別課題討論 1)ダムの堆砂　(中国、日本) 2)水質汚濁対策　(インドネシア、日本) 3)河川環境　(韓国、日本) 4)地盤改良　(タイ、日本) 5)トンネル　(シンガポール、タイ、日本) 6)火山災害・土石流・道路防災　(マレーシア、フィリピン、日本) 7)河　川　(中国、日本) 8)水　質　(韓国、日本) 9)土質基礎・交通　(マレーシア、タイ、日本) 10)舗　装　(フィリピン、シンガポール、タイ、日本) 11)道 路 橋　(フィリピン、日本)
	視察旅行 北海道方面（新千歳空港、開発土木研究所、室蘭白鳥大橋、青函トンネル他） 関東方面　（東京湾横断道路、宮ヶ瀬ダム）
参 加 者	海外８名、日本３７名、来賓３５名（海外５、日本３０）

第2回アジア地域土木研究所長等会議

期　　間	平成5年11月15日～26日
場　　所	建設省土木研究所
ﾌﾟﾛｸﾞﾗﾑ	基調講演 1)持続可能な開発のための土木技術者の役割 日本海外コンサツタンツ㈱社長　濱守　厚 2)経済発展段階と建設技術の移転 建設省土木研究所長　住吉　幸彦 3)日本における研究について　－土木工学を中心として－ 筑波大学構造工学系教授　椎貝　博美
	カントリー報告 ①国の概要 ②公共事業の現状 ③研究機関・技術開発担当部局の概要 ④　〃　の研究開発 ⑤　〃　の国際研究交流)
	特定課題討論Ⅰ「災害および防災に関する研究開発」 1)総合的な治水対策 2)道路のり面災害対策 特定課題討論Ⅱ「環境と社会資本整備の調和に関する研究開発」 1)ダム湖や河川の水質保全対策 2)都市部における道路交通による大気汚染及び騒音への対策
	分野別課題討論 1)土石流　(中国、フィリピン、日本) 2)道路橋の材料－ｺﾝｸﾘｰﾄ－　(インドネシア、日本) 3)洪水防御　(韓国、日本) 4)河川愛護　(マレーシア、日本) 5)地下空間利用　(シンガポール、日本) 6)大気汚染対策　(タイ、日本) 7)舗装材料　(インドネシア、日本) 8)環境改善－下水道－　(韓国、タイ、日本) 9)河川環境の創造　(マレーシア、日本) 10)道路交通管理　(シンガポール、日本)
	視察旅行 中国・四国方面（瀬戸大橋） 九州方面（吉野ヶ里歴史公園、六角川改修・軟弱地盤対策、雲仙防災事業他） 関東方面（東京湾横断道路）
参 加 者	海外7名、日本41名、来賓60名（海外7、日本53）

第1回アジアにおける国土開発と土木技術に関する国際シンポジウム

開催日	平成5年2月22日
場所	札幌グランドホテル
主催	建設省土木研究所、北海道開発局開発土木研究所
ﾌﾟﾛｸﾞﾗﾑ	基調講演「北海道の開発と社会基盤整備」 北海道大学工学部土木工学科　五十嵐　日出夫
	パネルディスカッション「地域開発事業と土木技術の方向」 ｺｰﾃﾞｨﾈｰﾀｰ：太田　利隆　北海道開発局開発土木研究所長 ﾊﾟﾈﾘｽﾄ：住吉　幸彦　建設省土木研究所長 陳　炳新　中国水利水電科学研究院長 Badruddin Machbub　インドネシア水資源開発研究所長 李　相垠　韓国建設技術研究院副院長 Abdul Rahman B. Abdullah　マレーシア公共事業省公共事業局次長 Manuel M. Bonoan　フィリピン公共事業道路省次官補 Tan Siong Leng　シンガポール公共事業局建設管理部長 Teeracharti Ruenkrairergsa　タイ道路局道路研究開発センター長
参加者	200名

第2回アジアにおける国土開発と土木技術に関する国際シンポジウム

開催日	平成5年11月22日
場所	ソラリア西鉄ホテル
主催	建設省土木研究所、建設省九州地方建設局
ﾌﾟﾛｸﾞﾗﾑ	基調講演「九州の地域開発と土木技術」 九州大学工学部土木工学科教授　樗木　武
	パネルディスカッション「より良い生活環境の創造 －地域開発、防災、環境－」 ｺｰﾃﾞｨﾈｰﾀｰ：住吉　幸彦　建設省土木研究所長 ﾊﾟﾈﾘｽﾄ　荒牧　英城　建設省九州地方建設局長 呉　積善　中国成都山地災害及び環境研究所長 Soedarmanto Darmonegoro　インドネシア公共事業省研究開発庁次長 金　亘煥　韓国建設技術研究院企画調整室長 Teh Siew Keat　マレーシア農業省灌漑排水局河川部長 Jose H. Espiritu　フィリピン公共事業道路省研究基準局長 Khor Poh Hwa　シンガポール公共事業局土木技術担当課長 Anusornant Mahavinichaimontri　タイ内務省公共事業局材料研究部長
参加者	200名

３．参加者と関係機関の連絡先一覧

１）第１回アジア地域土木研究所長等会議

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（B）会 議 議 事 録

Ⅰ．開　会　式　挨　拶

開会式挨拶

建設省土木研究所長　住吉　幸彦

皆様お早うございます。

はるばる遠方からお越し下さったアジア各国の皆様、各国の在日日本大使館の皆様、本会議の開催のために全面的なご協力を賜りました国際協力事業団の皆様、建設省の中岡技術調査官をはじめとする多くの方々のご出席を得まして、「第２回アジア地域土木研究所長等会議」が私どもの土木研究所で開催されますことは、私の大きな慶びとするところであります。

土木研究所は、創立７１周年を迎えましたが、この間、わが国の公共事業の約７割を担当している建設省の直属の研究所として、国内のインフラ整備を進めるにあたり、幅広い分野において土木技術の研究開発面から大きな貢献をしてまいりました。

また、近年建設分野の国際交流が進む中で、土木研究所は国際研究交流の一環として、２５年の歴史を持つ「天然資源の開発利用に関する日米会議　耐風耐震構造専門部会」をはじめ、「道路科学技術に関する日米委員会」、「排水及びスラッジ処理に関する日独ワークショップ」等欧米諸国との間で、１０に近い定期的な国際会議を主催しています。この数年、交流の場が拡大するとともに、いずれも大きな成果を上げており、土木技術に関する研究開発を進める上で、国際研究交流は非常に重要な位置を占めてまいりました。

一方、アジア諸国との間でも、インフラ整備における技術協力に当研究所の職員が携わったり、アジア諸国の研究者や調査団の受入れ等の交流を行ってきました。

そこで、１９９３年２月に土木技術の研究開発と監理を担当するアジア各国の責任者が一堂に会し、各国の社会・経済発展の基盤としてのインフラ整備の必要性及びインフラ整備を支える土木技術の研究開発の重要性について話し合うためアジア地域土木研究所長等会議を企画開催致しました。参加各国の代表の方々からアジア諸国の土木分野における共通の課題や研究開発の現状について活発な御討議を頂き、このような交流が非常に有意義であるとの御意見を頂き、今回の第２回目の会議を開催するに至った訳であります。

この会議の趣旨は、アジア諸国の自然条件や社会・経済条件にあった土木技術を生み出すため、そして各国の天然資源、人的資源の活用を図るため、土木技術の研究開発の分野で発展及び交流を進めることにあります。そしてこの会議がいずれは、研究交流を通じてアジア地域を強く結び付けるネットワークとして機能するようになるのではないかと期待しております。

基調講演、カントリー報告、特定課題や分野別課題についての討論及び福岡市におけるシンポジウムや現地視察等を通じまして、今後の土木技術の研究開発に関するアジア地域諸国間の協力が活発化することを期待しております。

最後に、今回の会議開催にあたりご協力を賜りました関係の皆様にお礼を申し上げて私の挨拶といたします。

建設省技監　藤井　治芳
（代読：建設省建設経済局技術調査官　中岡　智信）

私、ただ今、ご紹介に預かりました建設省藤井技監の代理の建設経済局技術調査官の中岡でございます。

わが国と政治・経済・文化等のあらゆる面で深い関係を持っております中国、インドネシア、韓国、マレーシア、フィリピン、シンガポール、タイの７ヶ国より、土木技術の研究開発分野の責任ある地位におられる７名の方々を、ここ土木研究所にお迎えして、「第２回アジア地域土木研究所長等会議」が開催されますことはに、お慶び申し上げますとともに、ご挨拶を述べる機会を得ましたことは、私の名誉とするところであります。

皆様ご承知のとおり、社会基盤施設は経済・社会活動を支える最も重要な根幹施設であり、かつ豊かで活発な国民生活に欠くことの出来ない施設であります。わが国におきましては1991年からの１０年間で約430兆円の公共投資を実施する公共投資基本計画がスタートしておりますし、1993年度国家予算においては、一般歳出ベースで約40兆円のうち、約8.6兆円が社会基盤施設整備にあてられることになっており、一般歳出が対前年度比3.1%の伸びに対して社会基盤施設整備が5.8%と高い伸びとなっていることからもこの重要性がわかるところであります。また、建設省では来るべき２１世紀を見据えた上で、東京湾横断道路や明石海峡大橋の建設、安全で快適な生活環境を確保するための国土保全施設の整備、良質な住宅・宅地の供給等を進めるとともに、近年大きな問題となっている環境問題にも対応するため河川事業において近自然工法の開発や建設副産物のリサイクル技術の開発を行うとともに、効率よく安全に作業できる環境を整備するために省人化技術の開発等を最重点研究開発課題として、研究開発を進めているところであります。土木研究所は、土木技術の研究開発を実施し、その発展・普及を中心となって推進している機関であり、創立以来７１年の歴史の中で重要な役割を演じてきております。

さて今日の世界の状況を見ますと、これからの地域開発、防災、環境など経済基盤の発展に多くの努力を払わなければならない課題がたくさんあります。社会基盤施設整備には、各国の自然条件や社会・経済条件に即した土木技術の発展が必要であり、そのために近隣の各国の関係者が交流、協力することにより、相互に持つ力を補完し合うことが、重要であります。

社会基盤施設整備に不可欠な土木技術の研究開発分野において、責任のある担当の方々がアジア各国からこのように一堂に会し、現在抱えている課題等を紹介・討論するなどその経験を活かし合うことによって、それぞれの国の社会基盤整備に役立て合うことは、アジア地域の繁栄に大きく貢献するものと思います。アジア諸国間の協力が今後益々必要となる情勢の中で、この会議が開催されますことは誠に時宜を得たものであり、わが国にとっても極めて意義のあることであります。

今、日本は寒さが厳しくなる季節に入ってきておりますので、特に暖かい国々からお越しの方々は風邪などをめさぬよう充分にご注意をされながら、会議での活発な情報交換、討論、それに会議に続く視察旅行等で親睦を深められ、本会議が一層有意義なものとなりますことを祈念して、私の挨拶と致します。

国際協力事業団つくばｲﾝﾀｰﾅｼｮﾅﾙｾﾝﾀｰ所長　飯村　圭司

みなさん、お早うございます。国際協力事業団を代表いたしまして、本セミナーの開会式におきまして挨拶する機会を得ましたことに、心より敬意を表わします。

まず最初に、このセミナーに海外からこのようなたいへん素晴らしい方をお迎えすることができました。心より歓迎の意を表します。

みなさんご存知のことと思いますが、国際協力事業団は１９７４年８月に設立され、技術協力を通じ世界各国と日本との関係を促進することを目的としています。

この目的を進める試みとして、国際協力事業団は、土木研究所が各国の適正な社会基盤整備と公共事業を進めるための協力活動の一環として、このセミナーを組織しました。このセミナーでの発表と討論におきまして、日本の公共事業に関する技術開発が幅広く紹介・分析され、参加各国が見いだした共通の課題について、広く意見交換がなされることを希望します。

海外参加者のみなさんの日本滞在はとても短いですけれども、みなさんは日本の不慣れな気候、異なった習慣、生活条件等について感じるかもしれません。しかしながら、みなさんの日本滞在が楽しく、期待される成果が得られることを望みます。とともに、私は、このセミナーがみなさん方の国と私たちのよりよいコミュニケーションとより緊密な関係を確立する機会となると、確信致します。

私たちは、セミナーだけのことでなく、みなさんの個人的な問題においても支援する用意があります。私たちは、みなさんの日本滞在が最高に楽しく有意義なものとなるように、最前を尽くします。

国際協力事業団は、このセミナーに多大なる支援とご協力を賜りました本日ここに集われたみなさんに、深く感謝の意を表します。

最後になりますが、重ねて本セミナーの成功を記念致しまして、私の挨拶とさせて頂きます。
ありがとうございました。

タイ内務省公共事業局材料研究部長
Anusornant Mahavinichaimontri

住吉土木研究所長、藤井技監、中岡技術調査官、飯村筑波ｲﾝﾀｰﾅｼｮﾅﾙｾﾝﾀｰ所長はじめ、みなさんお早うございます。中国、インドネシア、韓国、マレーシア、フィリピン、シンガポール、タイの７ヶ国からの海外参加者を代表しまして、「第２回アジア地域土木研究所長等会議」の開会式のこの場でご挨拶させて頂きます。

まず最初に、私にこの場で挨拶させて頂く機会を与えて頂きましたことに心より敬意を表したいと思います。みなさま方もご存知のように、世界の国々は大きく３つに分けられることができると、思います。それは、後進途上国、発展途上国、先進国の３つであります。また、途上国か先進国かどうか判断する方法は、各国の技術が発展しているかどうかによるべきであります。

この会議は、各参加国への技術移転について、お互いの国々が技術的貢献することにに焦点が当てられています。そのためには、各国が自立しなければならないと思います。この意味するところは、世界中の人々は、その生活のためによい環境とよい環境基準を持つべきだということです。

幾人かの日本人は私に次のように教えてくれました。それは、人が他の人に何かを提供したり、聞くことは、その人をより幸せにする、ということです。私は、それは彼の考え方であり、また日本の文化であると、思います。今日日本がたいへん愛されるのは、日本人がその献身的な姿勢と尊敬すべき人格を持ち得ているからだと、思います。

最後に、私たちのここ日本滞在はまだ始まったばかりですが、みなさんが私たちを誠に暖かく歓待にお迎え頂きましたことを感謝致します。私にこのような機会を与えて頂いた土木研究所、建設省、国際協力事業団、日本政府、そしてこの会議の全参加者のみなさまに重ねて御礼申し上げます。、

どうも、ありがとうございました。

II. 議　事　録

１．カントリー報告

各国のカントリー報告は１１月１６日9時３０分～１６時３０分まで、日本、中国、インドネシア、韓国、マレーシア、フィリピン、シンガポール、タイの順に、各国の概要、公共事業の現状、研究機関の概要、主要な研究開発、国際研究交流について発表がなされ、順次、質疑応答がなされた。
討議の概要は次の通りである。

（1）日本

建設省土木研究所 飯島　尚研究調整官より、日本の概要、公共事業の現状、土木研究所の概要、主要研究開発プロジェクトと国際研究交流について報告され、特に、地震対策関連研究および共同研究の進め方について力点をおいた発表がなされた。

これに対して、日本の公共事業関係研究開発のマネジメント、民間との共同研究における問題点の有無、研究成果の活用方法などの質問があり、研究予算のしくみ、土木研究所５箇年研究計画、土木研究所における共同研究の現状及び調整方法、研究成果の普及について説明がなされた。

（2）中国

中国科学院成都山地災害及び環境研究所 呉　積善(Wu Jishan)所長より、中国の概要、公共事業の現状、ＩＭＨＥ（山地災害及び環境研究所）の概要、主要研究開発プロジェクトと国際研究交流について報告され、特に三峡計画プロジェクト及び土石流と地すべり対策の研究に力点をおいた発表がなされた。

これに対して、地域開発に関する研究の内容及び山村地域の人口問題について質問があり、山村地域の危険性あるいは山地に及ぼす影響に関する研究をしていること、山地部では都市部に比べてより早いスピードで人口が増加していることが説明された。

（3）インドネシア

インドネシア公共事業省研究開発庁 Soedarmanto Darmonegoro次長より、インドネシアの概要、公共事業の現状、ＡＲＤ（研究開発庁）の概要、主要研究開発プロジェクトと国際研究交流について報告され、特に公共事業省研究開発庁の紹介とインドネシアにおける国際研究交流の課題に力点をおいた発表がなされた。

これに対して、道路、人間居住環境、水資源研究所に関するマネージメント、民間・大学との共同研究、地震に関する研究体制について質問があり、研究開発庁長官及び各研究所長間で調整していることや、民間や大学との共同研究の事例紹介及び地震に対して三研究所共同で研究を行っていることが説明された。

（4）韓国

韓国建設技術研究院 金 亘煥(Kim Keung Hwan)企画調整室長より、韓国の概要、韓国の発展と公共事業、公共事業に関する研究開発、ＫＩＣＴ（韓国建設技術研究院）の概要と主要研究開発プロジェクト、国際研究協力について報告され、特にインフラ整備の仕組みおよび最近設立された建設情報センターに力点をおいた発表がなされた。

これに対して、公共事業に関する研究についての予算・資金について質問があり、ＫＩＣＴには政府・公社・民間の資金があてられること、民間の研究所や大学との共同研究の実施方法、韓国のその他の研究組織について説明がなされた。

（5）マレーシア

マレーシア農業省灌漑排水局 Teh Siew Keat河川部長より、マレーシアの概要、公共事業の現状、ＤＩＤ（灌漑排水局）の概要と主要研究開発プロジェクト、国際研究協力について報告され、特に、河川の利用、クアラルンプール洪水軽減プロジェクト等の主要プロジェクト並び

に新設予定の国立水理研究所の紹介に力点をおいた発表がなされた。

これに対して、河川の利用、管理の総合調整者、タイダルボア現象に関する調査及び対策について質問があり、河川の利用、管理に関する調整は農業省が中心に行っているが、より高度な調整機関設立が検討されていることやタイダルボア現象について説明がなされた。

（6）フィリピン

フィリピン公共事業道路省 Jose H. Espiritu研究基準局長より、フィリピンの概要、公共事業の現状、ＢＲＳ（研究基準局）の概要、主要研究開発プロジェクトと国際研究交流について報告され、特に、インフラ整備を行う上での問題点やフライアッシュを混和材として利用したコンクリートなどの土木材料の研究に力点をおいた発表がなされた。

これに対して、高速道路計画への予算配分、島を結ぶ交通システムについて質問があり、公共事業予算の多くがマニラ首都圏に集中的に配分されていることや、島を結ぶ道路計画の現状と船の連絡について説明がなされた。また、各国で実施している研究開発の内容が重複しているのではないかとの指摘があり、土木技術の研究であるのである程度の重複はやむを得ないとの反論もあった。これに対し、各国の研究所が実施している研究内容についての情報交換の必要性が指摘されこの問題については将来の会議で議論することとした。

（7）シンガポール

シンガポール国家開発省公共事業局 Khor Poh Hwa土木技術担当課長より、シンガポールの概要、公共事業の現状、ＰＷＤ（公共事業局）の概要、主要研究開発プロジェクトと国際研究交流について報告され、特に、シンガポール国土利用計画（400万人構想）及び道路網計画に力点をおいた発表がなされた。

これに対して、交通需要の管理方法について質問があり、ＣＯＥ（自動車取得資格制度）やＡＬＳ（都市部への乗り入れ規制）の実施状況が説明された。また、ＰＷＤが国内の大学、ナンヤン工業大学、シンガポール国立大学と共同研究を行っている現状が説明された。

（8）タイ

タイ内務省公共事業局 Anusornant Mahavinichaimontri材料研究部長より、タイの概要、公共事業の現状、ＰＷＤ（公共事業局）の概要、主要研究開発プロジェクトについて報告があり、特に公共事業局の主要な研究課題としての３つの研究課題に力点をおいた発表がなされた。

これに対して、タイにおける水理学の研究実施状況、バンコク地下道路の研究等について質問があり、アジア工科大学における研究状況や公共事業局におけるメコン川の研究内容、バンコクの高速道路計画および地下道路の調査概要について説明がなされた。

カントリー報告は以下に要約される。

1) 各国の自然、社会、経済についての報告があり、アジア各国の共通する課題および各国独自の課題について相互に理解を深めた。
2) 各国の発展に不可欠の道路、河川、ダム、砂防、下水道など社会基盤整備を進める上で土木技術研究・開発の必要性と重要性が指摘された。
3) 各国の公共事業に関する研究開発の状況が報告され、各国とも熱心に研究に取り組んでおり、研究すべき課題・研究の実施方法において多くの共通点が認識された。また、各国がかかえる特有の課題及び取り組みについて興味深い報告がなされ、それらについて各国相互に理解を深めた。
4) 各国とも意欲的に国際研究交流を行っていることが見受けられ、今回の討議により、さらに国際研究交流の推進の必要性を認識した。

２．特定課題討論

特定課題の討論は１１月１７日９時３０分から１７時２０分にわたり、８ケ国の全員の参加を得て実施された。討論課題として、参加者の用意したカントリーレポートの内容に基づいて以下のものを選定した。

特定課題Ⅰ　「災害および防災に関する研究開発」
　課題１　総合的な治水対策
　課題２　道路のり面災害対策
特定課題Ⅱ　「環境と社会資本整備の調和に関する研究開発」
　課題１　ダム湖や河川の水質保全対策
　課題２　都市部における道路交通による大気汚染及び騒音への対策
討論は上記の４つの課題についてそれぞれセッシヨンを設けた。

第一のセッションは土木研究所の河川部長の中尾氏が、第二のセッシヨンは同じく材料施工部長の池村氏が、第三、第四のセッションは同じく環境部長の水谷氏が、それぞれ座長を務めた。それぞれのセッションは、参加国からの代表者による討論課題に関する発表と討論から成っている。

発表資料は主としてカントリーレポートが用いられたが、会議で配布された資料はカントリーレポートの巻末に収録した。

特定課題Ⅰ　「災害および防災に関する研究開発」

課題１　「総合的な治水対策」

中尾議長より特定課題の主旨と経緯、総合的な治水対策の一般的概念について説明があり、その後日本、韓国、マレーシアから報告とこれに基づく討論があった。

１）話題提供

・日本

建設省土木研究所栗城都市河川研究室室長が以下の項目の発表を行った。

1. 総合的な治水の考え方の採用されるにあたっての背景
2. 総合治水特定河川事業による各種施策
3. 土木研究所の技術的支援
4. 日本における総合的な治水の特徴と同対策の普遍性

・韓国

韓国建設技術院金亘換（Kim Keung Hwan）企画調整室長が以下の項目の発表を行った。

1. 韓国の洪水災害の特徴
2. 韓国における自然災害に対する組織的な取り組み
3. 長期的な防災対策、短期的防災計画及び災害軽減のための暫定的処置及び関連研究
4. KICTにおける洪水防護に関わるプロジェクト

・マレイシア

マレイシア農業省灌漑排水局Teh Siew Keat河川部長が以下の項目の発表を行った。

1. マレイシアの洪水被害の特徴と歴史
2. 灌漑排水局の洪水軽減における役割

3. 常設の洪水調節委員会及び洪水災害救援機構の設置
4. 河川流域の調査、構造物対策の実施及び非構造物対策

2）討論

各国からの報告の後、次のような討論がなされた。

1. 総合的治水対策事業における小規模ダムの効果について
2. 治水対策における河川水質浄化及び美化の配慮について

3）まとめ

発表と討論の結果は次のようにまとめられた。

1. 治水対策における非構造物対策の有効性と必要性が確認された。
2. 洪水対策としてダム・堤防建設は抜本的な対策であるがすぐには完成しない。
   また完成後も洪水対策等の有効性を確保するには非構造物対策が重要である。
3. 今後もこの方面での研究が重要である。

課題2　「道路のり面災害」

池村議長からこのテーマの背景に関する説明があり、その後日本、中国、インドネシアから報告とこれに基づく討論があった。

1）話題提供

・日本

建設省土木研究所三木土質研究室室長が以下の項目の発表を行った。

1. 道路のり面災害の現状について
2. 道路のり面防災対策の現状について
3. 道路のり面防災対策の今後の課題について
4. 土木研究所における研究の取り組みについて

・中国

中国科学院成都山地災害及び環境研究所呉所長が以下の項目の発表を行った。

1. 道路沿いの土砂崩壊の被害状況について
2. 土砂災害の総合的な防災対策について
3. 土砂崩壊の個別対策工法の事例紹介

・インドネシア

インドネシア公共事業所研究開発庁Soedarmanto Darmonegoro次長が以下の項目の発表を行った。

1. 災害時における行政の体制について
2. 地質、地形の概要について
3. 西部ジャワの地滑り地帯の分布状況について
4. 地滑り災害、および対策工の事例について

2）討論

各国からの報告の後、次のような討論がなされた。

1. 日本における道路防災地図の進捗状況について
2. 日本における斜面崩壊予知機器及びシステムの事例について
3. 道路管理や災害予測のための、斜面崩壊に関するのり面台帳のデータベース化について

4. 日本における新しい植生のり面工法（厚層種子吹付工等）について

3）まとめ

発表と討論の結果は次のようにまとめられた。

1. のり面災害の現状、各国の状況に合った対策、研究課題についての情報交換は有意義であった。
2. 道路防災地図（ハザードマップ）の作成、斜面及び斜面崩壊情報のデータベース化、斜面崩壊の予知システムや対策工法の開発が望まれる。

特定課題Ⅱ．「環境と社会資本整備の調和に関する研究開発」

水谷議長から環境問題に関する国際的動きと前回会議からの背景の説明があり、その後日本、フィリピン、タイ、シンガポールから報告とこれに基づく討論があった。

課題１　「ダム湖や河川の水質保全対策」

１）話題提供

・日本

建設省土木研究所丹羽環境計画研究室長が以下の項目の発表を行った。

1. 総合的水環境の中での水質保全の位置付け
2. 水質問題の歴史的展開と行政分担
3. 河川・ダム湖の水質保全対策

・フィリピン

フィリピン公共事業道路省Espiritu研究基準局長が以下の項目の発表を行った。

1. 水質規制を設定する水域区分、水質区分基準、水質観測体制
2. 汚濁負荷評価、排水基準、汚濁制御技術・手法、下水処理に関する技術の現状
3. 水質対策関連の計画と政策

・タイ

タイ内務省公共事業局Anusornant材料研究部長が以下の項目の発表を行った。

1. 下水処理に係わる取り組み状況
2. 実施済み及び実施中の水質対策事業
3. 下水道の未整備に起因する諸問題

２）討論

各国からの報告の後、次のような討論がなされた。

1. 日本における下水道整備状況と河川水質の関係について
2. 下水処理水の再利用について
3. 工業用水の回収利用の状況について

３）まとめ

発表と討論の結果は次のようにまとめられた。

1. 各国の下水道整備状況がわかった。
2. 河川・ダム湖の水質対策は、各国の事情に応じた対応が求められている。このた め、水環境に有効な下水道の整備や水のリサイクルについての情報交換は有用である。
3. 今後各種課題の解決のために一層の情報交換を行う事が重要である。

課題２　「都市部における道路交通による大気汚染及び騒音への対策」

１）話題提供

・日本

建設省土木研究所石田交通環境研究室長が以下の項目の発表を行った。

1. 環境関連法規、環境基準、環境影響評価制度

2. 自動車排出ガスによる大気汚染対策（自動車構造の改善、道路網整備、道路構造、植物によるNOxの吸収等）
3. 自動車交通騒音対策（自動車構造の改善、道路構造による対策、遮音壁、低騒音舗装等）

・シンガポール

シンガポール国家開発省公共事業局土木技術担当Khor Poh Hwa課長が以下の項目の発表を行った。

1. 自動車排出ガスによる大気汚染対策（自動車の排出ガス基準、燃料の無鉛化、総合交通政策等）
2. 自動車交通騒音対策（車体規制、沿道の土地利用計画、低騒音舗装、遮音壁、トンネル及び堀割り道路等）

2）討論

各国からの報告の後、都市の道路沿道環境について参加者による質疑応答と討論が行われた。討論された内容は以下のものであった。

1. 大気汚染
   a)低濃度用脱硝装置の研究開発状況と実用化した場合のコストについて
   b)日本における低濃度用脱硝装置の研究開発の必要性・背景について
   c)平面道路と高架道路からの大気汚染物質の予測について
   d)自動車の速度と排出ガス量の関係について
2. 交通騒音
   a)韓国における透光型遮音壁の清掃メンテナンスコストについて
   b)遮音壁清掃機及び管理の容易な遮音壁の日本での研究開発状況について
   c)遮音壁の心理的響について
3. 日本における交通振動の主要因について
4. 日本の環境に関する法令についての説明

3）まとめ

発表と討論の結果は次のようにまとめられた。

1. 道路交通による大気汚染及び騒音は都市部の生活環境保全の上で重要な課題であることが認識された。
2. これらの現状と対策について情報を交換することは、各国の環境改善のための調査研究を行ううえで有益であり、今後とも一層の情報交換の推進が必要である。

発表と討論から得られた主な結論は以下のようである。

1. 各国の災害と防災対策ならびに環境と社会資本との調和を目指した事業に関する状況、さらにはそれらに関連した研究の取り組みについて意見交換により理解を深めることができた。また、このことは今後とも一層重要である。
2. 洪水対策としてダム・堤防建設は抜本的な対策であるがすぐには完成しない。また完成後も洪水対策等の有効性を確保するには非構造物対策が重要である。
3. 道路のり面災害は、各国において道路交通の障害をもたらす重要な課題となっている。このため、道路防災地図（ハザードマップ）の作成、斜面及び斜面崩壊情報のデータベース化、斜面崩壊の予知システムや対策工法の開発が望まれ　る。
4. 河川・ダム湖の水質対策は、各国の事情に応じた対応が求められている。このため、水環境に有効な下水道の整備や水のリサイクルについての情報交換は有用である。
5. 道路交通による大気汚染及び騒音は都市部の生活環境保全の上で重要な課題と　な

っている。したがって、これらの現状と対策について情報を交換することは、各国の環境改善のための調査研究を行ううえで有益であり、今後とも一層の情報交換が必要である。

３．分野別課題討論

分野別課題討論は、１１月１８日の９：３０～１６：３０にわたり、個別の土木技術分野について、関係する参加者が集まって実施された。

各分野における、参加国と討論の概要は以下のとおりである。

（１）　土石流 …… 中国、フィリピン、日本（砂防部）

中国、フィリピン、日本から土石流による災害と対策の実態およびそれらに関する調査・研究が紹介された。また、各国間の研究協力は「土石流の発生、流下、堆積実態の調査と対策手法」に関する研究を推進する上で極めて重要であることが認識された。各国は、土石流に関する情報交換を行うことを合意した。

（２）　道路橋の材料－コンクリート－ …… インドネシア、日本（材料施工部、構造橋梁部、国際地震工学部(建築研究所)）

インドネシア側から、主に、いくつかの地点の道路構造物におけるコンクリート用骨材に関する問題および人工軽量骨材の研究開発に関する紹介があった。日本側は人工軽量骨材、コンクリート橋の耐久性、橋梁基礎の洗掘の非破壊検査手法に関する説明を行った。双方において技術情報の交換を開始することが合意された。

（３）　洪水防御 …… 韓国、日本（河川部）

日韓の河川事業の現状と動向についての説明を行った。さらに、日本側は自然環境に配慮した河岸防御技術について、韓国側は河川改修技術および河川環境管理について研究紹介を行った。多自然型川づくりに関する研究をさらに押し進め、両国の研究成果の情報交換を継続することが確認された。

（４）　河川愛護 …… マレーシア、日本（河川部）

小貝川下妻市地先のフラワーベルトの見学を行ったあと、日本側から住民参加型の川づくりの試み、マレーシア側から河川愛護のためのキャンペーンが紹介された。河川をさらに身近なものにし、河川愛護を促進するための研究が必要であることで認識が一致し、研究成果・技術情報を交換することが合意された。

（５）　地下空間利用 …… シンガポール、日本（企画部、道路部）

日本、シンガポール両国の近接構造物がある場合のトンネルの設計法、地下利用の現状が紹介・討議された。また、双方で近接構造物－建物、地下鉄－がある場合のトンネル建設に関する技術や工事実績の情報交換を図るとともに、今後の技術協力について検討することが合意された。

（６）　大気汚染対策 …… タイ、日本（環境部、構造橋梁部）

日本、タイ両国により大気汚染状況とその対策および騒音・振動規制について紹介・討議された。大気汚染対策、騒音・振動対策は、両国にとって重要な課題であるとの認識に至り、必要に応じて情報交換を行うこととした。

（７）　舗装材料 …… インドネシア、日本（道路部、材料施工部）

インドネシア側からは舗装材料として試験されている人工骨材について、日本側からはＲＣＣＰ、リサイクリング、排水性舗装等、現在の舗装の技術動向について説明があり、それに関

する討論を行った。そして、技術情報の交換が合意された。

（8）　環境改善－下水道－ …… 韓国、タイ、日本（下水道部）

韓国、タイ、日本から、それぞれの国における下水道の現状について発表があり、討論がなされた。また、日本における下水道整備五箇年計画についての情報提供がなされた。各国は、下水道に関する研究成果を相互に交換することを合意した。

（9）　河川環境の創造 …… マレーシア、日本（環境部）

日本、マレーシア両国より河川環境に関する情報および現状が紹介された。両国の重要な課題である生態系および景観の保全・創造技術、水質浄化技術の研究を効果的に実施する上で、研究協力を行うことは双方にとって極めて重要であることが認識され、今後、相互に情報交換をすることが合意された。

（１０）道路交通管理 …… シンガポール、日本（道路部、国際地震工学部(建築研究所)）

日本側より、日本の交通渋滞の状況および現在実施中あるいは実施が検討されている交通管理政策について説明が行われた。シンガポール側からは、同国で実施されているロード・プライシングシステムについて説明が行われた。両国は、道路交通管理が今後の道路交通政策においてますます重要になるとの認識で一致し、必要に応じて双方の技術情報および研究成果を交換することで合意がなされた。

上記討論により、各国の抱える諸問題や研究状況等、各分野における討論参加国相互の立場を理解しあえた。また、同時にそれぞれの土木技術分野において、今後詳細な情報交換を行う等、より一層の技術協力の必要性が相互に認識された。

（1）討論要約（土石流）

開催日：平成５年１１月１８日（木）　９：３０～１２：００
　　１４：００～１６：３０

場所：建設省土木研究所　　８階会議室

出席者：中国

	呉　積善	中国科学院および水利部 成都山地災害および環境研究所長
フィリピン		
	Jose H. Espiritu	フィリピン公共事業道路省研究基準局長
日本		
	矢澤　昭夫	砂防部長
	石川　芳治	砂防研究室長
	欧　国強	砂防研究室受入れ研究員
	山田　孝	砂防研究室研究員
	吉松　弘行	地すべり研究室長
	綱木　亮介	急傾斜地崩壊研究室長

１．討議内容

土砂災害（土石流、地すべり、急傾斜地崩壊）とその対策に関する相互の研究活動を推進するための協力を行うために討議を行った。

日本側は、土木研究所砂防部（砂防研究室、地すべり研究室、急傾斜地崩壊研究室）および新潟試験所で実施されている土砂災害に関する研究内容の説明を行った。主な、内容は、

１）土石流の対策手法
２）土石流の現地観測
３）土石流の氾濫シミュレーションを用いた危険区域図作成手法
４）地すべり対策手法
５）地すべりの現地観測
６）急傾斜地崩壊対策手法
７）急傾斜地崩壊の実態

この他に、１９９１年の雲仙岳噴火に伴う火砕流災害に関する研究の概要についてスライド、模型実験装置を用いて説明した。

中国側は、土石流に関する研究内容の説明を行った。主な内容は、以下の通りである。

１）土石流の現地観測
２）土石流に関する調査・研究の実態
３）土石流の運動機構に関する研究

フィリピン側は１９９１年のピナツボ火山の噴火に伴い発生している土石流による災害の調査・研究の必要性について説明を行った。主な内容は、以下の通りである。

１）火砕流堆積物地帯からの土石流の発生
２）ピナツボ火山周辺における土石流観測
３）今後の土石流観測計画
４）土石流対策工の設計法に関する研究と新たに開発した工法の現地試験
５）土石流の発生、流下、堆積特性

２．今後取り組むべき研究課題

今後協力して研究を進めることが望ましい研究課題として土石流の発生、流下、堆積実態の調査と対策手法に関する研究があげられた。

中国側は雲南省の東川において土石流の現地観測を継続して実施する。

フィリピン共和国側はピナツボ火山における火砕流堆積物地帯から発生する土石流の現地観測を実施する。

また、日本側は１９９１年以来火砕流が頻発している雲仙岳において土石流の現地観測を実施する。

各国は観測結果を用いて土石流の発生予測、土石流の規模予測手法を検討するとともに、対策工の検討を行う。

３．今後の協力方法

１）土石流および対策手法に関する研究成果の情報交換を行う。

２）情報交換を基に研究項目を絞り込む。

３）必要に応じて、予算の許す範囲で、研究者の派遣を行うよう努める。

４．会議における合意事項

土石流に関する研究成果・技術情報について相互に交換する。

（2） 討論要約（道路橋の材料　－コンクリート－）

開 催 日：平成５年１１月１８日（木）　9:30－12:00
場　　所：建設省土木研究所　531会議室
出 席 者：インドネシア　Soedarmanto Darmonegoro 公共事業省研究開発庁次長
日本　池村　雅司　材料施工部長
河野　広隆　コンクリート研究室長
渡辺　博志　コンクリート研究室主任研究員
菊森　佳幹　コンクリート研究室研究員
府内　洋一　コンクリート研究室部外研究員
木村　嘉富　基礎研究室研究員
元田　良孝　建築研究所　第二耐震工学室長

１．討議内容

インドネシア側は、道路橋用の材料に関する現状の説明を行った。話題の中心はコンクリート用骨材についてであり、いくつかの地点での道路構造物におけるコンクリート用骨材に関する問題、および、人工軽量骨材の製造・利用技術に関して紹介した。

日本側は、土木研究所コンクリート研究室で現在実施している道路橋の材料に関わる研究内容の説明を行った後、インドネシア側提案に関連する次のトピックスに関する説明を行った。

１）日本における人工軽量骨材の利用
２）日本の骨材の状況と問題点
３）コンクリート橋の耐久性

この他に、基礎研究室で行っている橋梁基礎の洗掘の非破壊検査手法に関する技術開発の紹介を行い、共同研究推進法についても議論がなされた。

２．今後取り組むべき研究課題

人工軽量骨材の適切な使用方法などについて研究を推進することの重要性が認識された。

３．今後の協力方法

１）道路橋に用いられる材料および非破壊検査手法に関する情報の交換を行う。
２）必要に応じて、予算の許す範囲で、技術者の相互派遣を行うよう努める。

４．会議における合意事項

道路橋に用いられる材料に関する研究成果・技術情報について、少なくともabstractについては英文で、相互に交換を開始することで合意した。

（3）討論要約（洪水防御）

開催日：平成５年１１月１８日（木）　9:30～12:00
場　所：建設省土木研究所　河川部輪講室
出席者：韓　国　　Dr. Keung-Hwan Kim　韓国建設技術研究院企画調整室長
　　日　本　　中尾　忠彦　　土木研究所河川部長
　　平林　　桂　　〃　　河川研究室研究員
　　服部　　敦　　〃　　河川研究室研究員
　　藤井　政人　　〃　　河川研究室研究員

１．討議内容

1-1　各国における河川事業をめぐる現在の課題

日本側は、現在日本で取り組まれている河川事業の動向について説明を行った。主な内容は以下のとおりである。

1)超過洪水対策関連事業
2)外郭放水路事業
3)多自然型川づくり

韓国側は、韓国での河川改修事業の現状について説明を行った。主な内容は以下のとおりである。

1)河川改修事業の目的
2)河川の現状
3)現在実施中、およびこれまでに実施された河川改修事業
4)都市河川に関する統計値

1-2　各国における技術開発の現状

日本側は、現在土木研究所河川研究室で現在実施されている自然環境に配慮した河岸防御技術に関する研究内容の説明を行った。研究課題はつぎのとおりである。

1)ベーン工法の設計法に関する研究
2)植生の流水に対する耐侵食性評価に関する研究
3)自然河岸の形成手法の開発に関する研究

韓国側は、韓国建設技術院で実施されている河川関係の研究の現状について説明を行った。主な研究課題はつぎのとおりである。

1)河川改修技術に関する研究
-河床材料の流送
-河道変遷
-貯水池への堆積
-汚濁土砂管理
2)河川環境管理
-水量の確保
-水質保全
-河川空間管理
-河川生物の保護
-河川景観の改良

２．今後取り組むべき課題

多自然形川づくりに関する研究をさらに積極的に推し進める。

３．今後の協力方法

1)双方の研究成果の情報交換を行う。

2)情報交換を通じて、研究協力の対象となる個別課題を絞り込む。

４．会議における合意事項

上記の協力方法に基づき、今後も情報交換を進める。

（4）討論要約（河川愛護）

開催日　平成５年11月18日（木）　　9:30～12:00
場所　　小貝川（下妻市）、建設省土木研究所　５３２会議室
出席者　ﾏﾚｰｼｱ　Teh Siew Keat　マレーシア農業省潅漑排水局河川部長

　　日本　　栗城　　稔　　建設省土木研究所河川部都市河川研究室長

１．討議内容
　討議に先立ち、フラワーベルト建設の進む小貝川を視察した。

　日本側は鬼怒川・小貝川における住民参加型の川づくりの試みを中心に、わが国の河川愛護の現状を説明した。その主な内容は、

　　鬼怒川・小貝川博覧会
　　鬼怒川・小貝川「河川コーディネーター」
　　鬼怒川・小貝川 '川の憲法'
　　小貝川フラワーカナル
　　鬼怒川・小貝川フラワーベルト
　　ラブリバー制度

　マレーシア側は、１９９３年にマレーシアで行われた 'ラブ・アワ・リバー' キャンペーンについて、説明し、このキャンペーンの下に実施された数々の活動について報告した。氏は日本の河川愛護月間についての情報を強く要請した。これは、マレーシアが１９９４年及び、それ以降のフォローアップキャンペーンを計画しており、その参考とするためである。

２．今後取り組むべき研究課題
　河川愛護についての支持は十分得られるものと考えられる。河川をさらに身近なものにし、河川愛護を促進するための研究が必要である。

３．今後の協力方法
　１）双方の研究成果の情報交換を行う。
　２）予算の許す範囲で相互訪問を行う。

４．会議における合意事項
　研究成果・技術情報を交換することについて合意した。

（5）討論要約（地下空間利用）

開催日：平成５年１１月１８日（木）９：３０～１２：００
場　所：建設省土木研究所　６２７会議室
出席者：シンガポール（国家開発省）Khor Poh Hwa　公共事業局土木技術担当課長
　　日本（建設省土木研究所）　古賀　泰之　地下開発研究官
　　瀬尾　卓也　交通安全研究室長
　　猪熊　　明　トンネル研究室長
　　真下　英人　トンネル研究室主任研究員

１．討議内容

両国とも都市トンネルの建設や地下利用、特にシンガポールの地下道路方式に関する国際技術協力について熱心に討議を行った。

日本側は、トンネルと既存の建物との近接施工の問題、地下利用のあり方について日本の設計事例の説明を行った。主な内容は、

１）近接トンネルの設計の考え方、対策工法、対策の検討方法
２）地下利用の現状
３）今後の国際協力の方法

シンガポール側は、シンガポールの地下利用やトンネル建設の現状と問題の説明を行った。主な内容は、以下の通りである。

１）地下利用、トンネルを含めた道路ネットワークの計画
２）近接トンネルの設計条件

２．今後取り組むべき研究課題

都市トンネルの建設に伴う課題、特に近接構造物がある場合のトンネルの設計法、施工法、地下利用のあり方などが今後の研究課題とされた。

３．今後の協力方法

１）双方の研究成果の情報交換を行う。
２）必要に応じて、予算の許す範囲で、技術者の相互派遣を行うよう努める。

４．会議における合意事項

双方で近接構造物がある場合のトンネル建設に関する技術や工事実績の情報交換を図る。また、今後の技術協力の方法について検討する。

(6)討論要約(大気汚染対策)

開催日：平成5年11月18日(木)　9:30～12:00
場　所：建設省土木研究所　526会議室
出席者：タイ　Anusornant Mahavinichaimontri　内務省公共事業局材料研究部長
日本　水谷　敏則　環境部長
藤原　稔　構造橋梁部長
石田　稔　交通環境研究室長
上坂　克巳　交通環境研究室研究員
稲沢　太志　交通環境研究室研究員
今野　久志　構造研究室研究員

1.討議内容

日本側は、日本で現在実施されている大気汚染対策の概要について説明を行った。主な内容は、以下のとおりである。

1）排ガス規制
2）渋滞対策による効果
3）バッファーゾーン・植物のNOX吸収効果

また、振動について要請があったので説明を行った。主な内容は、以下のとおりである。

1）道路交通振動の原因、評価量
2）建設工事中の振動に関する規制
3）建設機械の開発状況

タイ側は、都市域大気特性の概要について説明を行った。主な内容は、以下のとおりである。

1）交通に起因する大気汚染
2）工業に起因する大気汚染
3）発電に起因する大気汚染

さらに、生活環境改善へ期待される効果についての説明を行った。
最後に、大気汚染実験施設および騒音実験施設の見学を行った。

2.今後取り組むべき研究課題

自動車排出ガスによる大気汚染の対策は発生源対策が基本であるが、道路構造等によってもできるだけの対策を行う必要がある。今後とも幅広い調査研究を行う。

3.今後の協力方法

双方の研究成果の情報を提供する。

4.会議における合意事項

研究成果・技術情報について、英文あるいは英文のabstractで作成されたものがあれば、相互に提供する。

（7）討論要約（舗装）

開催日：平成５年11月18日(木)　14:00～16:30
場　所：建設省土木研究所 531会議室
出席者：インドネシア　Soedarmanto Darmonegoro　公共事業省研究開発庁次長
　　日本　中村　俊行　土木研究所舗装研究室長
　　桐山　孝晴　舗装研究室研究員
　　森　修二　舗装研究室研究員
　　小森谷一志　舗装研究室
　　佐々木　厳　化学研究室研究員

１．討議内容

インドネシア側は、舗装材料として使用される人工骨材について、製造方法、品質規定、アスファルト混合物としたときの性状についての説明を行った。

日本側は、現在の舗装に関する技術として、ＲＣＣＰ、リサイクリング、排水性舗装等についての説明を行った。

主な討議内容は以下のとおりである。

・人工骨材を用いたアスファルト混合物は、最適アスファルト量が多く、マーシャル安定　度が高く、ホイールトラッキング試験は通常混合物と同等である。
・重交通道路の耐流動対策として、日本ではギャップ粒度が用いられるが、インドネシア　では効果が少ない。
・インドネシアの舗装の設計法は、AASHTO、BSに基づき、仕様書を作成している。
・インドネシアでは、リサイクリングを始めた。
・インドネシアにおける現在の主要プロジェクトは、ジャカルターバンドン間の有料道路　の建設である。

２．今後取組むべき研究課題

人工骨材の適切な使用方法、重交通道路におけるアスファルト混合物の配合設計について研究する必要がある。

３．今後の協力方法

当面は、情報交換を行う。将来は、共同研究の実施についても検討する。

４．会議における合意事項

情報交換を通じて、両国の技術交流を促進する。

（8）討論要約（環境改善－下水道－）

開催日　平成５年11月18日（木）　14:00～16:30
場所　建設省土木研究所　526会議室
出席者　韓国
Kim Keung Hwan　韓国建設技術研究院企画調整室長
タイ
Anusornant Mahavinichaimontri　タイ内務省公共事業局材料研究部長
日本
市村　訓男　建設省土木研究所下水道部長
佐藤　和明　下水道部新下水処理研究官
田中　修司　下水道研究室長
高橋　正宏　三次処理研究室長
渡部　春樹　汚泥研究室長
田中　宏明　水質研究室長
塩路　勝久　下水道研究室主任研究員

１．討議内容

各々の国における下水道事業を巡る現状について韓国・タイ・日本側よりそれぞれ説明を行い討議を行った。次に日本の下水道整備５箇年計画について情報を提供した。以上により韓国・タイ・日本それぞれの抱える課題が明らかになると共に、各国の相互の情報交換の重要性が認識された。

２．今後取り組むべき研究課題

熱帯・亜熱帯地方に適した下水処理技術の開発
栄養塩の除去

３．今後の協力方法

１）情報交換
双方の研究成果の交換を行う。
２）人的交流
国際協力事業団を通じた技術者の派遣（タイ）

４．合意事項

研究成果を相互に提供する。

（9）討論要約（河川環境の創造）

開催日：平成５年１１月１８日（木）　１４：００～１６：３０
場　所：又次沢（つくば市）、建設省土木研究所５３２会議室
出席者：マレーシア　Teh Siew Keat　マレーシア農業省潅漑排水局河川部長
　　日本　鈴木　興道　河川環境研究室主任研究員

１．討議内容

日本側から、「多自然型河川工法の効果（Effect by Naturally Diverse River Construction Methods）」と題した参考資料が提出された。また、土木研究所河川環境研究室で実施されている生態系保全を配慮した河川整備、河川景観の保全・創造技術、水質浄化技術等に関する研究内容の説明を行った。

主な内容は以下の通りである。

１）河川改修が生態系に与える影響に関する研究
２）多自然型河川工法及びビオトープに関する研究（実施例含む）
３）ＣＧ等を利用した河川景観の保全・創造に関する研究
４）水質浄化対策の現状と水質浄化技術の開発に関する研究

この他に、日本の河川や生物、水質の特徴等について説明を行った。

マレーシア側は、都市域における河川環境の現状及び今後の計画について説明を行った。

２．今後取り組むべき研究課題

自然の機能を生かした水質浄化技術、及びそれと組み合わせた生態系保全技術、河川景観の保全・創造技術の開発。この課題は、日本においても鋭意研究が進められており、今後種々の機能の効果や設計法について研究を行い、河川や湖沼、多様な水辺への適用を図る。

３．今後の協力方法

１）河川環境の創造に関する情報交換を行う。
２）情報交換を通じて、研究協力の対象となる個別課題をしぼり込む。
３）予算の許す範囲で、技術者の交流及び訪問を行うよう努める。

４．会議における合意事項

河川環境問題及びその改善技術に関する研究成果・技術情報について相互に交換する。

（１０）討論要約（道路交通管理）

開催日：1993年11月18日(木)　14:00～16:30
場　所：建設省土木研究所　627会議室
出席者：シンガポール　Khor Poh Hwa　国家開発省公共事業局土木技術担当課長
　　日本　松村哲男　総合交通安全研究官
　　山田晴利　新交通研究室長
　　瀬尾卓也　交通安全研究室長
　　元田良孝　建築研究所第二耐震研究室長

１．討議内容

日本側より，わが国の交通渋滞の状況及び現在実施中あるいは実施が検討されている交通管理政策について説明を行った。主な内容は次の通り：

(1)　現在の渋滞状況と対策
①道路交通の現況
②交通渋滞の現況
③交通渋滞の影響
・時間損失
・エネルギー消費と環境への影響
・交通事故と渋滞
④最近の渋滞対策
(2)　将来の交通管理政策
①新渋滞対策プログラム
②検討中の渋滞対策
・交通アセスメント
・ロジスティックス
・ロード・プライシング
③実施例
・バス専用/優先レーン
・首都高速道路のランプ閉鎖
・フレックスタイム

シンガポール側は，同国において実施されているロード・プライシングについて説明を行なった。主な内容は，次の通りである：

(1)　地域ライセンス・システム
(2)　電子式ロード・プライシング・システムの実験

２．今後取組むべき研究課題
(1)　道路交通管理の実施方法
(2)　道路交通管理による効果の推定方法

３．今後の協力方法

必要に応じて，双方の情報交換を行う。

4．会議における合意事項

必要に応じて，研究成果・技術情報の交換を行う。

４．会議の将来計画

本会議の将来計画について、１１月１９日１０時３０分から１１時４０分まで、住吉土木研究所長を議長として、８ヶ国全員による討論が行われた。概要は以下のとおりである。

各国の参加者から本会議の有効さと継続発展の重要性が述べられ、本会議がアジア地域の土木技術研究ネットワークの一翼を担い、各国で抱えている技術的課題に対し、研究情報の交換、人的交流を通してその解決へ相互に協力していくことが合意され、また、第３回以降の開催計画として以下の合意がなされた。

１）基調講演

基調講演は継続して２～３題を行うこことし、特定課題で討論されるテーマについても基調講演が行われるように配慮する。

２）カントリー報告

各国の概要、公共事業の概要等については第１、２回会議において報告されており、今後の会議では既発行のパンフレット等により充分にカバーすることとする。

カントリー報告においては公共事業における研究機関の役割、研究機関における研究開発の内容、トピック、研究マネージメント、研究成果の普及方法等の発表とする。

３）特定課題

テーマ数を絞り２テーマ程度とする。テーマの候補としては、以下のテーマに関する研究開発とする。次回の具体的な特定課題のテーマの決定は、次回会議の参加者等を考慮して決定される。このうち適当なテーマについては、基調講演により行われるように配慮する。また、環境、防災等の広いテーマで行われる場合もある。

①環境
1)環境改善のための社会資本整備
2)環境に配慮した社会資本整備
②材料・施工技術
3)地域資源を活用した土木技術
4)新材料及び先進建設技術
③防災
5)災害予測、警戒、避難等の災害事前対策
6)災害時の応急復旧等の緊急対策
7)再度災害防止のための復興計画
④道路
8)道路建設、維持管理
9)交通管理、交通安全対策
⑤アジア地域における共同研究の現状と課題
⑥研究情報交換システム
⑦技術の普及、技術基準整備と研究所の役割
⑧品質管理
⑨その他

4）分野別課題
継続する。

5）開催方法
①開催時期
1994年10月
②開催期間
2週間
③開催国、場所
日本、つくば市、土木研究所
④参加国
拡大の可能性がある。
⑤参加者
研究開発に直接携わっている研究所長、本省の局長クラスを対象とする。
参加者の事業分野をＧＩに明記する。

III. 会 議 最 終 結 論

「第２回アジア地域土木研究所長等会議」最終結論

平成５年１１月１５日（月）～２６日（金）、土木技術の研究開発とその推進を担当するアジア地域諸国の研究所長等の責任者が一堂に会する「第２回アジア地域土木研究所長等会議」が国際協力事業団の協力のもと建設省土木研究所で開催された。

中国、インドネシア、韓国、マレイシア、フィリピン、シンガポール、タイおよび日本の８カ国の公共事業の研究開発およびその推進に携わる政府関係機関の責任者の参加を得て、各国のカントリーレポートを使って、お互いの国の課題等について理解を深め、互いの経験を生かし合うという共通の認識のもとに報告と意見交換を行った。

その概要は以下のとおりである。

１．基調講演

カントリー報告・討議に先立ち３題の基調講演が行われた。日本海外コンサルタンツ（株）濱守 厚 社長による、経済発展とインフラ整備、大規模開発における環境問題への対応および２１世紀への挑戦を内容とする「持続可能な開発のための土木技術者の役割」、建設省土木研究所　住吉 幸彦 所長による、明治維新以降の日本の経済発展と土木技術の進歩・アジア諸国の各社会資本施設ごとの整備状況と問題点およびアセアン諸国における技術移転の実態を内容とする「経済発展段階と建設技術の移転」、筑波大学構造工学系　椎貝 博美 教授による、日本の科学技術の特色、土木研究所の役割および研究における重要な要素を内容とする「日本における研究について　－土木工学を中心として－」が講演された。

２．カントリー報告

各国の概要、公共事業の現状、研究機関の概要、研究機関における主要な研究開発、国際研究交流について発表がなされ、順次、質疑応答がなされた。

報告は以下に要約される。

１）各国の自然、社会、経済についての報告があり、アジア各国の共通する課題および各国独自の課題について相互に理解を深めた。

２）各国の発展に不可欠の道路、河川、ダム、砂防、下水道など社会基盤整備を進める上で土木技術研究・開発の必要性と重要性が指摘された。

３）各国の公共事業に関する研究開発の状況が報告され、各国とも熱心に研究に取り組んでおり、研究すべき課題・研究の実施方法において多くの共通点が認識された。
また、各国がかかえる特有の課題及び取り組みについて興味深い報告がなされ、それらについて各国相互に理解を深めた。

４）各国とも意欲的に国際研究交流を行っていることがみうけられ、今回の討議により、さらに国際研究交流の推進の必要性を認識した。

３．特定課題討論

特定課題討論では、「総合的な治水対策」、「道路のり面災害対策」、「ダム湖や河川の水質保全対策」、「都市部における道路交通による大気汚染および騒音への対策」について報告と討議を行った結果、つぎの結論を得た。

１）各国の災害と防災対策ならびに環境と社会資本との調和を目指した事業に関する状況、さらにはそれらに関連した研究の取り組みについて意見交換により理解を深めることができた。また、このことは今後とも一層重要である。

２）ダム・堤防建設は抜本的な対策だがすぐには完成しない。また完成後も洪水対策等の有効性を確保するには非構造物対策が重要である。

3）道路のり面災害は、各国において道路交通の障害をもたらす重要な課題となっている。このため、道路防災地図（ハザードマップ）の作成、斜面及び斜面崩壊情報のデータベース化、斜面崩壊の予知システムや対策工法の開発が望まれる。
4）河川ダム湖の水質対策は、各国の事情に応じた対応が求められている。このため、水環境に有効な下水道の整備や水のリサイクルについての情報交換は有用である。
5）道路交通による大気汚染及び騒音は都市部の生活環境保全の上で重要な課題となっている。したがって、これらの現状と対策について情報を交換することは、各国の環境改善のための調査研究を行ううえで有益であり、今後とも一層の情報交換の推進が必要である。

4．分野別課題討論

分野別課題討論では、個別の土木技術分野について、関係する参加者が集まって討論した。今回は、多岐にわたる土木技術分野の中から各参加者に関心のあるテーマに分かれて、土石流(中国、フィリピン、日本)、道路橋の材料－ｺﾝｸﾘｰﾄ－(インドネシア、日本)、洪水防御(韓国、日本)、河川愛護(マレイシア、日本)、地下空間利用(シンガポール、日本)、大気汚染対策(タイ、日本)、舗装材料(インドネシア、日本)、環境改善－下水道－(韓国、タイ、日本)、河川環境の創造(マレイシア、日本)、道路交通管理(シンガポール、日本)の１０の討論テーマについて、個別に討論を行った。

討論を通じ、個別の土木技術分野における各国の諸問題や研究状況等について、討論参加国相互に理解を深めることができた。また、それぞれの土木技術分野において、今後さらに詳細な情報交換を行う等、より一層の研究協力の必要性が認識された。

5．本会議の将来計画

各国の参加者から本会議の有効さと継続発展の重要性が述べられ、本会議がアジア地域の土木技術研究ネットワークの一翼を担い、各国で抱えている技術的課題に対し、研究情報の交換、人的交流を通してその解決へ相互に協力していくことが合意され、また、第３回以降の開催計画として以下の合意がなされた。

1）基調講演および分野別課題は継続することとした。
2）カントリー報告については、研究機関における研究内容、トピック、研究マネージメント、公共事業における研究機関の役割、研究成果の普及の発表とする。
3）環境、材料・施工技術、防災、道路建設・維持管理・交通マネージメント、共同研究、研究情報の交換、技術の普及・基準整備、品質管理に関する研究開発が提案され、これらのうちから２つ程度のテーマに絞り、参加者等を考慮して第３回会議の特定課題とすることとした。
4）第３回アジア地域土木研究所長等会議は、1994年10月頃とし、開催期間は２週間、日本国建設省土木研究所で行うこととする。

6．シンポジウム

本会議の活動の一環として、「第２回アジアにおける国土開発と土木技術に関する国際シンポジウム」を１１月２２日（月）に福岡市にて、建設省土木研究所および九州地方建設局の主催により、産・官・学の各界より２００名の参加を得て開催された。その概要は、以下のとおりである。

1）九州大学工学部 樗木　武教授による古代から現代に至る九州地方の発展と土木技術の果たしてきた役割、および今後期待される土木技術発展の方向を内容とした「九州の地域開発と土木技術」と題する基調講演が行われた。
2）「より良い生活環境の創造　－地域開発、防災、環境－」をテーマとしたパネルディスカッションでは、住吉土木研究所長をコーディネーターに、７ヶ国の海外参加者と

荒牧九州地方建設局長をパネリストとして、各国の生活環境改善のためのプロジェクトについて発表と討論を行い、各国の現況について相互に理解が深まった。また、今後環境と調和した社会資本整備と土木技術の研究開発の推進が一層求められており、相互の研究情報の交換や日本のアジア諸国に対する技術協力への一層の期待が表明された。

7．まとめ

1）カントリー報告を通じ、互いの国の現状、抱える課題、研究開発状況及び展望等について幅広く理解を深めることができた。

2）特定課題討論を通じ、災害および防災に関する研究開発および環境と社会資本整備の調和に関する研究開発を推進するための情報交換を積極的に進めることが合意された。

3）分野別課題討論を通じ、各国の現況、課題、研究活動について相互理解が進み、一層の情報交換等の研究協力の重要性について意見交換がなされた。

4）環境、材料・施工技術、研究情報の交換等に関する研究開発が提案され、これらのうちから２つ程度のテーマに絞り、次回会議の特定課題とすることとした。

5）関係各国の一層の社会基盤整備のために関係国の蓄積された経験と研究成果の共有の重要性を認め、この会議の有効さと継続発展の重要性が全員一致で合意された。

Ⅳ. 閉　会　式　挨　拶

閉会式挨拶

建設省土木研究所長　住吉　幸彦

「第２回アジア地域土木研究所長等会議」の閉会を迎えるに当たり、日本からの出席者を代表しまして一言ご挨拶させて頂きます。

１１月１５日にこの会議を開会してから本日で１１日目を迎えたわけですが、このつくばでの本会議及び九州地方での視察旅行を通じて土木技術の研究開発分野におけるアジア各国の責任ある地位の方々と各国の主要プロジェクトや研究開発の現状と問題点等について意見交換が出来たことは国の発展の基礎である社会資本整備上の、同じような課題を抱えるアジアの隣人同志が今後一層交流を深め、新たな協力の枠組みをつくり上げるための大きな原動力となるものと、思います。

この会議におきましては、基調講演、各国の公共事業の現状・土木技術の研究開発の現状と課題、国際研究協力等についてカントリー報告がなされ、さらには各国共通の課題である「災害及び防災に関する研究開発」、「環境と社会資本整備の調和に関する研究開発」についての討論を行いました。また、各国が抱える個別の分野についても関係国で意見交換を行い、最後には本会議全体を取りまとめた最終結論を採択致しました。

今回の会議での一番の成果は、各討論を通じまして、このように各国の関係者が協力していくことの必要性があらためて、強く認識されたところでございます。今後、このアジア地域土木研究所長等会議をさらに発展させていくことによって、土木技術の研究開発分野のみならず、その枠を越えたところでも質の高い国際交流が、ますます盛んになると確信致します。ひいては、アジア各国の経済社会の発展を支える社会基盤施設の整備が益々進むことになるものと考えられます。

海外よりご出席されましたみなさまにおかれましては、明日は本省表敬と東京湾横断道路の視察が予定されておりますが、ご健康に気をつけられ残り少ない日本での滞在を楽しんで頂きたいと思います。

最後になりましたが、会議運営に携わられた関係者の方々のご協力にお礼申し上げまして、私の挨拶と致します。

マレーシア農業省灌漑排水局河川部長 Teh Siew Keat

「第２回アジア地域土木研究所長等会議」の閉会式におきまして、海外参加者を代表しましてこのようなご挨拶を述べる機会を与えて頂いたことに感謝いたします。

まず最初に私はこの会議は大成功であると述べたいと思います。また、非常に見事に運営されました。海外のみならず日本からも含めた参加者全員により、情報経験を分かち合い交換するたいへん良い機会となりました。そのお互いの交流は、自由に活発で建設的なものでした。この会議は非常に素晴らしい成果をあげました。このことは、今後のアジア地域間での土木技術の一層の進歩に貢献し、国の発展と繁栄に大きく貢献すると、思います。

私共はみな、情報、意見交換により互いに分かち合い、その成果を国に持ち帰って伝えていこうと、期待をしてまいりました。つくばを離れ、日本を離れる日も間近です。当初の期待が現実になったことに満足して帰れます。この会議が、今後の長きにわたって継続し、他のアジア諸国間の参加も考慮されれば幸いです。私は、アジア地域の土木技術水準の向上と相互理解の促進というこの会議の重要な役割を固く結んだと、確信します。それは自然な相互協力の形態だと思いますし、日本が牽引者であると認識しています。みなさんは、先進的な土木技術研究開発を行っています。私たちは、日本での経験を分かち合い、知識を共有して下さるという気持ちの広さを知っております。

さらに、私たちの滞在は心地よく楽しいものして頂き、みなさんはホストとしての力量も素晴らしいものであります。四国・九州方面への視察旅行は、たいへん楽しく学ぶところの多いものでした。福岡での「第２回アジアにおける国土開発と土木技術に関する国際シンポジウム」に参加できたこと、また本州四国連絡橋を含め非常に素晴らしい公共事業、土木技術を視察できましたことは、本当に幸せであります。

このあたりで、私の気持ちを話すことをお許し下さい。私たちは、とても喜ばしい思い出を胸に日本を発ちます。住吉所長はじめスタッフのみなさま、ＪＩＣＡのみなさま、視察でお世話になった地方建設局等のみなさんの勤勉さには、私共にとって明らかであります。みなさんは、私たちに再度、日本人の勤勉さと指示と訓練を尊重することを教えてくれました。

最後に、私たちは次のことを思いつつ日本を発ちます。

1)実りある成功裡に終了した会議の結論

2)日本の現在を深く知ったこと

3)多くの友人をつくることができたこと。

これらは、すべて今後の協力に役に立つでしょう。

そして、この会議に携わりました土木研究所、建設省、国際協力事業団はじめみなさんに重ねてお礼を申し上げます。ありがとうございました。

（C）基　調　講　演

Ⅰ．持続可能な開発のための土木技術者の役割

日本海外コンサルタンツ(株)社長　濱　守　　厚

持続可能な開発のための
土木技術者の役割

濱守　厚
日本海外コンサルタンツ（株）社長

1．序言

此の度第２回アジア地域土木研究所長等会議の開催に当たって、基調講演を行う機会を与えられた事を大変光栄に存じます。私は、河川工学、水資源開発、災害対策等を専門とする土木技術者として、日本政府の建設省に３０年間在籍し、その間、この土木研究所にも勤務して現在の施設の建設計画や、国際協力活動などに従事した経験があります。国際的な経験としては、１９６１年からオランダの国際水理学講座に参加して、多くの国の友人を得たのをはじめとし、国連の食糧農業機関（ Food and Agriculture Organization）の専門家としてスリランカの水資源総合開発計画に３年間、国連アジア太平洋経済社会委員会（ＥＳＣＡＰ）の職員となってマニラの台風委員会事務局に台風災害軽減専門家（Expert in Typhoon Damage Reduction）として約６年在勤し、さらに、建設省を退職する直前の５年間は、ＪＩＣＡ派遣専門家となって、インドネシアの公共事業省のアドバイザーを勤めた経験があります。

建設省退職後は、国際建設技術協会（International Engineering Consultants Association ）に１０年間在勤し、その間、多くの開発途上国の経済社会基盤整備のためのプロジェクトの発掘（finding）および促進（promotion）に従事するほか、ＪＩＣＡおよび海外経済協力基金（Overseass Economic Cooperation Fund）等の依頼により、事業計画審査（project appraisal）や環境配慮（environmental consideration） のガイドライン作成等の仕事を引き受けるという経験を致しました。　本日、私は上述のような、国際的な場におけるインフラ整備に従事する間に考え続けて来た「土木技術者の役割」について、特に「開発」と「持続可能性（sustainability）」というキーワードを巡ってお話をすすめたいと存じます。よく知られているように、土木事業は多額の資

金と、多数の人間を集めなければ実現されないので、古来、中央集権国家の成立がその実現の必要条件であり、したがって、事業の内容も為政者の政治目的に従って、例えば、古代エジプトのピラミッドのような権力の象徴であったり、古代中国の万里の長城や、中世の世界各地に築造された城のような防衛施設であったりして、開発や、持続的な発展に縁遠いものも多くあります。今日でも土木技術は政治目的の実現に用いられる属性を持っていますが、その目的とする処は、インフラ整備によって経済の発展と国民の福祉に貢献する事であります。このように平和的な手段によって国の繁栄を支える（sustain ）するのが、シビルエンジニアであり、ミリタリエンジニアに対比される存在と考える事も出来ましょう。

第２次世界大戦が終わってから、半世紀が経過する間に、戦争による壮大な破壊（destruction）から復興（reconstruction ）への努力がはじまる一方、新たに独立した国々の経済的な離陸（take - off）のための開発努力が展開され、多大な成果が得られる一方、事業の失敗や環境問題をはじめ、開発に伴う好ましからざる影響も経験されるに至り、その結果、「持続性（sustainability）」なる語が、流行的（trendy）にもてはやされるようになりました。この流行語であるサステナビリティは、２つのケースに用いられているように思われます。１つは、広い意味で、「持続可能な開発（sustainable development）」という場合で、どんな事業をやれば開発が持続的に進むか、という事が命題となります。もう一方のケースは「事業効果の持続性（project sustainability）」という場合で、ここでは事業そのものをどうすれば成功裡に継続させられるかが問題となりましょう。いづれの場合も、開発方針あるいは事業計画の初期の段階で予見されなかった要因によって、開発努力の成果が阻害されたり割引されたりする点で共通しています。そして、これらの不都合を避けるような計画の作成と、若し発生した場合の是正と、いづれの場合にも、より高度な技術力が要求され、土木技術者の役割がますます増大すると云えましょう。そこで、次に、インフラ整備、開発、環境問題等について、土木技術者の係わりを事例にもとづいて考えてみたいと思います。なお、本講において土木技術者という場合は学校で土木工学を専攻した者に限らず、土木技術を用いて行うインフラ整備事業に関与する人と理解していただきたいと思います。

2．経済発展とインフラ整備

相互支持（mutual sastenance）

インフラストラクチャーとは、人間の存在と活動を支えるために、自然環境の上に設けられた物理的な施設と理解されます。その目的によって自然災害を防いだり、生活に快適さや便利さを与えるためのものが社会インフラと呼ばれる一方、物流やエネルギー供給などを支える施設を、経済または産業インフラと呼ぶ場合もありますが、この区別は厳密にはつけ難く、殆どのインフラがこの両面の機能を持ち合わせています。いづれのインフラも広域的、かつ多大の人に便益をもたらす大規模な施設であるため、その実現には適切な技術に裏づけられた計画と、莫大な資金の投入を必要とします。ローマ帝国の水道や中国の大運河など、国家の繁栄と中央集権のもとに膨大な資金と労力を投入したからこそ出来上がったものであります。インフラ整備事業の中でも最も難しく、金のかかる干拓によって国土の４０％を造成したオランダは、度重なる高潮災害によって干拓した土地を奪い返されながら経験を積み重ねた土木技術の上に、香辛料の貿易で得た莫大な富の蓄積があったから、実現されたのであります。

インフラは、また、その建設に大金が要るだけでなく、その機能を維持するにも金がかかるものです。よく引き合いに出される例として、古来、国が滅亡した後には堆積物（sediment deposit）によって航行不能になった水路が残されています。インフラがよく整備されているという事は、その国が経済的に豊かであった事、そして現在も豊かである事を端的に示すものと云えましょう。

最近、堅実な経済発展を続けているインドネシアを例にとって見ると、例えば、ジャカルタ・チカンペック（Cikampek）高速道路が完成するや、沿線に続々と工場が進出しつつあります。ところが、その一方、電力の供給不足が著しくなり、ジャカルタ市内の交通渋滞は益々ひどくなり、渇水年の水供給不足も心配されるに至り、企業が進出を断念するというケースも出はじめ、政府はこの発展のモーメンタムを維持（sustain ）しようと、道路、水資源、発電施設等のインフラ整備をあらためて促進する必要に迫られています。これは、インドネシアが石油価格の低下で国際収支が悪化した時期に、債務の累積を恐れてインフラ整備を抑制した後遺症であると云われていますが、実際問題として経済的に苦しい時期に、発展のための投資をする事は難しい決断ではないでしょ

Fig. 1

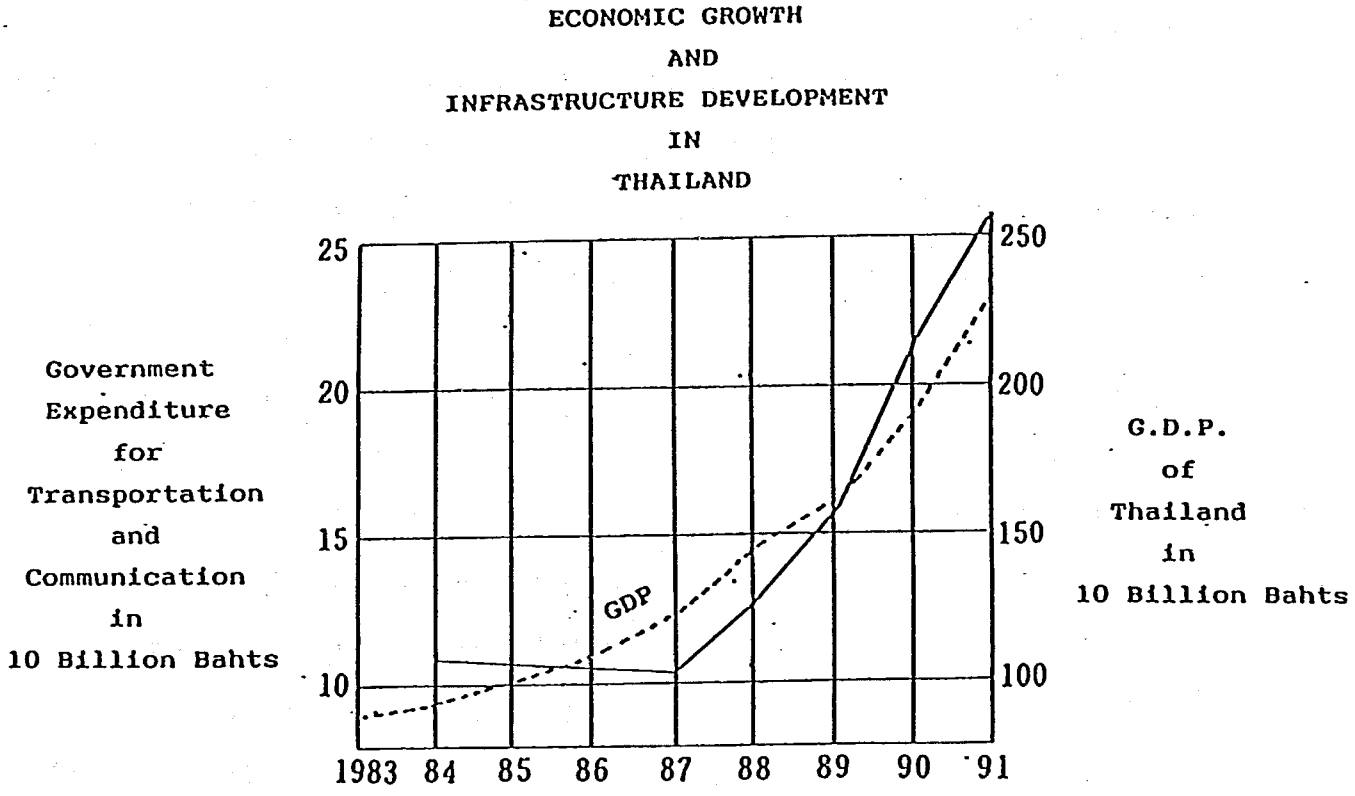
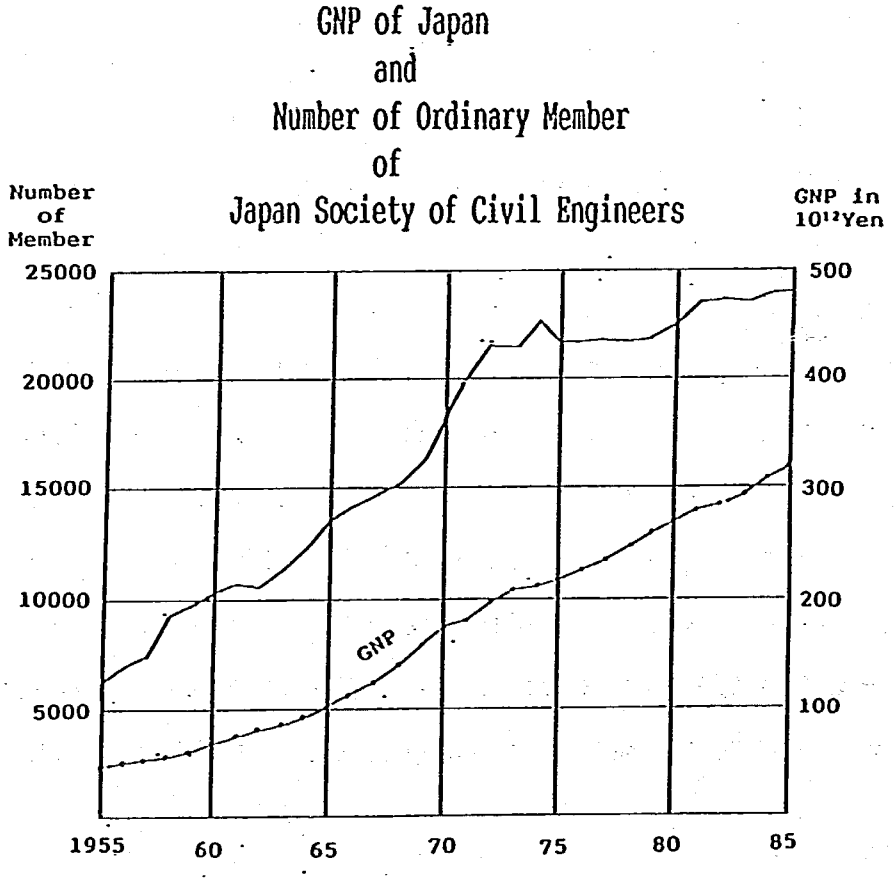

ECONOMIC GROWTH
AND
INFRASTRUCTURE DEVELOPMENT
IN
THAILAND
Government Expenditure for Transportation and Communication in 10 Billion Bahts
G.D.P. of Thailand in 10 Billion Bahts
GDP
25
20
15
10
250
200
150
100
1983
84
85
86
87
88
89
90
91

Fig. 2


GNP of Japan
and
Number of Ordinary Member
of
Japan Society of Civil Engineers
Number of Member
GNP in 10^{12}Yen
25000
20000
15000
10000
5000
500
400
300
200
100
GNP
1955
60
65
70
75
80
85

うか。

経済発展をインフラ整備の関係はこのように追いつ追われつの関係にある事を、近年目ざましい経済成長を遂げたタイの国内総生産（Ｇ．Ｄ．Ｐ．）と経済インフラの代表とも云える運輸通信部門への政府支出との対比で示すと、Ｆｉｇ．１のようになります。このようにインフラ整備と経済発展とは、相互に支持（sustain）し合うという、「良い循環」が成り立つ時に経済もインフラも共に発展を持続すると云えましょう。

日本の経験（experience in Japan）

日本においてもインフラ整備は時代の要請に応じて富国強兵、失業救済、民生安定、景気刺激等の政策を実現する手段として実施されて来ましたが、最も急速かつ持続的な発展を遂げたのは１９５０年代末からはじまった高度経済成長期でありました。この時期、つまり１９６０年代には日本の国民所得は毎年１０％を超える成長を何年も続け、公共事業費も同様の伸びを記録して、建設事業を行う現場では５・６年で倍増する事業予算の消化に苦慮する状態でありました。

Ｆｉｇ．２は日本のＧ．Ｎ．Ｐ．の推移と土木学会正会員の数とを対比させたものです。土木学会会員の数は土木技術者の総数ではありませんが、比例的な関係にあるものと考えられます。図から明らかなように、経済成長と土木技術者の数の増加には、どちらが先におこるかは別として、明らかに強い相関があると云えましょう。

なお、この時期のインフラ整備のために日本は１９５３年から１９６６年までの１４年間にわたって合計８億６千万ドルに及ぶ世界銀行の融資を受けている事をつけ加えて申し上げます。その融資の大部分は東海道新幹線、東名・名神高速道路、水力発電等のインフラ整備に用いられました。日本は借り入れた資金は元本共１９９１年までに全額返済し、逆に世銀に対し米国に次ぐ出資国となるほか、二国間ベース（bilateral basc）により、毎年７０億ドル以上の低利資金を発展途上国の主としてインフラ整備のために提供し、途上国の経済発展に協力する立場になっています。

3．環境問題への対応

アラル海（Aral Sea）の悲劇

開発が持続的でなくなる要因としては、資金の欠乏、計画の欠陥、維持管理の不適正等、種々ありますが、最も多いのは環境インパクトの発生であります。最近、世界の注目を集めている深刻な例は、旧ソ連のアラル海（Aral Sea）と、その流域の荒廃（devastation）であります。アラル海は中央アジアのシルダリア（Syr Darya）、アムダリア（Amu Darya）２大河川によって涵養され、約７万ｋｍ²の面積を持つ内陸湖でした。第二次世界大戦後、この流域の不毛の地を、両河川の水を利用して７４０万ｈａのかんがい農地に転ずるという壮大な自然改造プロジェクトでした。ところが、かんがい面積が増大するに従ってこの両河川からアラル海に流入する水量が減少し、その結果、湖の面積は６０％に減少、水面は１４メートルも低下し、湖岸線の後退は１００ｋｍにも及ぶという変化が現れました（Ｆｉｇ３参照）。この直接の影響は湖水の塩分濃度の増加となって現れ、魚が住めなくなった結果、年間４万ｔｏｎあった漁獲量が、皆無となってしまったほか、次のような環境インパクトが現れました。

（１）湖周辺の湿地帯に生息する貴重な動植物種が消失した。

（２）綿花が主要作物として導入され、機械による摘花を可能にするために使用された枯葉剤や他の農薬が地下水や河川水を汚染し、下流地域に肝炎その他の病気が多発し、幼児死亡率は１１％という高さに達した。

（３）乾陸化した湖底に塩が結晶化して堆積し、風によって撒き散らされ、農地の塩害、眼病その他の健康被害をもたらした。

以上は湖周辺の被害ですが、この事業の主目的である新たに開拓されたかんがい農地の何と４０％以上が塩害を受けているのです。これは砂漠のかんがいの場合に往々にして出会う困った現象で、かんがいによって地下水位が上昇するに伴い、土壌中の塩類が溶出され、毛細現象により塩分濃度の高い地下水が地表に運び上げられ、そこで蒸発して塩類が析出されて起こるものです。この事業の場合には次のような原因で特に塩害が甚だしくなったと考えられています。すなわち、

（１）導水路のライニングが施されていないため、漏水が多く、地下水位上昇を増大させている。

Fig. 3

REDUCTION OF WATER SURFACE AREA
OF
THE ARAL SEA

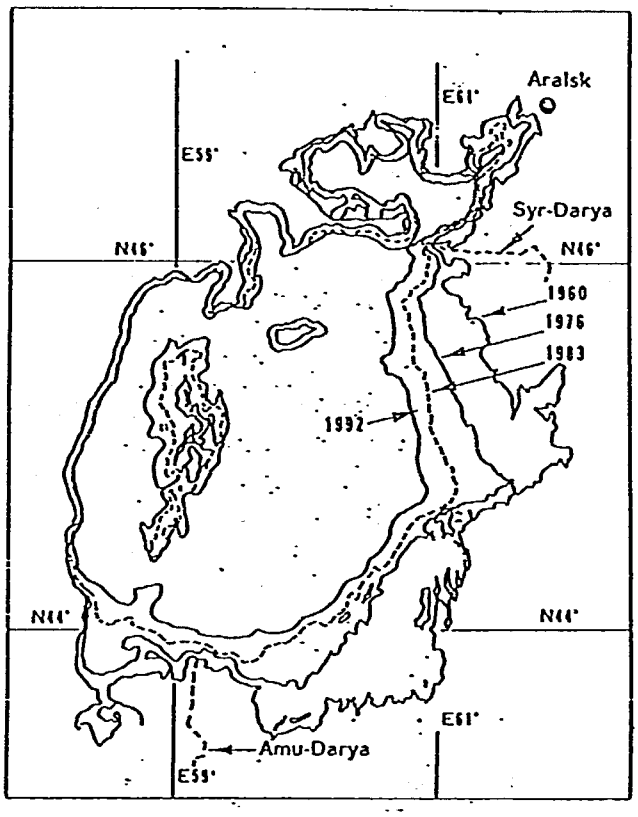
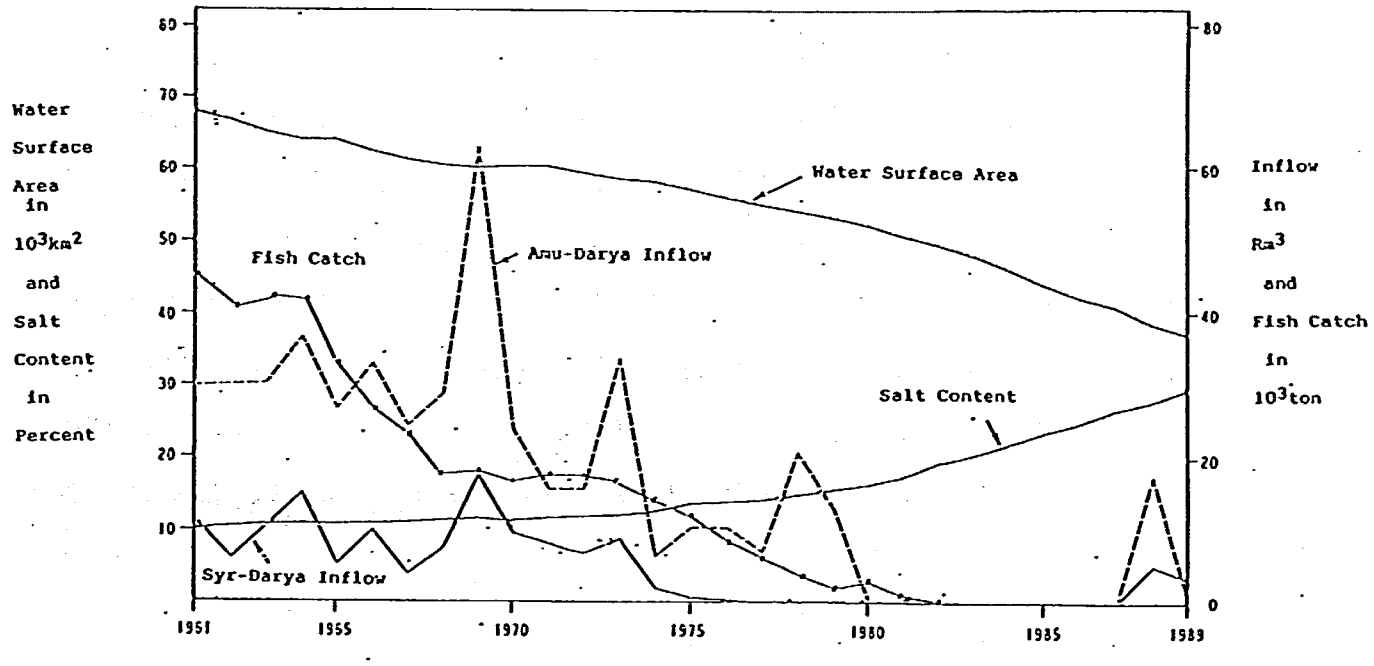


Fig. 4

DIMINISHING PROCESS OF THE ARAL SEA
AND
ENVIRONMENTAL IMPACT



（２）取水量に応じて管理人に賃金が支払われるシステムであったため、かんがい用水の過剰な取水が行われる。

このようにして塩害がひどくなった農地は荒廃して結局は見捨てられ、開発は文字通り持続不可能（unsustainable）となってしまいます。

アラル海問題解決への道

上述のようなアラル海流域環境破壊の影響は３７００万人の住む５つの共和国に及んでおり、そのうち災害多発地域の住民約３００万人が、飲料水や医薬品の供給等の緊急対策で必要としていると云われています。そのほかに、環境を少しでも良くし、あるいはこれ以上悪化させないため、減反や過剰取水防止、節水栽培等の管理的手段によって湖への流入量を増加させる方策が考慮されています。しかし、根本的な解決策としては、長期的に次のような対策が必要と考えられています。

（１）水路のライニング

（２）取水施設の改善

（３）排水施設の新設

（４）貯水システムの再構築

（５）道路および通信網の整備

すなわち、この事業による持続的な開発（stastainable development）を可能にするためには、これまたインフラの整備に頼らざるを得ない、と云えましょう。

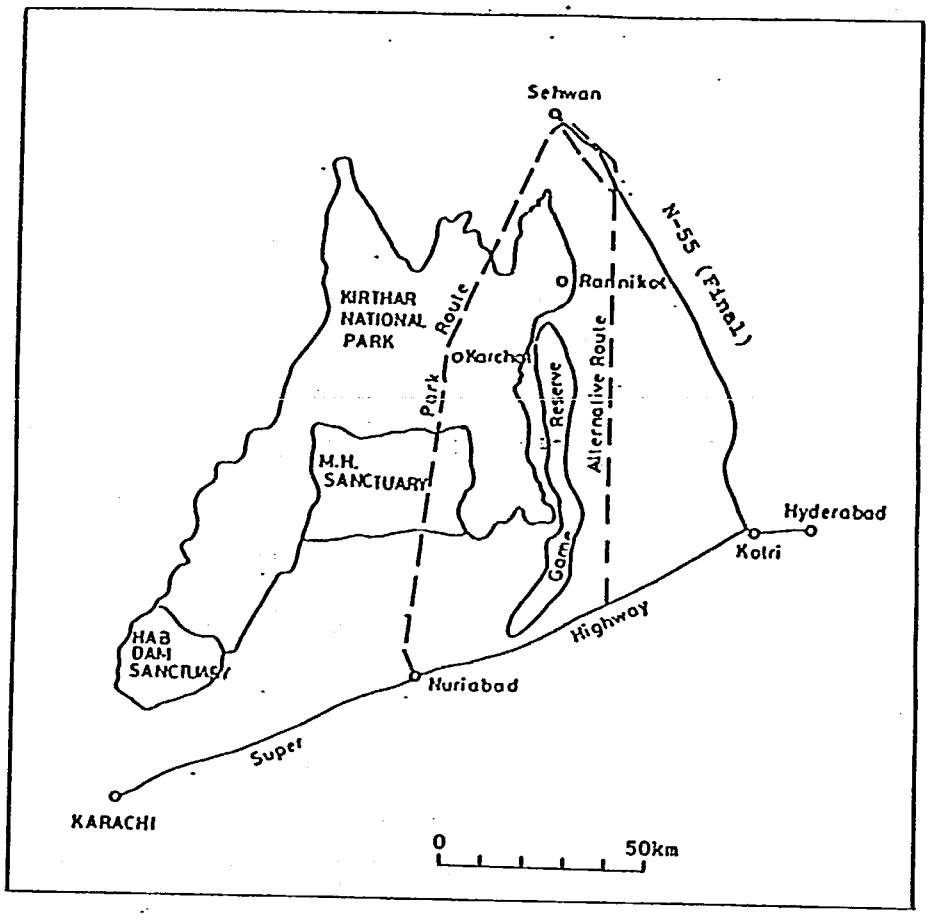
転ばぬ先の杖（prevention is better than cure）

アラル海の悲劇は、実は全く予見されなかったのではなく、旧体制下のソ連では中央政府の政策を批判する者には研究費も調査費も与えられなくなるような状況にあり、事業実施機関もノルマの達成に専念せざるを得なかった。つまり、チェック機能が働かないシステムだったわけです。中央集権がこのような大事業の実施を可能にしながら、中央集権的事業推進手法が事業を破滅に導いたのは何とも皮肉な結果です。ここで重要なポイントは、事前の対策の重要性であります。日本には転ばぬ先の杖という諺があります。これは、転ぶおそれ

のある人は杖をついて転ばぬようにした方が、転んでから手当をするより得策である、という意味です。年寄りなどは転び易いだけでなく、転んで命を落とす事もあるからです。環境問題に関する対策も事前に処置する方が有効かつ経済的な場合が多く、問題の種類によっては起こってからでは回復不可能という場合もあります。事前の対応の例は種々ありますが、私が関与した事業の例を次に紹介します。

Fig. 5

ENVIRONMENTAL CONSIDERATION
IN
PLANNING INDUS HIGHWAY PROJECT
(PAKISTAN)



Ｆｉｇ．５はパキスタンを縦断するインダスハイウエイ（Indus Highway）の最南部の路線設定に当たって検討された３つのルートを示したものです。最初の案は国立公園を通過するもので、特にその中の鳥獣保護区（sanctuary）を

通過する案でしたが、環境影響評価の結果、重大な影響ありと判断され、既存道路（Ｎ－５５）の拡幅・改修と、国立公園の東側を通る別のルートとが代替案として提案され、結局既存道路の拡幅、改修案により計画を進める事になりました。

Ｆｉｇ．６はインドネシア、スマトラ島のアチエ（Aceh）川放水路の例です。この放水路は、アチエ市（Banda Aceh）を頻発する洪水から守るために提案され、図に示すように、市の約１０ｋｍ上流から海へ洪水流を分水（divert）する計画が立案され、原案では、市の北東部のラグーンに放流するようになっていましたが、環境影響評価の結果次のようなインパクトがある事がわかりました。

（１）此のラグーンはエビおよびミルクフィッシュの産卵場として好ましい条件を備えているため、周辺の住民は満潮時に海水と共に幼魚を養魚地に取り込み、養殖して出荷している。放水路の建設により洪水流が導入されると、ラグーンの塩分濃度が低下すると共に濁度（turbidity）が著しく高くなり、幼生の生育に害がある上に、産卵のための親魚がラグーンに入らなくなる。魚の習性として、一度悪化した環境には戻って来なくなる可能性があり、数年に一度の放水であっても不可逆的な影響が残るおそれがある。

（２）放水路の底面の高さは満潮面より低く設計されるため、放水路沿いに海水が侵入し、両岸の土地の地下水の塩分濃度が増加し、飲料水やかんがい用水としての利用に支障を来す惧れがある。

このような悪影響を回避するため（１）については放水路をラグーンに開口せず、図に示すように外海に直接放流するように延長し、ラグーンを通過する部分は両側に築堤してラグーンの水と遮断する設計に改訂されました。（２）については、図に示す位置に防潮水門（tidal gate）を設ける事となりました。なお、放水路延長による地域分断の影響を緩和するために、防潮水門を橋梁と兼用の施設とするように設計されました。

このような事前の対策を落度なく行うために、世界中のインフラ整備に関与する機関がマニュアルやガイドラインを作成しています。私は国際建設技術協会在勤中、ＪＩＣＡの依託により１９８９年にダム建設計画に係る環境インパ

Fig. 6

ENVIRONMENTAL CONSIDERATION IN PLANNING ACEH RIVER FLOOD CONTROL PROJECT (INDONESIA)

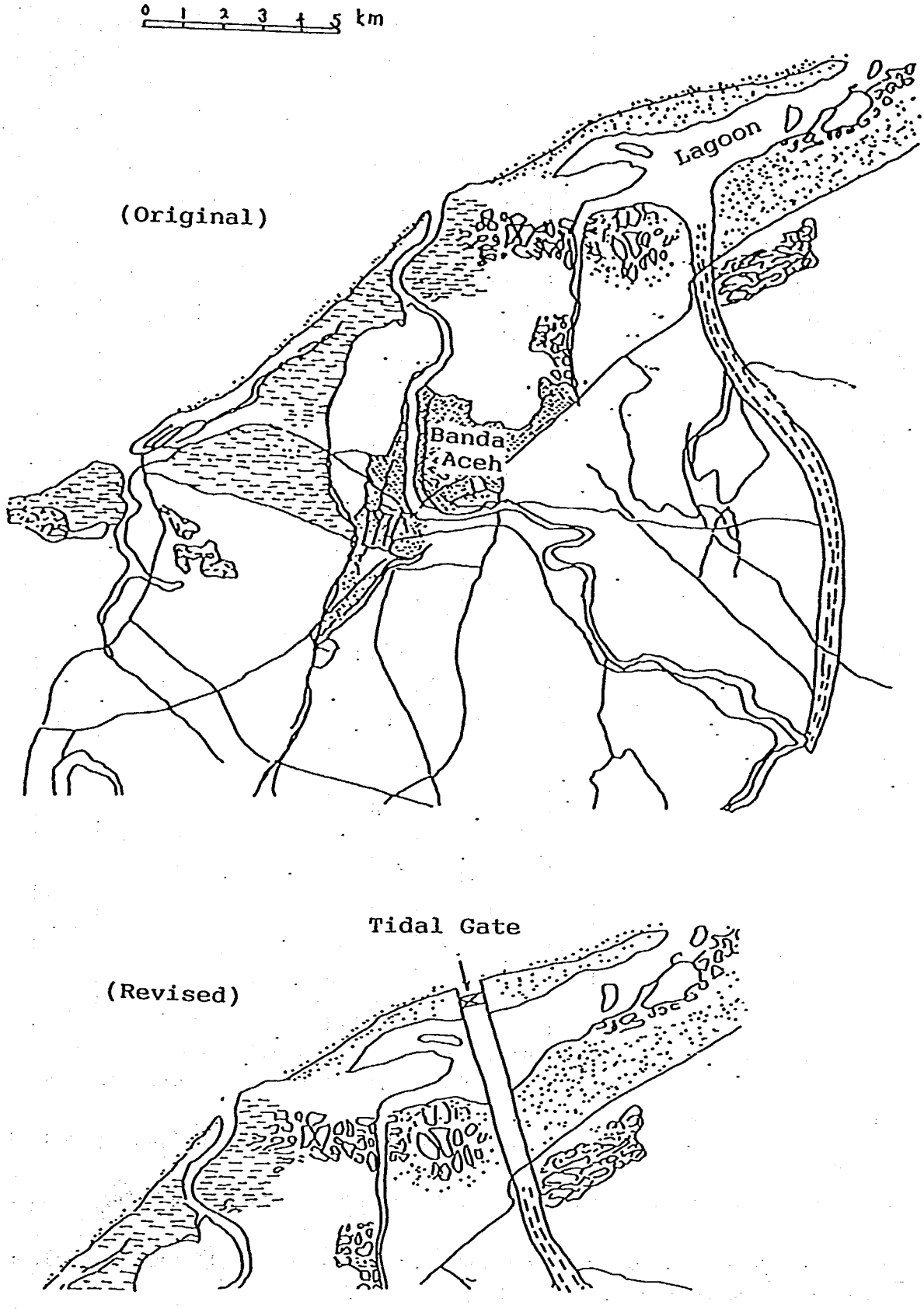


Fig. 7 Comprehensive Matrix for Scoping Guide (JICA Environmental Guidelines for Infrastructure Project)

		Project Type / Sectors / Environment Items	Sectoral Development									Comprehensive Development			
			1. Port and Harbor	2. Airport	3. Road	4. Railway	5. River and Erosion Control	6. Solid Waste Management	7. Sewerage	8. Groundwater Development	9. Water Supply	10. Regional Development	11. Tourism Development	12. Transportation Development	13. Urban Transportation Development
Social Environment	1	Resettlement	◎	◎	◎	◎	◎	○	○		○	○	○	○	○
	2	Economic Activities	○	○	○	○						○	○	○	○
	3	Traffic and Public Facilities	○	○	○	○	○	○				○	○	○	○
	4	Split of Communities		○	○	○	○					○	○	○	○
	5	Cultural Property	○	○	○	○	○					○	○	○	○
	6	Water Rights/Rights of Common	◎	○	○	○	◎			○	○	○	○	○	
	7	Public Health Condition				○		○				○	○	○	
	8	Waste	○	○	○	○	○	○	○			○	○	○	○
	9	Hazards (Risk)	○	○	○	○						○	○	○	○
Natural Environment	10	Topography and Soil Condition	○	○	○	○	○					○	○	○	
	11	Soil Erosion		○	○	○						○	○	○	
	12	Groundwater			○	○		○		◎		○			
	13	Hydrological Situation	○	○	○	○	◎	○			○	○	○	○	○
	14	Coastal Zone	◎	○	○	○	○	○				○	○	○	
	15	Fauna and Flora	◎	◎	◎	◎	◎	○	○		○	○	○	○	○
	16	Meteorology										○		○	
	17	Landscape	○	○	○	○	○	○	○		○	○	○	○	○
Pollution	18	Air Pollution	○	○	◎			◎	○			○		○	○
	19	Water Pollution	○	○	○	○	○	◎	○	○	○	○	○	○	
	20	Soil Contamination	○		○			○						○	○
	21	Noise and Vibration	○	◎	◎	◎	○	○	○	○	○	○	○	○	○
	22	Ground Subsidence								◎					
	23	Offensive Odor	○					◎	○			○		○	

Note: ◎ : The environmental items to which special attention has to be paid, because they might cause serious impacts that may affect the project formulation, depending on the magnitude of the impacts and the possibility of the measures.

○ : The environmental items which may give a significant impact depending upon the scale of project and site conditions.

No mark : The environmental items which require no impact assessment since the anticipated impacts are not significant.

In case of the comprehensive development projects, all the items are classified in ○, because their studies are usually at the master planning stage and extent of impacts are not clear.

クト調査に関するガイドライン（Environmental Guidelines for Dam Construction Project）を起草し、さらに１９９１年から１９９２年にかけて、社会・経済インフラ整備に係る環境配慮ガイドライン（JICA Environmental Guidelines for Infrastructure Projects）を港湾（Port an Harbor）、空港（Airport）、道路（Road）、鉄道（Railway）、河川・砂防（River and Erosion Cortrol）、廃棄物処理（Salid Waste Management）、下水道（Sewerage）、地下水開発（Groundwater Development）、上水道（Water Supply）、地域総合開発（Regional Development）、観光（Tourism Development）、運輸交通一般（Transportation Development）、都市交通（Urban Transportation Development）という１３のセクターについて作成する業務の総括を行いました。このガイドラインは、プロジェクトの初期の段階で、環境問題の専門家でない人でも起こり得る環境問題のスクリーニング、スコーピングを行い得るという実用性を目的として作成されたものです。参考までに、１３セクターに共通のスコーピング用のマトリックスをＦｉｇ．７に掲げました。

なお、これらのガイドラインはＪＩＣＡによって英訳が作成されつつありますので、近い将来には皆様も関心があれば全文を御覧になる事ができる筈です。

４．２１世紀への挑戦

２０世紀はあと６年を残すのみとなっています。最近の世界は目まぐるしく変動しており、来世期には何が起こるか、予測は困難でありますが、それにもかかわらず、土木技術者の役割は２１世紀に向かって益々増大すると思われます。その重要な要因は次の通りです。

世界の人口の増加

世界の人口は２０３５年には１００億になっているだろうと云われています。世紀半ばには現在の２倍に達するでしょう。この人口が生存するためには、新たな資源の開発、有効利用を進める必要があります。また、人口が２倍になれば自然災害に伴う被害は２倍以上になるでしょう。このような状況に対処するためには、水資源開発、交通施設、防災その他のインフラ整備が益々必要にな

ります。

環境問題の増加

環境影響は時間的おくれをもって顕在化する場合が多いので、例えば温暖化（greenhouse effect）に伴う海面上昇など、今世紀の開発事業に伴う環境影響が次第に増加し、それに対処する処置が必要になるでしょう。また、人口の増加に伴い、インフラ整備の必要が増大する一方、インフラ整備のための困難も益々増大する事でしょう。この状況に対処するには土木技術者はより高度かつ多岐にわたる技術的能力が要求されるでしょう。特に重要な事は、土木技術者の使命は、無責任な環境保護論者と違って、持続可能な技術的解決策（sustainable engineering solution）を見出す事にある、という事です。これは土木技術者の職業倫理（professional ethic）に係わる問題であります。

環境問題については、定説となっている事象も、土木技術者が遭遇する多種多様な条件に当てはまらない場合が往々にしてあり得ます。ひどい洪水が経験されると、水文調査を行わずに、山の木を切ったからだ、という結論を出す人が居ます。これは、専門家（professional）としては無知か、怠慢か、更に悪い場合には俗説への迎合であり、いづれにしても職業倫理に反するものであります。私の知る限りでは森林伐採の影響が洪水流量観測の誤差より大きいかどうかは、まだ実証的に把握されてない筈です。環境問題には原因と結果の関係が不明確なものが多々あります。中には、実証的な根拠なしに、教訓的な意味を込めて語られた説が定説となって独り歩きしている場合があります。環境問題の科学的な、そして出来るだけ定量的な因果関係の解明のために、忍耐強い調査・研究の展開が必要です。

手造りの土木事業

土木技術は種々の基礎的な学問の応用分野であり、様々な特質を備えていますが、大きな特徴は、同じものを２度と作らない技術だと云われています。同じ規格の橋をかける場合でも場所が違えば物理的環境が違います。土木技術者に必要な経験は、同じ物を作る能力ではなく、異なった環境に適応する能力です。土木構造物はいかに技術が進歩し、自動化、省力化が進んでも最後までマ

スプロダション出来ずに残るものでしょう。

国際協力の展開（evolution）

世界の人口の増加は主として発展途上国の人口増によるものとされています。それらの国の中には人口増加率が経済成長率を上回る状態が続くと思われる国が数多くあります。これらの国は、したがって自力で必要なインフラ整備を実行する資金も技術も無い状態に留まるおそれがあります。このような条件下で、倍増するインフラ整備のニーズを、現在の先進国だけの援助でやって行けるものでしょうか。一つの大きな希望はアジア地域の幾つかの国が人口増を超える経済成長を確実（steady）に続けていることです。此の会議に御出席の方々の国はすべてこのカテゴリーに含まれていると思います。これらの国は２１世紀には十分に経済成長を遂げ、他の発展途上国を経済的、技術的に支える力を備えるようになるでしょう。そうでなければ２１世紀に向かって世界人類の前途（prospects）は暗澹たる（gloomy）ものとなりましょう。

なお、国際技術協力は勿論先進国の間でも必要、かつ有効なものであります。ボーダーレス化が進行する世界の中で、土木技術者は手を取り合って２１世紀の人類の生存と繁栄を支えるという偉大なる挑戦を試みる時が来ています。

II．経済発展段階と建設技術の移転

建設省土木研究所長　住　吉　幸　彦

経済発展段階と建設技術の移転

1．まえがき

300年近く続いた江戸幕府が倒れた明治維新(1868)により日本の新政権を担った明治政府は、日本を近代国家として建設するため富国強兵、殖産興業政策を二本柱に据えた。そして政策を進めるための基盤として社会資本の整備が重要視され、ここに近代的な建設技術の導入が始まった。欧米先進諸国の技術者を破格の高給で雇い技術の伝達を図り、あるいは日本人技術者が先進国に留学し、技術を貪欲に吸収した。その後、社会の発展に伴い経済制度や教育制度などの諸制度を整備すると同時に技術力を高めていき、日本の建設技術は海外の模倣・踏襲、改良、独自技術の開発と各段階を踏んで発展を遂げてきた。

国造りの基礎となる社会資本整備を効率的に推進するためには、その国の天然資源や人的資源を活用し、かつ自然条件や社会・経済条件に合った建設技術を確立することが重要である。日本はその時代時代の社会・経済状況に応じて、必要な建設技術を的確にかつ積極的に海外から導入してきた。アジア各国においても、建設技術の移転には、その国の経済発展や社会資本整備の段階に対応した効果的な技術の移転方法があるものと考えられる。本論文では、日本の発展過程と建設技術の進展、アジアの経済及び社会資本整備の状況、そして建設技術の移転方策について考察する。

2．近代日本における経済発展と建設技術

明治政府は国力の増強を第一目標に掲げ、その基盤となる鉄道、道路等の輸送施設、治水、治山等国土保全施設など社会資本の充実・整備を急いだ。明治、大正、昭和と続いた各時代においても、経済の発展段階に応じた社会資本整備が着実に実施された。特に、第二次世界大戦の戦災復興後には平均経済成長率が10%にも達し世界史の中で特筆されるほどの経済発展を成し遂げたが、建設技術の進捗による社会資本整備の着実な展開がこの経済成長を支えたと言える。

わが国は効率的な社会資本整備を可能とするために、まず海外の先進技術を導入し、土木分野の人材を育成し、研究開発を進めわが国の厳しい自然条件やその時々の経済・社会条件等に適合した技術に改良を加え、ついには独自の技術を生み出すに至っている。以下に明治以降の日本の経済成長と建設技術の発展過程を述べ、その要因を分析する。

2．1経済発展と建設技術

1）明治期(1868～1910頃)

近代的経済制度の確立のため、明治政府は貨幣制度・金融制度を整え、さらに近代産業を育成するため軍事工業や繊維工業等の官営事業を開始した。これらは必然的に交通通信網の整備を促し、そのため社会資本整備の中でもまず鉄道の敷設と舟運のための河川の低水工事及び電信の普及が優先された。しかし、当初は近代的な建設技術を持っていなかったため、政府はイギリス、オランダ、ドイツ、アメリカ等外国人技術者を雇い、トンネル、橋梁、鉄道建設や舟運のための河川・港湾工事に取り組んだ。例えば鉄道建設においては、測量、設計、現場監督に至るまですべての段階で外国人技術者に任せていた。

明治10年代(1878-)にはいって、外国人技師に学んだ日本人技師は自らの手で設計施工に取りかか

り始めた。この時期の代表的工事である逢坂山トンネル（完成明治12年(1879)、延長665mの鉄道トンネル）は日本人技術者の手で完成した最初の近代トンネルで、日本古来の建設手法である手掘と、西洋の技術である焼レンガ床や、硬い岩には発破が用いられ、和洋折衷により造られたと言える。また、琵琶湖疏水事業（完成明治23年(1890)）は、お雇い外国人から受けてきた技術指導の経験と当時の先進技術を利用して琵琶湖から京都市街地まで人工水路（延長19.3km）を建設し、水資源開発（導水量14m³/s）、水力発電（当初出力約150KW、明治31年(1989)には約1500KW）、舟運等古都京都の近代化推進をめざした日本人の手による最初の大規模多目的水利事業であった。

近代日本の最初の交通施設としてめざましい発展を遂げた鉄道は、明治22年(1889)東海道線全線（東京・神戸間）が開通し、明治40年(1907)には総延長約8,000kmに及んだ。一方、明治初頭から取り組んでいた舟運のための河川低水工事と運河掘削は、用水の開発・開拓事業の進展には貢献したものの、洪水の備えにはなっておらず、度重なる洪水により農業生産は大きな打撃を受けていた。明治29年(1894)河川法が制定され国が直轄で国内10大河川の治水計画を策定することとなり、また明治43年(1910)には関東・東北地方が未曾有の大洪水を被ったこともあり、以後河川改修事業は洪水防止のための高水工事へと切り替えられる。これには、物資の輸送の主力が舟運から鉄道へ移っていったことにも大きな要因がある。

ところで、明治時代には地租改正や貨幣制度・金融制度の整備が進み、資本主義体制が着実に確立されていった。また官僚制や平等な身分制度、全国的な戸籍、国民皆学が次々と実現され、これらが日本の技術力発展の基礎となったと考えられる。

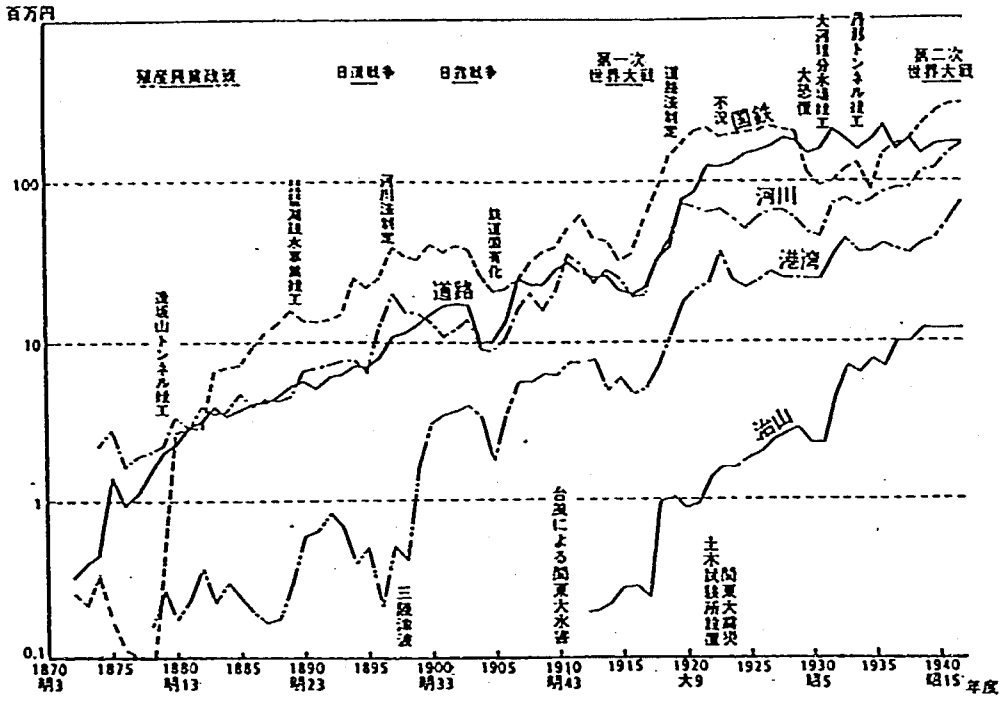
2）大正から昭和初期・第二次世界大戦まで(1911～1945)頃

日清戦争（明治27年(1894)）、日露戦争（明治37年(1904)）、第一次世界大戦（大正3 -6年(1914-1918)）は、日本の経済構造に大きな変化を与えた。戦後賠償や特需は日本の産業革命を生み出し、日清戦争前後の軽工業から日露戦争前後には重工業に中心が移っていった。特に第一次大戦中は空前の好景気を迎え重化学工業は急速に進展した。しかし、外債による経済開発が急ピッチ過ぎたために第一次大戦後は正貨危機に直面し逆に景気は停滞した。

それまでの交通運輸施設は鉄道が中心であったが、自動車の普及や第一次世界大戦中において自動車の有用性が認められたこともあって、大正9年(1920)には道路法が制定された。また、大正12年(1923)の関東大震災による甚大な被害（死者行方不明者約14万人）は東京都内の貧弱な道路網が大きな原因となったこと、震災の復興にあたって不通となった鉄道に代わって自動車が活躍したことなどから道路整備の重要性が認識された。

こうした社会状況に呼応し、内務省道路材料試験所が大正10年(1921）に設立され、翌11年(1922)には土木試験所と改称された。これが土木研究所の始まりである。当時わが国独自の基準や試験方法は皆無であった。土木試験所の研究は海外の技術情報を収集し、これを理解、解釈するとともに、実験等によりこれを確認、補足することから始まった。まず行われたのは路面性状と道路勾配が馬車輸送に及ぼす影響に関する研究や瀝青材料に関する研究であった。また、関東大震災後には、土木試験所は災害調査を実施したほか、耐震工学に力を注ぎ、塔、吊橋、けた橋等の構造物の振動とその耐震性、地震時の土圧等に関する研究が実施された。これらの成果は「土木耐震学」としてまとめられ、現代においても耐震工学の基礎となっている。なお、関東大震災後は我が国においてはレンガ造りの建物はその耐震性の低さから廃止されることとなった。

しかし土木事業全般としては、昭和初期まで軍備増強の優先により土木分野への予算が削られる傾



図－1　インフラ施設別投資状況（第二次世界大戦前）

向にあり、新しい技術開発の機会が減じられ技術は停滞している。本州と九州を海底で結ぶ関門トンネルのみが注目すべき事業であった。

昭和７年(1932)の世界恐慌は日本経済、特に主産業が農業である地方部に痛手を与えた。政府は地方の失業者対策として道路や河川改修工事を起こした。このとき、社会資本整備推進のための最初の道路法および第２、第３の治水計画が策定された。これはわが国のエポックをなすものであるが、この時代の法や計画はいずれも財政上の裏付けがなかったために、それらは縮減されるか中止の憂目を見ている。

第二次世界大戦中（昭和14-20年(1939-1945)）においても予算は大半は軍事費に用いられ、社会資本整備は後回しにされた。軍事費による圧迫により大規模な工事はなされず、また経済不況のため土木工事に雇用創出が求められたために人力作業を中心とした工事が行われ、大がかりな機械施工は見送られた。

図－１は第二次世界大戦前の鉄道、道路、河川、港湾、砂防の事業別に社会資本投資額の推移を示したものである。明治初期から第一次世界大戦前まで、交通に関する投資は鉄道に重点が置かれていたが、昭和初期には道路投資額が鉄道投資額を抜いた。

３）戦後の復興期（1945-1955頃）

第二次大戦終戦後まもなく大型の台風がたびたび来襲し大洪水の災害に見舞われたが、これは戦時中社会資本投資を怠ったことも大きく影響している。そのため戦後直後は食料増産の要請もあり河川の洪水対策が優先された。

戦後のわが国の経済的転機は昭和25年(1950)頃から始まった。朝鮮戦争の特需に対応するため外国から最新鋭の設備が導入され、急速な重工業化が進んだ。このため電力需要が急速に伸び大規模なダムの建設が進むとともに、道路、橋梁の建設計画が生まれた。同時に、昭和25年(1950)に制定された国土総合開発法及び昭和27年(1952)に制定された電源開発促進法は、治水、利水、水力発電等の機能を合わせ持つ多目的ダムの建設を促進させた。

海外、特にアメリカから導入された技術は建設工事に大きな影響を与えた。代表的な海外技術の導入工事は佐久間ダムである。アメリカからの機械化建設技術はわが国の建設現場を一変させ、150mもの高さを有する佐久間ダムをわずか28カ月で完成（昭和31年(1956)）させている。この時期の欧米諸国の技術の導入は、次の時代のわが国独自技術の発展の重要な基礎となった。

また、わが国初の長大支間吊橋となる若戸大橋（中央スパン長367m）の建設にあたっては、長大橋梁建設の経験不足と、わが国特有の地震と台風を克服するため、土木研究所、大学を含め日本の総力を結集して約２年半にわたり設計及び各種調査試験を実施した。若戸大橋の完成（昭和33年(1958)）は、その後の世界最長の吊り橋を含む本州四国連絡橋等長大橋梁の建設を可能にした。

4）高度成長期（1955-1975頃）

戦後経済は立ち直り、昭和29年(1954)にはＧＮＰは第二次世界大戦前のレベルにまで回復した。そしてわが国は所得倍増計画（昭和35年(1960)）に代表される高度成長期にはいる。この間、法制、財政ともに整備され、各分野で５カ年計画が実施された。各種の政策の結果、昭和30年代(1955-64)のＧＮＰ年平均成長率は10%に達した。また、自動車保有率は急激に伸び道路整備が本格化した。昭和30年代後半(1960-)の名神・東名高速道路の建設は東海道新幹線建設とともに高速交通網整備の幕開けと位置づけられる。これらは全国の地方への工業開発の促進をめざす新産業都市建設基本計画（昭和40年(1965)提唱）に必要不可欠な動脈となった。また、昭和39年(1964)には河川を地域的に管理開発するための新河川法が成立し、水系一貫で治水を考える新治水事業が確立した。

この時代には鉄鋼、機械、コンピューター等土木以外の分野の技術革新にも支えられ、大規模構造物建設のためのわが国独自技術がみられるようになってきた。本州四国連絡橋と青函トンネルがその代表例である。さらに、関西新空港、東京湾環状道路、東北・上越新幹線、関越自動車道、東北自動車道などの大規模プロジェクトが立案・計画され、いくつかは現在供用され、いくつかは工事中である。

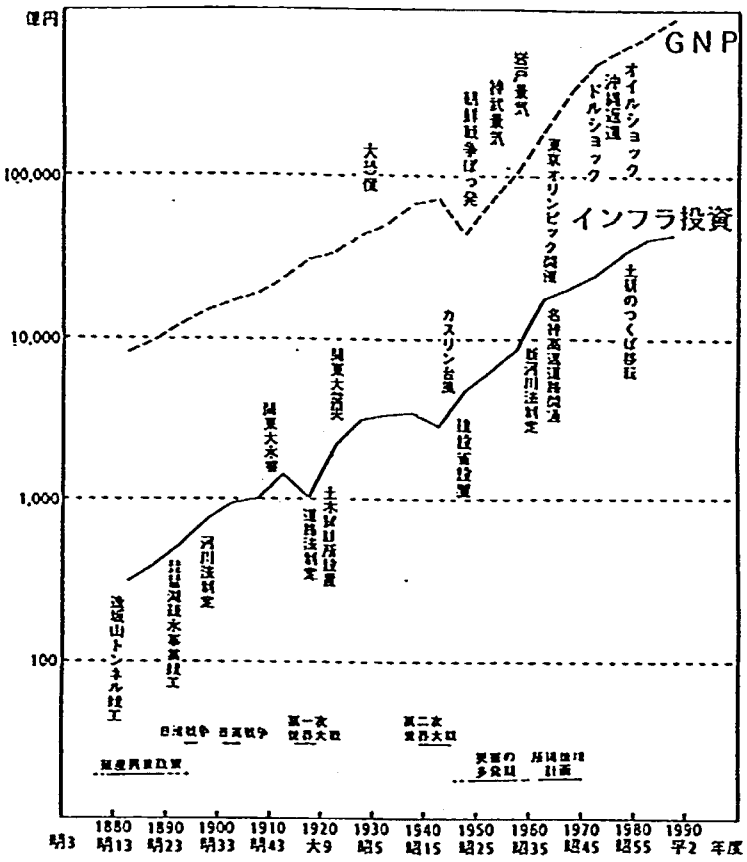
しかし、昭和40年代(1965-74)には 高度成長の歪みがみられるようになった。工場廃液による水俣病、イタイイタイ病、河川の水質汚濁、光化学スモッグの発生、大気汚染、交通騒音はこの時期を代表する公害である。これに対応して、土木研究所においても都市河川研究室、交通安全研究室、水質研究室、交通環境研究室、三次処理研究室等続々と新しい研究室が発足し、それまでの主として土木技術の開発、合理化に関する研究に加え、社会のひずみを是正するための研究課題を実施できる体制となった。

5）安定成長期（1975-現在）

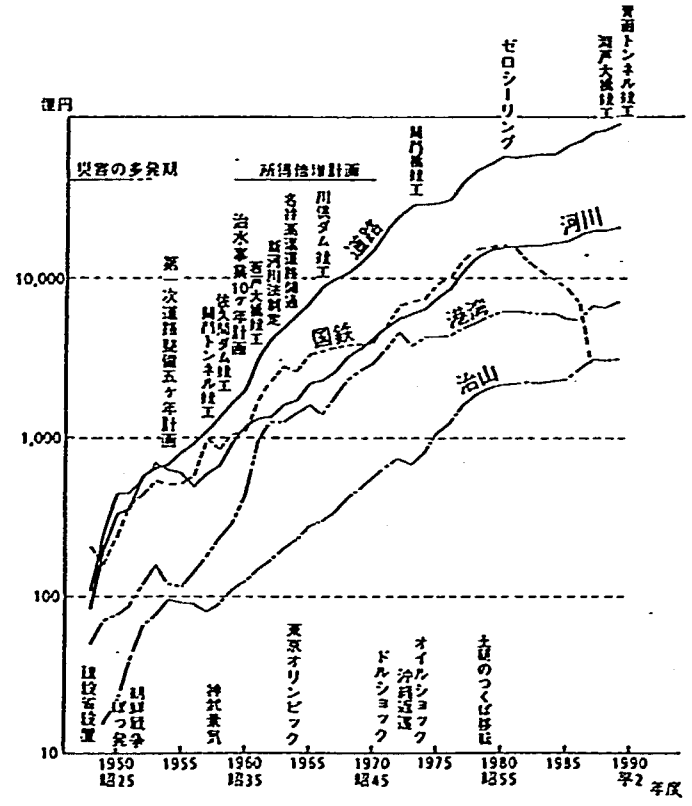
ドルショック(1971)、オイルショック(1973)はわが国の経済の急成長にブレーキをかけ根本的改革を迫ることになり、以後日本経済は安定成長に移行した。高度成長の結果として国民一人あたりの所得が上昇し生活レベルが飛躍的に向上したことから、安定成長期には社会資本整備は産業基盤の整備から生活基盤の整備へと変化した。また、常に環境問題、都市問題を重視する方向になった。

昭和55年(1980)には国家プロジェクトとして計画された筑波研究学園都市が概成した。これは、東京一極集中を緩和することを一つの目的に、国の研究・教育機関を移転あるいは新設し、高水準の科学技術・学術研究・高等教育の拠点を建設するものであった。現在では、約50の国立研究・教育機関等に加え200を超える民間企業の研究機関がつくばに進出し、産学官の研究者が多様な研究活動を展開している。

昭和57年(1982)から７年間は、財政再建の旗印のもと公共事業関係一般会計予算が前年度以下に抑えられたいわゆるゼロシーリング、マイナスシーリングの時代となった。この間ＧＮＰは平均3.7%で伸びたのに対し社会資本整備は平均1.4%に過ぎず、社会資本整備は経済・社会のニーズに対して大きく立ち後れたといえる。



図－2　GNPとインフラ投資額の推移



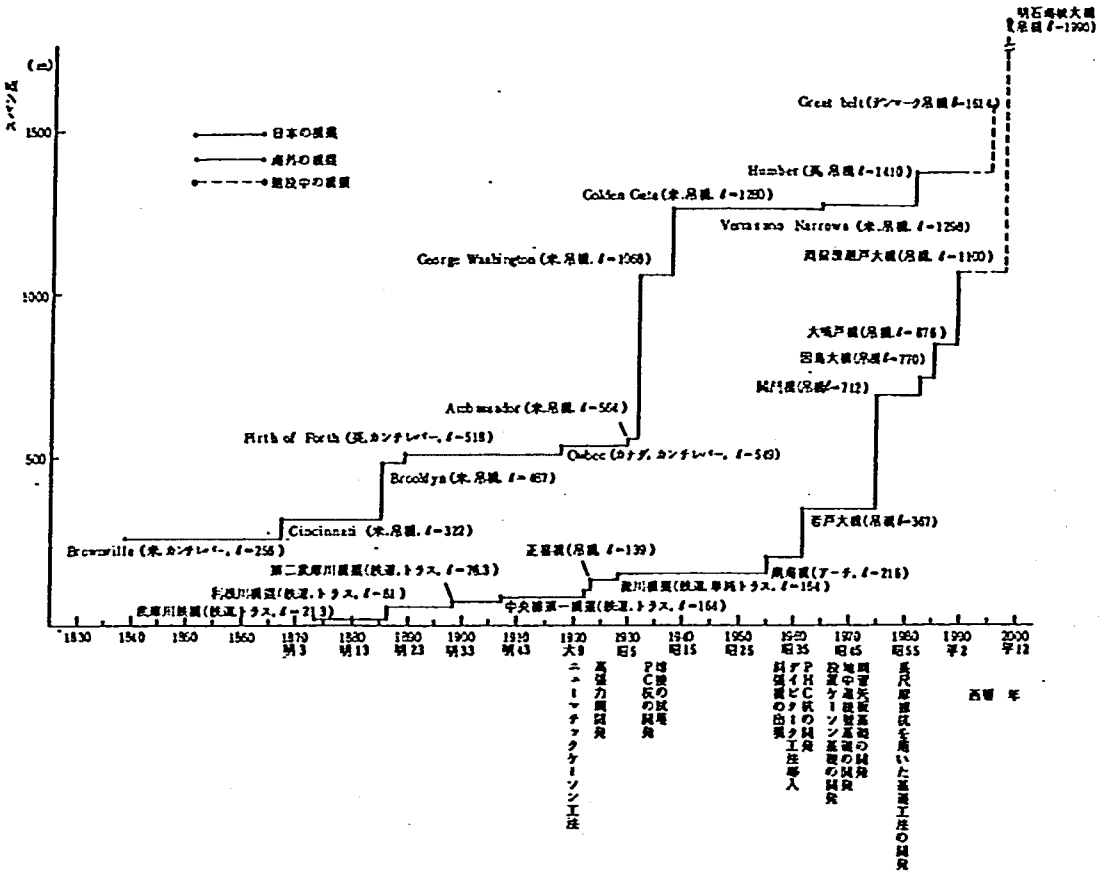
図－3　インフラ施設別投資状況（第二次世界大戦後）

平成２年(1990)、日米構造協議の結果、公共投資10カ年計画が策定された。この計画は1991-2000年度の間にその前の10年間の1.6倍に相当する総額430兆円の公共投資を行うもので、下水道、都市公園、住宅・宅地整備、域内の道路及び河川等の緑化等生活関連施設の整備に重点的に配分されることになっている。

現在では、国民生活の質の向上に向けた社会資本整備の拡充に大きな期待が寄せられている。特に、新しい規格の高速道路や長大橋梁の建設による国土の高度利用の推進、火山災害等新しい災害を防止し安全に暮らせる基盤づくり、環境との調和、建設労働者の質・量の変化に対応した新しい施工技術、材料の開発、社会資本の維持管理に関する技術開発等が重要な課題となっている。

図－２は、明治から現代までのＧＮＰと社会資本投資額の推移である。全体として、社会資本投資額はＧＮＰの伸びに比例している。経済社会の発展に伴い、社会資本に対して新しいニーズがうまれ、必然的に新しい建設技術が発展してきた。図－３は第二次世界大戦後の分野別の社会資本投資の推移である。戦後一時期河川への投資額が増大したが、全体的には道路整備が優先されていると言える。昭和50年(1975)まではすべての分野で社会資本投資額が高い伸び率で推移している。なお、昭和55年(1980)以降、鉄道への投資額が減少しているが、これは国鉄の民営化が進められたためである。

技術開発の進歩を表わす指標として、構造物の大型化を用いることができる。図－４に橋梁のスパン長の大型化を示す。大型化をもたらした主な要因として、溶接技術の向上、高張力鋼の開発、基礎工や上部工の設計・施工技術の向上が挙げられる。欧米の先進技術の導入から始まり、それを日本の自然的、社会・経済的なニーズに合わせ、同時に土木に関連する産業分野の進展を取り込んで独自の技術開発力を持つまでレベルを上げていった好例である。



図－4　橋梁スパン長の変遷

2.2　近代日本における建設技術発展の要因

日本の建設技術が着実な発展をなし遂げられた主な要因は次のように考えられる。

1）国策としての技術移転への取り組み

明治初期、わが国は近代資本主義の形成に努め、先進資本主義国の技術と運営システムを積極的に受け入れる体制にあった。政府は計画的に外国の技術者を招へいすると同時に、エリートを海外へ留学させ、徹底的に先進技術・知識を吸収した。また学校を開設するなど教育基盤の整備を進めた。外国人技術者からの知識や海外留学での見聞は、彼らに続く新しい大学や学校を卒業した後輩に着実に引き継がれ伝承されていった。

新しい知識や技術はさらに、国内の現地で実際に適用し試行錯誤を重ねることで実践的な技術となり、合理的な考えに基づく理論解析や実験能力も向上した。また、得られた成果は各種の技術基準やマニュアル、仕様書として発刊され残すことにより、個人やグループ内の技術から国全体の技術として広く伝播された。これらのことは土木研究所のような国の研究所や大学を中心として国の基本的政策として実施され、技術力の普及・向上に大きく貢献した。

2）技術教育の充実

優秀な技術者が着実に育成されたことも土木技術の急速な発展を支えたひとつの大きな理由である。

明治３年(1871)文部省が設置され、先進諸国の例をモデルに国民皆学・機会均等をめざす近代的な教育理念が示された。最初の土木教育はイギリス人技師モレルの進言により明治５年(1873)に開校した工部大学校に始まる。その後東京大学及び札幌農学校等の高等教育機関が開校した。当初、講師は外人技師であり、英語による講義は日本人学生にとって内容理解の妨げとなっていた。そこで明治17

年(1884)、文部省は英語に代わって日本語による講義の実施を決定し、これがわが国の各層にわたる熟練技術者を増大するのに大いに役立った。また、技師の下につくべき工手の養成を目的とした工手学校の設立など初等、中等教育機関が整備され、技術が下層まで普及することとなった。

戦後多くの大学、工業高等学校、工業高等専門学校が設置され、多くの技術者が社会に送りこまれ、わが国の土木技術の発展に大きな貢献を果たした。特に工業発展の基礎となるべき人材養成機関としての工業高等学校、工業高等専門学校は、高度な科学的知識を身につけた中堅技術者や技能者の育成・確保に必要不可欠であった。

3）研究開発体制の整備

土木研究所は大正11年(1922)の設立以来、常に土木の全般分野にわたり基礎研究とともに先導的な研究開発を実施し、土木技術の中枢研究機関として、わが国経済、社会のニーズに応えてきた。大正時代の耐震工学の研究や第二次大戦後の河川の流砂量公式の開発、近年の軟弱地盤改良法や道路・橋梁の建設技術等土木研究所の研究成果が現在の社会資本の整備技術の基本となっている。また、建設省内外の技術者の育成にも大きな役割を果たした。

第二次世界大戦以前は、内務省の直営事業を中心として理論・基礎面の研究開発は土木研究所で、応用技術開発は各事業現場で行われてきたものであったが、大戦後は公共事業の実施量の増大に伴い工事の請負化が進み、また政府の奨励や保護策もあり大手企業を中心に研究施設の充実がなされ、特に応用技術の開発について各企業の研究所も積極的に取り組んできた。計画、研究開発、施工の各段階において産学官で組織的な実行がなされたのである。そこでは産学官のいずれの研究者も、問題を解決するにあたり常に現場の経験を重視する実証的姿勢で望んだ。

民間企業の研究所が成長するに従い、土木研究所は、概して基礎的・学究的研究を担当する大学と現場対応的な研究を担当する民間研究所の両者の中間的な研究機関として、産学官の連携の推進という点においても非常に重要な役割を果たすようになった。また、民間企業のなかでも建設と設計の分化が図られゼネコンの研究所と設計コンサルタントがそれぞれ専門化、高度化されていった。さらに、鉄鋼、重化学、機械等の企業が力を付け、土木の関連分野の技術開発も取り込み、建設業界の発展とあいまって土木材料や施工技術の面での技術の発展が加速された。

これらの産学官の組織的な研究体制の充実が、建設技術を大きく発展させた一つの要因である。

4）諸制度の整備

第二次世界大戦後、日本政府は社会資本整備のための財源確保のシステムや法の整備と各分野での５カ年計画の策定を進めた。さらに、公団法が制定され、有料制度のもとに直接事業を実施できる組織として多くの公団が設立された。財政投融資制度（郵便貯金、簡易保険、国民年金等を原資として国の関係する機関等に貸し付ける制度であり、社会資本の建設等に活用される）も公的事業への安定的な財源確保のために役立っている。

また、わが国では、経済社会の変化と国民のニーズに整合して開発を進めるため、昭和37年(1961)の全国総合開発計画から現在まで四次にわたって全国総合開発計画が策定されている。これらは国土の均衡ある発展や豊かな環境の創造などそれぞれの時代における社会問題の解決に総合的に取り組むことを唱い、社会資本整備の基本理念となった。

民間の研究機関の育成には、研究開発費の税制上の優遇措置や官民の共同研究等の法制度の整備が支援した。そして大規模事業を実施する際、官が主導して計画設計作業には委員会制をひいて大学の

基礎知識を導入するとともに、施工面では民間企業の技術開発を促した。このような体制を組むことによって、その時代の各分野における技術の総力を結集することができた。

以上の法や制度の整備は、計画的な国土開発、国土保全を効率的に進めるために非常に重要な役割を果たしてきた。

３．アジア諸国における社会資本整備

アジア諸国はここ２０～３０年急激な発展を遂げているが、それらを支える社会資本整備は自国の人材、技術、資金でまかなうことが困難であり、多くは先進国による経済協力や技術援助に頼っている。また、急激な成長に社会資本整備が追いつかず大都市問題や環境問題等の社会問題が顕著となっている。

ここでは、各社会資本の分野別にアジア諸国の整備状況と課題を探る。

３.１　アジア諸国の経済状況

アジア地域は、表－１に示すとおり、ミャンマー、カンボジア、ベトナム、ラオス、ネパール、バングラディシュのような一人当たりＧＮＰが200ドル前後の最貧国から、インド（同330ドル）、中国（同370ドル）、パキスタン（同400ドル）、スリランカ（同500ドル）のような低所得国、あるいはインドネシア（同610ドル）、フィリピン（同740ドル）、タイ（同1,580ドル）、マレイシア（同2,490ドル）といったアセアンの中所得国、さらにはＮＩＥＳと称される韓国（同6,340ドル）、台湾（同8,000ドル）、シンガポール（同12,890ドル）、香港（同13,200ドル）のような目ざましい発展を遂げた諸国・地域まで様々であり、アジア地域は多様な経済発展段階にある国が混在している。

この地域に含まれる各国は、おおむね恵まれた国土と天然資源を有し、基本的には１次産品の輸出により外貨を獲得し、その外貨で資本財と中間財を輸入し、さらに、それらを利用して製品を輸出するという経済構造となっているが、なかでもＮＩＥＳ諸国・地域は重化学工業、ハイテク産業社会の形

表－１　アジア諸国の経済状況（１９９１年）

国又は地域名	人口（百万人）	国民総生産（百万ドル）	１人当たりGNP（ドル）	実質経済成長率（GDP）（%）	消費者物価上昇率（%）	貿易収支（億ドル）
カンボディア	8.7	1,725	200	n.a.	n.a.	n.a.
スリ・ランカ	17.2	8,665	500	4.8	12.2	△10.2
香港	5.9	77,302	13,200	4.2	12.0	△16.8
インド	865.0	284,668	330	2.5	13.9	△27.8
パキスタン	115.6	46,725	400	6.5	11.8	△29.1
ネパール	19.1	3,289	180	2.0	8.2	n.a.
タイ	56.7	89,548	1,580	8.2	5.6	△97.1
ラオス	4.3	965	230	n.a.	n.a.	n.a.
マレイシア	18.3	45,787	2,490	8.6	4.4	△23.4
バングラデシュ	108.8	23,449	220	3.6	8.9	△18.0
中国	1,150.1	424,012	370	7.3	2.9	81.2
インドネシア	181.4	111,409	610	6.6	9.4	32.7
韓国	43.2	274,464	6,340	8.4	9.7	△96.6
シンガポール	3.0	39,249	12,890	6.7	3.4	△71.3
フィリピン	62.7	46,138	740	△0.9	17.7	△32.0
ベトナム	67.8	5,016	200	3.8	67.6	△ 4.0
台湾	20.2	161,539	8,000	7.2	3.6	133.2
ミャンマー	42.5	n.a.	200	5.6	34.0	△ 5.7
日本	124.0	3,337,191	26,920	4.0	3.3	1,031
米国	250.9	5,445,825	21,810	△1.2	4.3	△736
イギリス	57.5	923,959	16,080	△2.2	5.9	△180
フランス	56.5	1,099,750	19,590	1.2	3.1	△101
ドイツ	77.3	1,411,346	22,360	3.6	4.5	231

（注）・ドイツの国民総生産、１人当たりGNPは旧西独地域のみ
・ネパールは１９９０年のデータ
・台湾の人口、国民総生産、１人当たりのGNPは１９９０年データ
・ミャナマーの一人当たりのGNPは1986年データ

態をとりつつある。

一人当たりのＧＮＰが200ドル前後の最貧国は、政治的に不安定なミャンマーやカンボジア、社会主義的計画経済から市場経済システムへ移行し始めたベトナム、ラオス、災害の多いネパール、バングラディシュである。これらの国の1991年の経済成長率は前年比2.0～5.6%であり、物価上昇率は8.2～67.6%と非常に高く、貿易赤字を抱え、経済的に不安定な状態にある。

一人当たりのＧＮＰが300～500ドルの低所得国は、スリランカを除いて、中国（人口1,150百万人）、インド（同865百万人）、パキスタン（同116百万人）では人口規模が大きいため、国民総生産が大きい割には一人当たりのＧＮＰが低くなっている。1991年の経済成長率はインドの2.5%を除き4.8～7.3%と比較的高く、物価上昇率は中国の2.9%を除いて11.8～13.9%と比較的高くなっている。貿易収支は中国を除いて赤字となっている。これらの国の中で、特に中国は物価が安定し、貿易収支も黒字となり経済発展が拡大しており、中でも広東省等の沿海部では、隣接する台湾、香港との貿易、投資活動が活発に行われており、華南経済圏を形成し、高い経済成長を遂げている。

アセアンの中所得国は、積極的な外貨導入と輸出主導型経済の推進により高い経済成長を達成し、域内経済の発展並びに政治的安定に大きな貢献を果たし、近年、世界の高度経済成長地域として注目を浴びている。1991年の経済成長率を見てみると、前10年の政治的混迷により経済がまた影響を受けている、フィリピンの-0.9%を除いて6.6～8.6%と高く、物価上昇率もフィリピンの17.7%を除いて4.4～9.4%と比較的安定してきている。貿易収支については、石油、天然ガス資源のあるインドネシア以外は赤字となっている。

ＮＩＥS諸国・地域は、世界的に高度な経済発展をしている地域であり、一人あたりのＧＮＰが大きいのに加え、1991年の経済成長率が4.2～8.2%と高く、物価上昇率も3.4～12.0%と比較的安定している。貿易収支については、台湾以外は赤字となっている。

３.２　鉄道

表－２に、アジア諸国の人口、国民一人当たりのＧＮＰ、鉄道網密度、線路延長、複線化率及び電化率を示す。アジアで鉄道網密度の高い国は、バングラディシュ、インド、韓国、スリランカで、主として英国の影響を受けている国が多い。鉄道網密度では中国は低い値を示しているが、広大な面積を有しているためであり、線路延長、複線化率、電化率はアジアでトップクラスの値である。また、インド、韓国も中国同様に複線化率、電化率は高い値を示している。　アジア諸国の鉄道はいくつか

表－２　アジア諸国の鉄道の状況

国　名	人口(1988年)(100万人)	ＧＮＰ／人(1991年)(US$)	鉄道網の密度(線路延長Km／国土Km²)	線路延長(km)	複線化率(%)	電化率(%)
スリ・ランカ	16.6	500	0.0221	1,423	7.0	
インド	815.6	330	0.0182	61,813	22.0	13.2
パキスタン	106.3	400	0.0110	8,774	11.8	3.2
タイ	54.5	1,580	0.0073	3,834	2.4	
マレイシア	16.9	2,490	0.0127	1,668	0.5	
バングクディシュ	108.9	220	0.0199	2,792	8.2	
中国	1,088.4	370	0.0052	52,611	21.3	8.8
インドネシア	174.8	610	0.0037	6,701	2.5	1.5
韓国	42.0	6,340	0.0325	3,130	25.9	14.9
フィリピン	59.9	740	0.0035	771	4.4	
ベトナム	64.4	－	0.0079	2,604	1.2	-
ミャンマー	35.3	－	0.0047	3,186	12.8	
日本	122.6	26,920	0.0563	18,984	31.1	50.0
フランス	55.9	20,600	0.1100	34,563	44.8	34.7
英国	57.1	16,750	0.0694	16,937	69.7	25.9

の問題を抱えている。表－３に示す営業係数は鉄道運賃に対する必要経費額の比であり、100ドルの鉄道運賃を稼ぐのに必要な経費額ともいえる係数であり、営業係数が100未満の場合には黒字経営、100を越える場合には赤字経営となる。アジア諸国で黒字経営を行っているのはインドと中国の二カ国のみで、これに続いてマレイシアと韓国が黒字一歩手前の状況である。

表－３　1987年の営業係数・定時到着率・事故件数・事故発生係数

国　名	営業係数(%)	定時到着率(%) 旅客	定時到着率(%) 貨物	事故件数 (脱線＋衝突)	事故発生率 事故件数／100万km
スリ・ランカ	233	55.0	37.0	57	7.6
インド	92	85.0		566	1.0
パキスタン	124	90.7		94	1.8
タイ	127			86	2.8
マレイシア	100	18.3	19.6	53	6.5
バングラディシュ	156	63.2		210	12.0
中国	61				
インドネシア	135	15.0	8.0	71	2.2
韓国	100	96.0		14	0.2
フィリピン	170	13.0		78	65.0
ベトナム	111				
ミャンマー	169	54.2		122	12.4
日本 JRH	159				
JRE	95				
JRC	93				
JRW	90			22	0.03
JRS	142				
JRK	122				
JRF	93				

赤字経営の最大の原因は、国営のため公共機関として営業収支を度外視した経営が要請されることと、非能率的な運営や技術革新の遅れ等により自動車をはじめとする他の交通機関に優位にたたれていることにあり、これがさらに一層経営の悪化を招いている。インドや中国においては黒字経営となっているが、これは鉄道以外の交通手段があまり発達していないことによるのであろう。

２番目の課題は、鉄道の安全性及び信頼性の問題である。表－３に示すように日本の鉄道では100万列車キロ当たりの事故発生率は0.03と非常に低いのに対して、アジア諸国の鉄道では日本の約10倍から1000倍以上となっている。日本に次いで安全率が最も高いのは韓国であるがその事故発生率は0.2で日本の約７倍である。それに対してフィリピンの事故発生率は65と異常に高く、この値は日本の約2000倍である。事故率の高い国の鉄道は安全に対する信頼性が低いわけであり、そのために鉄道の利用率が低下しているともいえる。また、列車の定時到着率をみると、韓国、パキスタン、インドが85～96%、インドネシア、フィリピンが13～15%であり、定時到着率が比較的高い国の営業収支は良好である。例えば、韓国の営業係数は100であるが、韓国の定時到着率は96%とほぼ定時に到着している。また、黒字経営のインドでも定時到着率は85%となっている。定時到着率が70%を越えなければ利用者の信頼が得られず、鉄道離れを引き起こすといわれている。

今後、アジア諸国の鉄道で解決しなくてならない問題として、安全運行、定時運行及び健全な経営の確保が挙げられるが、安全運行は鉄道の信頼性を高めることにとどまらず、その結果として経営の健全化へとつながる。また、シンガポール、フィリピン、インドネシアの首都圏等の大都市部においては通勤手段の一つとしての地下鉄を含む都市型鉄道の整備が交通渋滞を解決する有力な対策となり得るだろう。

３.３　道路

アジア諸国の道路整備状況（表－４）はそれぞれの国の経済状況と深い関係を示すといえる。道路整備の進んでいる国は香港、シンガポールで、舗装率が90%を越えており、非常に整備の進んだ国といえる。逆に道路整備率の低い国は、ミャンマー、ラオス、ネパールで、ラオスにおいては舗装率が10%以下という状況である。

アジア諸国が抱える道路問題を論じるとき、それぞれの国の経済状況によって３つのグループに分けて考えるのがよい。これは、それぞれの経済状況によって抱えている問題が異なるからである。まず、第１のグループとしてはラオス、バングラディシュ、ミャンマーといった国々のグループとイン

ドや中国のように輸送手段を鉄道に依存している国である。これらの国ではまだ十分にモータリゼーションが発達していないが、今後の飛躍的な経済発展のためにも道路網を整備する必要がある。道路整備のための予算の確保、全国の幹線道路の整備、特に橋梁等の大規模構造物の建設等が課題である。

表－4　アジア諸国の道路網密度

国　別	道路延長 (km)	1人当り道路延長 (km/人)	1km²当り道路延長 (km/km²)	舗装率 (%)	調査年
スリ・ランカ	24,752	1.63	377	79.7	1982
香港	1,244	0.24	1,185	100	1983
インド	1,357,784	1.91	413	52.3	1982
パキスタン	94,987	1.09	119	68	1983
ネパール	5,546	0.36	39	44.8	1983
タイ	159,619	3.29	311	18.9	1983
ラオス	7,395	2.27	31	8.4	1974
マレイシア	30,412	2.75	92	79.8	1983
バングラディシュ	161,359	1.75	1,121	9.5	1984
中国	915,079	0.90	90	77.1	1983
インドネシア	182,882	1.20	96	63.6	1983
韓国	54,599	1.39	553	39.0	1983
シンガポール	2,568	1.04	4,382	92.3	1983
フィリピン	155,798	3.07	519	12.8	1983
ミャンマー	22,471	0.70	33	38.5	1978
日本	1,123,283	9.46	2,974	53.3	1983

第２のグループはタイ、マレイシア、インドネシア、フィリピン等である。これらの国ではモータリゼーションもかなり進んでおり、今後も一層進むものと思われる。ただし、すでに交通渋滞が発生しており、既設の道路保守のみでなく、都市部における高速道路や大量輸送機関の導入と地方における高規格道路の整備といった２次的な道路整備が必要な段階に入っている。このための予算調達が課題である。道路整備の一部は、有料道路制度や民間資金の活用等により実施され、あるいは検討されているが、有料道路制度の導入に当たっては料金設定、民間資金の活用に当たっては収入に関する政府保証、資金調達に関する政府の債務保証等の合意が大きな障害となっている。

最後に第３のグループとしてはシンガポール、香港、台湾、韓国等ＮＩＥＳ諸国・地域があるが、これらの国では社会資本が充実しており、道路分野においてもかなりのレベルに達している。高速道路の整備も積極的に進められており、また交通渋滞、交通安全への対応に加えて道路景観、緑化といった先進各国が現在直面している問題と同様な課題に取り組んでいる。経済発展に伴って交通騒音や排気ガスによる大気汚染といった交通公害も第３のグループでは問題化している。

３.４　水質保全・下水道

日本では鉱山開発や工場からの有害物質の排出による水質汚染が近代化政策の始まりから約100年の間に一定の流れをもって進行してきたが、それぞれの水質汚染に対して着実に対策を実施されてきた。しかし、開発途上国では日本が100年かけて進めた近代化を 20～30年で達成しようとしている。その結果、鉱業とその関連産業による古典的水質汚染と近代産業やハイテク産業による水質汚濁が同時に発生し、特に都市部の河川の水質悪化が問題となっている。日本をはじめとするアジア各国では、生活排水等の水質浄化を河川の自然浄化に頼っていた。しかし、工業化や都市部への人口の集中等により河川の自然浄化だけでは水質浄化は期待できず、河川や海洋の汚染といった環境問題や人体への影響等が懸念されている。

アジア諸国においては首都ですら上水道の普及率が低いのが一般的である。特に、低所得者層の居住する地域は環境の悪い所が多く、水質の悪化している河川の水をそのまま飲料水に使用している場合もある。上水道の普及が国民の健康状態に大きく関係することから、積極的な整備が必要であるが、水道施設の整備は道路等の交通網整備に比べて大きく遅れている。また、上水道が整備されていても、水道原水が汚染され水道水の水質が悪化し、水質基準が満足されていない国もある。特に工業化による各種化学工場からの排水、畜産等の屎尿、ゴミ処理場からの汚染水等が土壌や地下水を汚染する傾向が強い。

アジア諸国の下水道はどのような状況にあるのか。表－５に下水道整備状況を示す。シンガポールや香港では下水道普及率は90%を越しているが、多くの国では都市部において下水道の普及に取り組み始めたばかりである。現在ではタイ、マレイシア、台湾等の首都や都市部で普及率は数%から30%前後である。台北では2007年までに下水道普及率を42%に、バンコクでは1997年までに30%に、それぞれ目標を置いている。

表－５　アジア諸国の下水道整備状況

国　名	下水道普及率	改善計画及び現在の問題点
香港	90%以上	
タイ	0.5% 都市部　2.7% 地方部　0.02%	現在バンコク市内には下水道施設がないため、1997年までにバンコク市内の普及率を30%にする。
マレイシア	10.7% クアラルンプール　約30%	
バングラディシュ	都市部　20% 農村部　6%	
インドネシア	都市部のトイレ普及率38% 地方部のトイレ普及率25%	1994年の都市部下水道普及率0.6%、浄化槽等簡易処理施設の普及率を都市部で50%、地方部で35%とする。
シンガポール	95%	
台湾	3% 台北市　17% 2007年の目標　42%	2007年までに下水道普及率を42%に高める。
日本	47% 東京都　90%	

マレイシアでは、1980年代までに全国16都市の下水道のマスタープランが作成され、このうち３都市では公共下水処理場が完成している。しかし、現在稼働している処理場においても比較的簡便な処理法を採用しており、高度な処理ができず、良好な処理水が得られない場合が多い。また、インドネシアではこれまで環境衛生の重要性についての認識が低いこと、地方自治体の汚水処理施設に対するプライオリティーが低いこと、下水道施設に対する予算不足等から下水道の整備が進まなかった。最近になって国際機関や外国の援助により10都市での下水道計画の調査・建設工事が進みつつあり、1994年には都市部の下水道施設は人口普及率0.6%を見込んでいる。なお、いわゆる浄化槽等簡易な処理施設は人口普及率50%、地方部においても35%の普及率を目標としている。

アジア諸国においては、下水道が都市の活動を支え、衛生環境の改善に不可欠な基本的都市施設としてようやく理解が得られつつあり、大都市のパイロットプロジェクトが進行しだした。しかし、事業の実施に必要な技術者や財源が不足していることと、各都市・地域にあった計画や施設設計の手法の確立、管理手法、水質規制の整備が今後の大きな課題である。

３.５　自然災害

アジア地域における自然災害は非常に多く、世界中で発生している災害の約90%がアジアで発生しているともいわれている。。バングラディシュや中国などは地理的条件から幾度となく自然災害にみまわれている。また、多くのアジア諸国が環太平洋火山地帯に位置していることから、火山災害や地震災害が多発している。1900年以降93年間に死者1000名以上の被害が発生した自然災害65件を表－６に示す。これによればこの期間に全世界で65件の災害が発生しており、これによって220万人以上の死者・行方不明者が発生しており、このうちの約60%に相当する37件約150万人の死者・行方不明者がアジアで発生している。このうち台風・ハリケーン・洪水によるものが約半数の19件約87万人の死者・行方不明者で、地震・火山災害によるものが18件約78万人の死者・行方不明者となっている。１年半に１回の割合で自然災害が発生しており、ここ10年間では11件が発生し年間４件も発生している年がある。

地震による被害はアジア地域で12件あり死者はおよそ74万人に達しており、特に中国・日本に被害が集中している。昨年12月にインドネシアのフローレス島で発生した地震では、津波によって多くの犠牲者が発生し、この地震による死者・行方不明者は2000名を越えた。また、アジア地域における台

風・洪水による被害は19件で死者はおよそ87万人に達しており、特にバングラディシュ、インドに集中している。最近の例では、1991年にバングラディシュをおそったサイクロンによって、14万人もの死者・行方不明者が発生している。火山による被害では６件が発生し、約４万人が犠牲になっている。特に火山災害はフィリピン・インドネシアに集中している。

表－６　今世紀における主な自然災害の状況

年	災害の種類	国　　名（地名）	死者・行方不明者数（概数）
1900	ハリケーン	米国、テキサス	6,000
1902	火山噴火	マルティニク、（西インド、プレー山）	29,000
1902	火山噴火	グァテマラ、サンタマリア火山	6,000
1906	台風／津波	香港	50,000
1906	地震	台湾	6,000
1906	地震／大災	米国、サンフランシスコ	1,500
1908	地震	イタリア、シシリー	75,000
1911	火山噴火	フィリピン、タール火山	1,300
1915	地震	イタリア、中部	30,000
1916	地すべり	イタリア、オーストラリア	10,000
1919	火山噴火	インドネシア、クルー火山	5,200
1920	地震／地すべり	中国、甘粛省	200,000
1923	地震／火災	日本、関東	143,000
1928	ハリケーン／洪水	米国フロリダ	2,000
1930	火山噴火	インドネシア、メラピ火山	1,400
1932	地震	中国、甘粛省	70,000
1933	津波	日本、三陸	3,000
1935	地震	インド、バルチスタン	60,000
1939	地震／津波	チリ	30,000
1945	洪水／地すべり	日本	1,200
1945	地震／津波	日本、洞海	1,400
1948	地震	トルクメニスタン（旧ソ連）	100,000
1949	洪水	中国	57,000
1949	地震／地すべり	タジキスタン共和国（旧ソ連）	20,000
1951	火山噴火	パプアニューギニア、ラミントン山	2,900
1953	洪水	北海沿岸	1,800
1954	洪水	中国	40,000
1959	台風	日本、本州	4,600
1960	地震	モロッコ、アガディール	12,000
1962	地すべり	ペルー、ファスカラン山	4,000
1962	地震	イラン、北西部	12,000
1963	サイクロン	バングラデシュ	22,000
1963	火山噴火	インドネシア、バリ、アグン火山	1,200
1963	地すべり	イタリア	2,000
1965	サイクロン	バングラデシュ	57,000
1968	地震	イラン、北西部	12,000
1970	地震／地すべり	ペルー、北部	70,000
1970	サイクロン	バングラデシュ	500,000
1971	サイクロン	インド・オリッサ州	10,000
1976	地震	中国、天津～唐山	250,000
1976	地震	グァテマラ	24,000
1977	サイクロン	インド、アンドラ・プラデシュ州	20,000
1978	地震	イラン、北東部	25,000
1982	火山噴火	メキシコ、エルチチョン火山	17,000
1985	サイクロン	バングラデシュ	10,000
1985	地震	メキシコ、メキシコ市	10,000
1985	火山噴火	コロンビア、ネバド・デル・ルイス山	22,000
1985	有害ガス	カメルーン西部、ニオス湖	1,700
1986	地震	エルサルバドル、サンサルバドル市	1,000
1987	地震	エクアドル北東部	数　千
1987	洪水	バングラデシュ	1,000
1988	地震	インド、ネパール	1,000
1988	地震	中国、雲南省	1,000
1988	洪水	バングラデシュ	2,000
1988	地震	アルメニア共和国（旧ソ連）	25,000
1989	洪水／地すべり	中国、四川省他	2,000
1989	洪水	インド	1,600
1990	地震	イラン	41,000
1990	地震	フィリピン	2,000
1991	サイクロン	バングラデシュ	140,000
1991	洪水	中国、江蘇省他	2,300以上
1991	火山噴火／泥流	フィリピン、ピナトゥボ火山	900
1991	台風	フィリピン	5,000
1992	洪水	パキスタン	1,334
1992	地震／津波	インドネシア	2,149

アジアの国別の状況を見ると、中国においては洪水や地震によって多くの災害が発生している。1991年に発生した揚子江・ハイヘ河流域での洪水では、2300名以上の死者・行方不明者が発生し、農地等の冠水により経済的打撃も大きかった。中国政府はこの災害を契機に、災害の軽減を目的とした中国国家委員会を設立して災害軽減に向けた各種プロジェクトを実施している。また、国家災害軽減国立管理センターを1992年に設立し、同時に災害軽減のための科学研究プロジェクトを実施している。

バングラディシュは、ガンジス河及びブラマプトラ河の二つの大きな国際河川のデルタ地帯に発達し、国土の約半分が海抜８m以下に位置しているため、サイクロンやモンスーンによる洪水、排水不良、高潮という水災害が頻繁に発生している。ここ30年間に6回の大災害が発生し、計73万人以上の人命が犠牲となっている。世界で最も貧しい部類に入るといわれるバングラディシュを救うため、1989年から15の援助機関・国が参加して、治水の問題を多面的にとらえて計画を立てようというバングラディシュ洪水対策計画（ＦＡＰ）が進められており、今後の事業実施に大きな期待がかけられている。

フィリピンでは、地震や火山災害によって多くの犠牲者を生んでいる。特に、1991年のピナトゥボ火山噴火は、降灰等により多くの建物が押しつぶされたり、その後に発生した泥流によって多くの人命が奪われたのは記憶に新しい。また、ピナトゥボ火山の噴火はフィリピンのみならず、地球全体の気象条件、すなわち温暖化に大きく影響を与えるだろうと予測され、アジア地域にとどまらない問題に発展する可能性もある。フィリピンではこのような自然災害を受けて、主要幹線道路の道路防災長期計画を策定している。

インドネシアには活火山が約130あり、世界の活火山の約15%が集中しており、自然災害も火山噴火によるものが顕著である。特にジャワ島、バリ島等人口が集中している地域に活発な火山が存在し、火山活動に伴う大量の噴出物対策が課題となっている。また、最近では前述のフローレス島の地震災害の他、無計画な伐採や耕作による森林の荒廃、無秩序な開発行為や計画性の乏しい河川改修のしわよせ等から洪水災害が大きくなっているとの指摘もある。

日本においては、戦後から行われてきた防災対策が功を奏して1000名以上の人命を奪うような被害は発生していないが、日本海中部地震（1985年）、雲仙普賢岳における火砕流（1991年）、北海道南西沖地震（1993年）等の大規模な災害にみまわれている。これらの災害では100名を越える人命が奪われているが、今までに実施してきた防災対策により被害を最小限に留めている。また、災害復旧事業や災害関連緊急事業、助成事業等が災害発生後の早急な復旧や２次災害の防止に大きな役割を果たしている。

また、大災害には至っていないが、マニラ、バンコク、ジャカルタ等東南アジアの大都市においては、局地的雷雨や雨期の長雨により内水氾濫が頻発し、衛生上の問題や交通障害を招いている。いずれも政治的にも経済的にも重要性の高い都市であり、社会経済活動に与える影響は大きい。

今後、アジア諸国においては、地震、火山、台風・サイクロン、洪水等の災害に対して、各災害の発生確率・規模の予測及び災害に対する構造的補強すなわち耐震設計や、治水ダム、河川堤防、砂防施設等の建設、さらに復旧計画等の制度の確立も必要となろう。

４．アセアン諸国における技術移転の実態

建設技術の移転の現状について知ることは重要なことであるが、そのような調査事例は多くはない。ここではアセアン諸国について行われた建設省の調査をもとに技術移転の実態を紹介する。

建設省は１９８５年から１９８９年の５ケ年間にわたり、マレーシヤ、シンガポール、インドネシア、タイのアセアン諸国において建設技術の移転の実態調査を行った。調査は建設省から日本海外建設協会に委託され、海建協の調査担当者が調査国を訪問して調査を行った。調査国の関係機関（官庁、企業、業協会、大学等）の訪問調査と調査各国に進出している日本企業の日本人技術者へのアンケート調査を通じて、各国の建設技術水準、技術移転の実態、課題等の把握に務めた。技術水準や技術移転の程度を正確に把握することは、決められた方法論もなく、調査担当者の能力、考え方に大きく依存する点が多いが、この調査は各国に進出している日本企業の日本人技術者の眼を通したものであり、主観がまじった相対的なものであることは勿論であるが概略を把握するための資料としては充分役に立つものと考えている。

４．１　建設技術水準の評価

１）個別技術水準

４ケ国の個別技術水準を評価すると技術力が不足していると思われる分野は下記のとおり。

①土木技術者（大学卒業以上）については　○フィージビリティ調査、○下水道、ダム、河川、港湾、鉄道、砂防の設計、○準備工事の積算、○施工計画、工程、品質、安全管理の施工管理全般、○機械施工、鋼杭製作、深礎工、ニューマチックケーソン工、橋梁の製作、設置の施工

②土木技能者（技術系高校、専門学校卒業程度のフォーマン、または学歴がそれ以下のワーカー）については、○排水構造物、軟弱地盤処理工、オープンケーソン工、ニューマチックケーソン工の施工

③建築技術者については、○医療・福祉施設、通信・放送施設、鉄骨構造の設計、○仮設工事の積算、○施工管理全般、○仮設工事、鋼杭製作、中規模以上の鉄骨構造物製作と鉄骨検査、防水工事の全部

の施工、○情報通信、消化防煙、ゴミ処理施設等の電気、機械設備の設置、○各種管理技術

④建築技能者については、○施工図、○地盤改良工、排水、溶接工、鉄工、鉄骨建方、シート及び塗膜防水工の施工、○設備関係全般
⑤共通してそれぞれの国で今まで必要でなかった分野や未経験であった分野の技術、施工管理全般、仮設関係、設備関係の技術不足が指摘されている。技術者の知識力についてはいずれの国も満足する評価を得ているが、実施能力と管理能力に低い評価がついている。技能者については管理能力を除いてまあまあの評価を得ている。技能工は水準は低いがこれもまあまあの水準と評価されている。国別ではシンガポールが群を抜いて水準が高く、インドネシアが低い。

2）国別技術水準
①マレーシヤ
今までマレーシヤで経験のない技術（例えばトンネル、地下鉄、ダム、港湾等）及び気候、風土上必要でなかったと思われる技術（例えば防水工事、鉄骨工事）については技術不足であるが、今まで必要とされた個々の建設技術については着実に育成されている。しかし、これら技術を活用するための人材、組織の育成が一歩遅れている。また、建設に際して必要とされる固有の技術と管理技術のバランスをみた場合、管理技術が全般的にかなり弱いと評価される。

②シンガポール
今までシンガポールで経験のない技術（例えばトンネル、シールド、地下鉄、ダム）については技術不足であるが、その他については相対的に建設技術移転のニーズが低く、日本の建設技術の受け入れ余地が少ない。それはシンガポールの技術水準はすでに相当の高さにあり、またインフラ整備もほぼ完了しているので、管理技術を除いて一般的建設技術の導入はほとんど必要としない状況にあると言える。また技能者への訓練制度も充実している。

③インドネシア
インドネシア建設業の職人と技能工は、継続雇用の保障がないことから、未熟練であり、かつ下請企業も技術的信頼性が薄く、これらの職人や技能工をその都度直傭に近い形で使用しなければならない元請企業の苦労は大変なものがある。左官工、塗装工、石工などの職人クラスも殆ど未熟練工であり、品質と工程管理のため直傭の中級エンジニアが四六時中しっかりと監督しなくてはならない。そのため中級エンジニアも大勢必要で、本来であれば下請専門業者のするべき仕事が元請企業や発注官庁の肩にかかっている。
公共事業省建設産業振興局でも相当真剣にこの問題改善を考えているが未だ実施されていない。職人や技能者クラスの仕事の安定化がインドネシア建設産業の基盤強化の唯一の方法といわれており、訓練センター等特別なプロジェクトの実施や建設産業の雇用制度の改善が必要であろう。技術者や技能者へマネージメントや管理技術あるいは高度な技術の移転の必要もあるが、職人や技能工のダウンストリームの整備が焦眉の急であると認識されている。
日イ両国の技術移転の成功例として今でも有名なのは、カランカテス、カリコント、ウォノギリのダム建設プロジェクトで、日本側が技術と資材、イ側が施工を自ら実施する事業主体者となってプロジェクトを完成させたものである。成功の原因は事業主体者が公共事業省で、大学や専門学校を卒業

して役人になった若い技術者に対するプロジェクト全体の技術移転だったことである。

④タイ

タイにおける建設産業の技術移転は社会基盤整備の進歩に遅れることなく、順当に行われてきたとみるべきである。技能工の定着という問題は農業立国という社会事情と近代的職制体系が未だ整備されていない事情により、他のアセアン諸国と同様必ずしも安定しているとはいえないが、タイは比較的良い状態にある。１９７０年代後半の中東の建設ブームで出稼ぎに出たタイの技能工達が国際的市場で腕を磨いたこと等もあり、技能工クラスの技術水準はある程度国際的に通用する水準に達しているとみられる。

一方最高学府で教えられる理論的建設技術や手法については先進国と内容において異なることなく、またアジア各国の修士を専攻する学生を対象とするＡＩＴ（Asian Institute of Technology）がバンコク郊外にあり、この分野ではタイは恵まれた環境にある。

勿論、先端的建設技術や特殊技術の面については移転されていないものの方が多いが、これは背景となる経済基盤の進歩の度合から現在必ずしも必要であるとは言えず、今後技術移転の対象となる領域である。

日・タイの技術移転の最近の成功例としてはラマ９世橋（斜張橋）の建設に際して、橋梁製作、溶接の技術移転が行われたことである。元請である日本企業側が橋梁製作を徹底して現地で行ったことと技術移転を日本での実地研修、現地でのマンツーマン教育、オン・ザ・ジョブトレーニングで実施したことにある。橋桁製作に用いられた工場は現在も稼動中で、その後の橋梁製作の工事にも活躍している。

４．２　技術移転のポテンシャルの評価

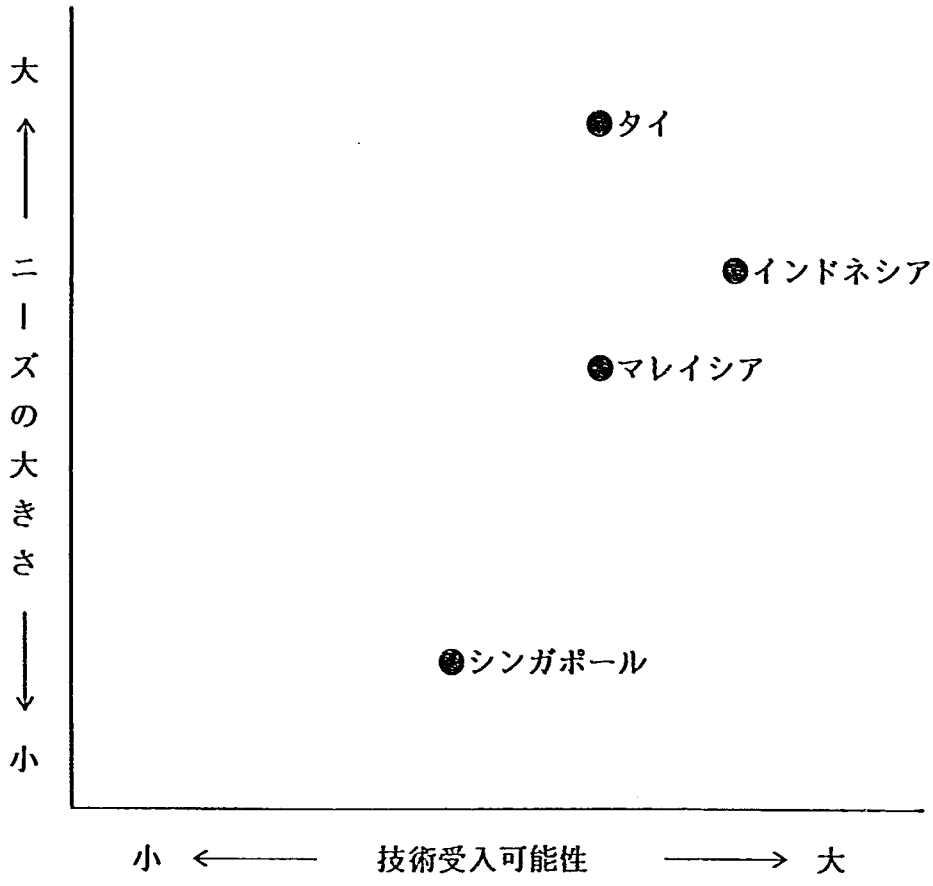
今回の調査を通じて調査４ケ国の建設技術移転に対する相対的位置付けを試みてみる。技術環境要因として、比較的各国の差がわかり易いものを取り上げ、建設技術移転へのニーズと技術受入可能性とし、各国のポテンシャルを表－７に示す。

その結果をまとめて各国の建設技術移転に対する位置を図示すると図－５のようになる。

図－５の示すところは、シンガポールは相対的に建設技術移転のニーズが低く、日本の建設技術の受け入れ余地が少ない。それは、当国の技術水準はすでに相当の高さにあり、またインフラ整備もほぼ完了しているので、一般的建設技術はもう必要としない状況にある。しかし、都市土木や高度な建築に関する日本の先端的技術については興味があるので、移転可能なものを選択し、移転促進を図る必要がある。

表－７　技術環境要因からみたアセアン４カ国の建設技術一般の移転ポテンシャル

技術環境要因		ﾏﾚｰｼｱ	ｼﾝｶﾞﾎﾟｰﾙ	ｲﾝﾄﾞﾈｼｱ	ﾀｲ
ニーズ要因	インフラ整備の必要性	高	低	高	高
	建設工事需要量	低	低	低	高
	公共投資政策	中	低	中	高
	技術水準向上の必要性	中	低	高	中
受入可能性要因	日本建設業進出に対する態度	低	低	高	中
	外国資金への依存度	高	低	高	高
	技術移転受け皿の整備状況	中	高	低	低
	日本の技術に対する受容性	中	低	高	中



図－５　建設技術移転に対するアセアン４カ国の位置づけ

これに対して、他の３国は程度の差こそあれ、建設技術一般に対してニーズが高く、受け入れ余地もある。マレイシアの場合は日本のオーバープレゼンスが問題になったこともあり、"Look East"政策にきめ細かく対応しながら、日本の建設技術で現地に移転できるもの、共同開発すべきものを見出し、官民の役割分担を明確にして移転方策を検討する必要がある。

また、需要拡大策に寄与できる経済援助を進めることも重要である。タイで重要なことは不満が出始めているオーバープレゼンス問題をいかにクリヤーにしつつ現地に即した技術移転の方策を検討するかである。インドネシアは全体的に建設基盤充実のために、特に多面的な技術移転方策を検討する必要がある。

４．３　建設技術移転推進上の課題

今回の調査を通じて得られた建設技術の移転を進める上での問題点について以下に記述する。

１）政府機関の技術者は殆どが大学卒という高学歴の技術者が中心であるが、プロジェクトの計画、設計、施工、施工管理の技術について学問的知識はもつているが、実践的知識や経験に乏しい。１９６０年代は公共事業を計画から施工に至るまで政府職員が直接関与する例があったが、最近は主要な建設プロジェクトの多くが外国からの援助によるものが多く、それらの実務は外国のコンサルタント、施工業者が行うことになるので、政府職員が益々実務から遠ざかる傾向にある。この傾向は国家開発計画の基盤になるプロジェクト設定に必要な知識と経験が乏しくなることであり、好ましくない。

2）民間の技術関係者のうち技術者については組織に頼らず、自分の技術に頼ろうとする型が多く、新しい技術を身につけても他人と共用しようとしない。また、雇用条件が良ければ簡単に転職する。建築士や技術士は社会的地位がかなり高いと見られており、そのため始めから経営的業務に従事したがり、施工とか施工管理のような業務はやりたがらない傾向がある。技能者（高卒程度、フォアマンクラス）は現場での作業のすべて、即ち材料手配から技能工の仕事の管理、施工図の作成に至るまで何でもこなさねばならない。グレードが検定によって認定されていないこともあり、努力と能力が正当に評価されていない。

技能工（職人クラス）については墨出し工、型枠大工、鉄筋工、配管工など一応は仕事をこなすが、未熟練工が多く、大半が農村からの潜在失業者である。質的にも量的にも必要を満たすには非常に不安定である。

3）構造的問題としては建設産業を直接管掌する機関がないことである。建設産業登録の受付は商業省、公共事業の発注、施工管理は公共事業省、技術者等の管理は労働省などと分かれている。建設産業について保護育成どころか建設単価の値上がりに伴う公共工事費の見直しなどについても検討されることは甚だ難しい状況である。

資格制度については大学卒以上の卒業生に与えられる建築士や技術士の制度はしっかりしているが、技能者（高卒程度）や技能工に対する資格については不明確なところが多い。技能工の資格や訓練についてはシンガポールが最も充実している。

民間会社は個人資本で設立した極めて商業的色彩が濃いものが多く、技術尊重の風潮が薄い。技術開発や技術者教育等を行えるほどの余裕のある企業は少ない。

また高度な技術者の供給源である大学卒業者の数が少なく、卒業者は大体官庁や教育界へ行くのが多い。タイでは最近民間企業の好待遇とプロフェッショナルな活動が大卒者を引きつけているようである。タイの今後の民間建設業の発展が大いに期待されている。

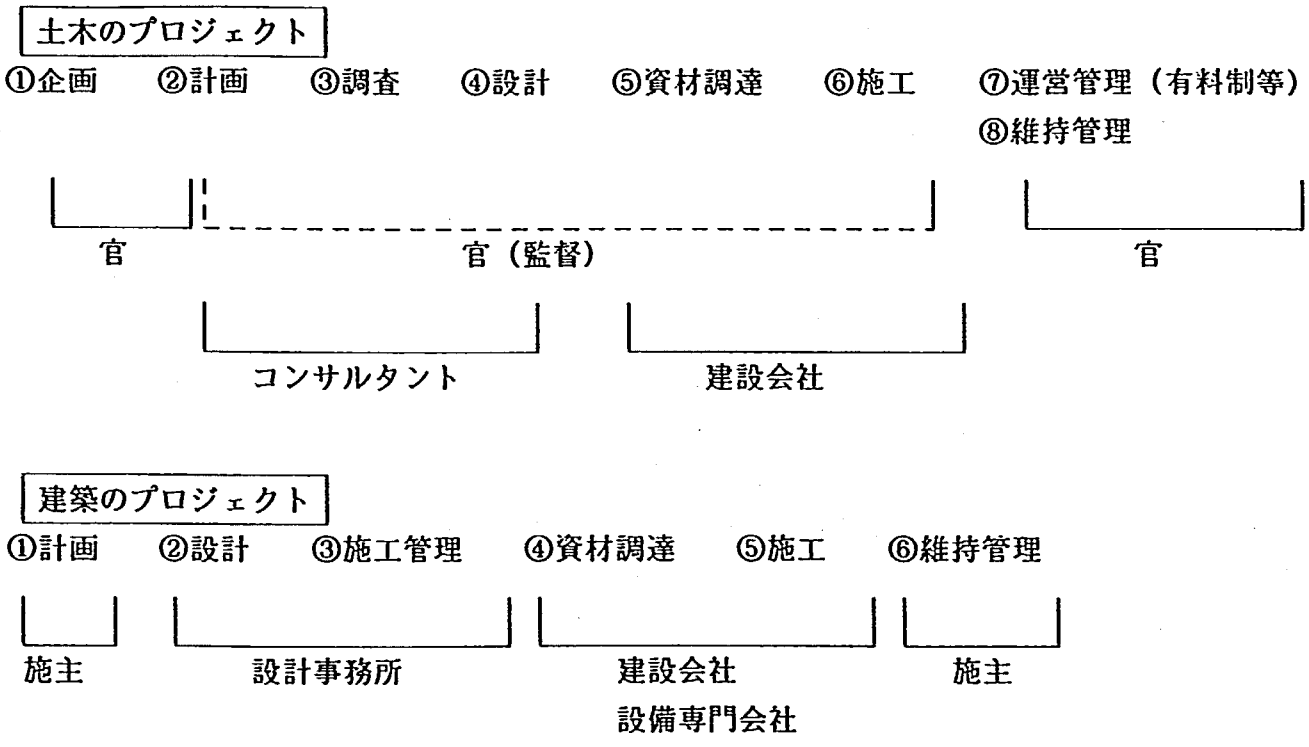
5．建設技術移転の推進に向けて

前章までの議論をもとに今後建設技術の移転を一層進めるために、受入側、供与側とも共通して検討し、配慮していく必要のある諸条件をまとめてみると以下のとおりである。

1）受入国の条件にあった技術移転の必要性

移転が必要とされる建設技術は、地形、地質、気象等の自然条件、社会・経済の発展段階、制度や慣習および社会資本の整備状況等受入国の条件によってそれぞれ異なっている。日本の技術移転の例でみたように、日本の近代化とともに必要とする建設技術は変遷し、より高度なものとなり、かつ独自技術が形成されてきた。アジア諸国の社会資本整備も経済・社会の発展に応じて異なっており、またアセアン諸国の例のように現時点における技術移転の状況からも判るように、個々の国で必要とされる技術は多様である。

技術移転について具体的な案件を実現するにあたっては、受入側、供与側ともこれら受入国の諸条件を事前に十分検討する必要がある。



図－6　プロジェクトの流れと各段階及び関与組織

2）プロジェクトの各段階や組織に沿った技術移転の必要性

建設技術と一口で言っても非常に広範囲であり、移転が必要な技術の特定が重要である。図－6に土木、建築別にプロジェクトの流れの各段階と関与する主な組織について示す。

土木のプロジェクトは、公共事業省などの官が企画、計画し、完成後の維持管理と運営管理（有料の場合）を行い、コンサルタントは計画、調査、設計を、建設会社は資材調達、施工を行う。また建築プロジェクトについては施主が計画し、設計、施工管理は設計事務所が、資材調達、施工は建設会社が建物や構造物を、設備会社が設備や施設を分担し、維持管理は施主が担当する。

従来から建設技術の移転というと設計、施工の段階の技術について論じられることが多かった。建設技術は個々の要素技術とそれぞれの段階における資材調達、段取、人員配置、品質管理等のマネージメントの技術から成っているが、最近はマネージメント面の技術移転への要請が強い。また各段階や要素技術で技術移転を図るべき職層も異なり、例えば施工では技能職や技能工が中心となり、資材調達や品質管理、施工管理では技術者、技能者層への移転が中心となるであろう。

さらにプロジェクトを全般的に執行する技術、即ちプロジェクトマネージメントの技術移転への要請も強く、その場合公共事業省等社会資本整備を担当する官庁の行政官や技術者への技術移転が必要となる。プロジェクトマネージメントの場合プロジェクトの企画あるいは計画の段階で資金調達あるいは採算性の検討等も重要な課題となる。

技術移転計画の具体的検討にあたっては段階や要素技術を特定し、移転を図るべき組織、職層についてはっきりさせることが重要である。

3）実施方法の適正な選択の必要性

技術移転の実施方法も様々である。移転を必要とする技術と移転の方法は密接に関連している。主として公共事業省の技術者を対象とするプロジェクトマネージメントの場合は政府間ベースのプロジ

ェクト方式技術協力が馴染むものと考えられる。具体的なプロジェクトを取り上げ計画の段階から完成に至る間、３～５年間にわたりプロジェクトの全工程についてプロジェクトマネージメント技術の移転を図るものであり、供与国から建物や施設の建設、資材の供給、専門家の派遣、研修の実施等を総合的に受けられるものである。過去インドネシアの３ダムのプロジェクトやタイの道路の機械化施工プロジェクト、ミャンマーの橋梁建設センターの例等がある。これらプロジェクト方式技術協力は全般的マネージメントから個々具体の技術の施工・管理に至るまで実地に技術の移転が行われ広範な効果が期待できる。その他政府技術者への移転としては供与国からの専門家派遣や供与国における研修（１ケ月～６ケ月が普通）への参加等がある。

民間企業間の技術移転を図る体制としては、現地企業をＪ．Ｖ．のパートナーとするものや下請企業とするものがあり、供与国からの資金協力による工事、あるいは途上国の政府資金単独工事では元請企業に技能職や技能工の研修の実施や技術移転を義務付け、必要経費をみている場合もある。しかしながら、最近のように受注競争が激しくなり、厳しい落札価格下での工事では技術移転をきちんと実施する余裕等も少なくなっているとも言われている。

建設技術の技能工養成のための研修機関として日本が援助した例がある。１９８２～１９９１年の１０年間にわたってフィリピンに設立されたアセアン人造りセンターの中で建設技術コースとして建設機械整備、溶接、電気、配管、鉄筋、鉄骨、ブロックの職種についてアセアン諸国からの技能工を育てたものである。このセンターの目的は農村地域開発の担い手となる指導者の養成を目的としたものであった。

技術移転が効果的に行われるためには理論的学習とあわせて実務研修、それも具体的なプロジェクトについて実地に経験し、試行錯誤を繰り返すオン・ザ・ジョブトレーニング方式が最も良いと言われている。さらに習熟した成果を正しく評価する制度があれば、さらに移転を効果的にすることができる。

４）受入国の主体性の確立の重要性

技術移転をより良く進めるためには受入国の主体性の確立が重要である。第４章で述べたアセアン諸国の例でも判るように、技術移転がスムーズに進まないような、あるいは阻害するような労働制度や慣習が受入国には多い。また企業体のあり方として長期的視点に欠け、技術を重視するような体質にないものも多いと聞く。受入国の高い立場の人々が技術移転の目的として国際競争力を有するような技術の移転を期待しているとすれば、受入国内の制度の改善を図り、建設産業の技術開発を促進するような法制度の整備や建設産業のより一層の重視策は今後とも重要である。

今後受入国の社会経済が高度化するにつれて、国民の行政サービスに対する要請はさらに強くなり、社会資本整備への要請も益々強くなるものと考えられる。先進国からの資金協力プロジェクトが増えるにつれて、外国コンサルタントや外国建設企業に任せる部分が多くなり受入国政府関係者のプロジェクトマネージメントへの関与が小さくなるとか、Ｂ．Ｏ．Ｔ．という民間活力活用型プロジェクトが増加することは、国の基本的施策として社会資本整備を主体的にすすめるという観点からは望ましいものとは言えないと思う。将来の国民の財産である社会資本整備は国の責任として企画、計画、実施することが必要で、その際におこるであろうリスクは国が基本的に負うべきであろう。

５）より高度な技術－研究開発技術の移転の必要性

日本の例で紹介したように、技術移転をより良く進めるためには、移転された技術をもとに各国の

条件にあうような技術に改良し、それを国内に広く伝えて国内技術を向上させ、さらに独自技術の開発を図ることである。
技術移転の対象となる技術もまず①工事を施工するため現に保有している技術(OperationalTechnique）から②現場の特性に応じて求められる改善技術へと進み、最終的には③顧客のニーズに応じるための研究開発技術へすすむべきであると思う。基礎及び応用研究を含めた研究開発分野への技術移転が求められている。

これは機械の分野でいえば機械を作る機械が必要であるということであろう。新しい技術を生産出来る技術を移転させるため何をすべきか考える必要がある。建設技術移転の究極の目標は国際競争力を充分有する高い生産性と優れた品質の成果物を生産できるような技術の移転である。建設技術の将来としては大規模化するプロジェクトに対応する技術、人力が主体では実現不可能な困難な条件下での工事を可能とする技術、機械化とコンピューターに支援された建設技術や他分野の進歩発展を取り入れた建設技術の発展が今後の技術開発の潮流と考えられるが、そのような先端的建設技術の移転は今後の大きな目的でもあり、課題でもあると思考される。

６．あとがき

アジア諸国の社会、経済が高度化するにつれて、経済発展に不可欠な基本的な施設として、また健康で快適な、かつ安全な国民生活を支える基幹的施設として、アジア諸国においては社会資本整備を一層進めて行かなければならない。また、アジア各国において社会資本整備を支える建設産業の発展は重要である。建設産業は関連する分野の極めて広い総合産業であり、農村を中心とする余剰労働力を吸収し、天然資源を活用し、資材・部材の供給源として中小工業を育成させる力を持っている。

社会資本整備を一層進め、建設産業の発展を図るためにはより高度な建設技術の移転を図る必要がある。建設技術は極めて裾野の広い多様な技術の集団であり、多面的、戦略的に移転を図る必要がある。

また先進国においても建設技術の進歩は早く、他分野の研究開発の進展、技術の革新を取入れた先端建設技術の移転や研究開発技術の移転が将来の課題であろう。

本論文がアジア諸国における建設技術の促進に多少でも貢献できれば望外の喜びである。本論文をとりまとめるにあたって、土木研究所企画部の方々のご援助を頂いた。ここに記して謝辞に代える。

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技術移転促進事業報告書（建設省委託　（社）海外建設協会受託）

昭和６０年度現地調査	（マレイシア、シンガポール）報告書	昭和６１．３
昭和６１年度現地調査	（インドネシア）報告書	昭和６２．３
昭和６２年度現地調査	（タイ中間報告）報告書	昭和６３．３
昭和６３年度報告書		平成　元．３
平成元年度報告書		平成　２．３

付属資料

建設省の国際協力

1．建設省全体の国際協力

1）　概要

ソビエト連邦の崩壊、中東及びカンボジア和平の進行など、国際社会の新しい枠組みが構築されていくなかで、日本の国際的役割は急速に大きなものとなっている。社会資本整備は経済発展の基礎であり、わが国の国際的貢献の中で最も重要な課題となっている。このため建設省では、開発途上国への国際協力、国際機関や諸外国との国際交流等を積極的に推進している。

以下、開発途上国への援助を目的とした技術協力と多国間、二国間の交流を推進する国際交流について、記述する。

2）　技術協力

建設省の行う技術協力には、国際協力事業団を通じて行う協力と建設省独自で行う協力がある。国際協力事業団を通じて行う技術協力には、外国人研修生の受け入れ、専門家の派遣、調査団の派遣、プロジェクトタイプ技術協力への参画がある。

研修生の受け入れは開発途上国からの要請に基づいて各専門分野の技術、行政事務の研修を実施している。表－８に研修生の受け入れ実績を示す。平成４年度では、集団研修が21コース237名、個別研修が128件357名、合計594名の研修生を受け入れている。

表－８　建設省の研修生受け入れ実績

区分＼年度	６３年度	元　年度	２　年度	３　年度	４　年度
長期派遣(1年以上)	20ヶ国　95名	26ヶ国　104名	26ヶ国　94名	24ヶ国　84名	22ヶ国　95名
短期派遣(1年未満)	24ヶ国　161名	27ヶ国　248名	25ヶ国　180名	23ヶ国　149名	26ヶ国　205名
計	256名	352名	274名	233名	300名

専門家の派遣については、河川、道路、住宅、都市計画、測量等の専門家をアジア、中近東、中南米、アフリカ等に派遣し、開発途上国の開発プロジェクトの計画立案、実施等に協力している。表－９に専門家派遣実績を示す。平成４年度では、長期派遣が22ヶ国95名、短期派遣が26ヶ国205名、合計300名の専門家が派遣されている。また、インドネシア地震災害及びエジプト地震災害に対する援助を行うため国際緊急援助隊が平成４年度に派遣されている。

表－９　建設省の専門家派遣実績

区分＼年度	６３年度	元　年度	２　年度	３　年度	４　年度
長期派遣(1年以上)	20ヶ国　95名	26ヶ国　104名	26ヶ国　94名	24ヶ国　84名	22ヶ国　95名
短期派遣(1年未満)	24ヶ国　161名	27ヶ国　248名	25ヶ国　180名	23ヶ国　149名	26ヶ国　205名
計	256名	352名	274名	233名	300名

調査団は、国際協力事業団が行う開発調査、無償援助の基本設計調査、海外経済協力基金が行う有償援助の審査等に関する、関係分野から派遣され、現地政府との打ち合わせ等の現地調査等の行い、報告書を作成し、援助要請国に提出して開発プロジェクトの促進に寄与している。調査団派遣実績を表－１０に示す。

表－１０　建設省の調査団派遣実績

区分＼年度	６３年度	元　年度	２　年度	３　年度	４　年度
派遣件数	９９	９９	８３	８３	１０５
調査団数	１３４	１４０	１０９	１０２	１３７
派遣者数	２８２	２８３	２０８	１８０	２４３

プロジェクトタイプ技術協力で現在実施しているものとしては、ネパールの治水砂防技術センター、フィリピンの交通研究センター、インドネシアの砂防技術センター等の技術協力がある。

建設省が独自に行っている技術協力には、①開発途上国の社会資本整備、建設行政に携わる高級管理者を日本に招へい（年間2～3名）し、日本の行政制度・技術水準について紹介する要人招へい事業、②援助要請国の自然的、社会的、経済的条件に適合した建設技術の開発を援助要請国のニーズに合った形で、効率的に推進するための海外建設技術開発事業（平成４度実施4件）、③災害復旧、防災、居住環境改善、生活インフラ整備等の建設分野においてＮＧＯ（民間援助団体）が行う国際協力活動に対し、専門家の派遣及び研修についての補助を行うＮＧＯ国際建設協力支援交流事業（平成４年度専門家派遣はフィリピン等へ総数15名）、④開発途上国における良質な建設計画についての概略的事前調査、⑤プロジェクトを実現させるための既調査のフォローアップ、⑥プロジェクト実施段階におけるアドバイス並びに⑦協力実施済みの完了プロジェクトについてのエバリュエーションを行う海外建設プロジェクト形成推進事業（平成４年度事前調査15件、プロジェクト実現化調査4件）等の技術協力を実施している。

３）　国際交流

建設省において行っている国際交流の主なものを以下に示す。

①国際連合関係

国連アジア太平洋経済社会委員会（ＥＳＣＡＰ）への専門家の派遣、会議への参加により、積極的にその活動を支援している。

②経済協力開発機構（ＯＥＣＤ）関係

道路輸送研究計画に関する専門家会議等に積極的に参加している。

③その他の多国間協力

アジア開発銀行（ＡＤＢ）、アジア工科大学（ＡＩＴ）、常設国際道路会議協会（ＰＩＡＲＣ）、国際大ダム会議（ＩＣＯＬＤ）等に参加協力している。

④二国間協力

主要な先進国との間では、政府レベルにおける二国間科学技術協力協定等に基づいて、二国間の科学技術協力を実施している。

⑤海外大規模プロジェクトに対する協力

パナマ運河代替案等の地球規模のスーパープロジェクトを推進するための国際協力を実施している。

⑥国際防災の10年の推進

1990年から始まった国際連合による国際防災10年の推進のために、国内におけるセミナーの実施や国際的活動に協力している。

2　土木研究所の国際協力

1）　概要

土木研究所では、国際社会におけるわが国の建設技術に対する期待の高まりに応え、国際交流を通してわが国の建設技術の普及・向上を図るため、諸外国との研究交流を積極的に推進している。特に、自然災害の防除、地球環境問題等の国際的規模で解決の迫られている問題や道路交通技術等の社会資本整備のための各種建設技術に対し、土木研究所の持つ技術力と各種施設を有効に活用した国際共同研究を積極的に推進している。

また、わが国の国際的貢献としての諸外国への技術協力、技術指導を推進するための専門家の派遣や、技術移転のための海外研修生の受け入れ等を行っている。

2）　国際研究協力

土木研究所の多国間研究協力の活動としては、表－１１に示す４国際機関における６つの委員会等へ参画し、約20テーマについて研究協力を実施している。また、二国間研究協力では、北米・欧州・アジア等の計10ヶ国との間で科学技術協力協定等の枠組みの下で39研究プロジェクトについて研究協力を実施している。協力内容としては、会議参加、文献等による情報交換、人的交流、共同研究等である。

上記の枠組みのもとでハイブリッド・コントロールによる耐震性向上技術に関する日米共同研究、新道路研究計画における試験舗装に関する日米共同研究、扇状地における土砂災害防止技術に関する日・インドネシア共同研究、下水汚泥の建設資材化とそのリサイクルに関する日独共同研究等の地球環境、海岸、河川、砂防、道路、ダム、地震等の分野における共同研究を進めている。

また、土木研究所は国際研究協力を積極的に推進するために、国際会議を主催し、研究者の交流を図っている。主な国際会議を表－１２に示す。一例として、1992年11月に行われた第１回日米道路科

表－１１　土木研究所の国際研究協力

(a)多国間協力

機　関　名	協力委員会名
OECD	国際道路運輸研究計画運営委員会
	〃　　専門家委員会
	国際道路運輸研究文献交換（IRRD）
PIARC	国際道路会議
ESCAP	海運及び運輸通信委員会
RILEM	国際建設材料構造試験研究機関連合

(b)二国間協力

国　名（テーマ数）	
オーストラリア（4）	ノルウェー（2）
カナダ（4）	スウェーデン（2）
中　国（6）	英　国（1）
ドイツ（1）	米　国（8）
イタリア（1）	
韓　国（1）	

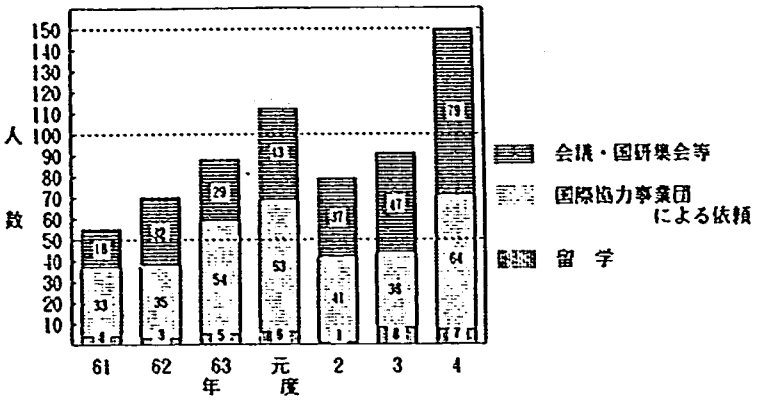
表－１２　土木研究所が主催している主な国際会議

会　　議　　名 ［開始年度；相手機関名］	概　　要
アジア地域土木研究所長等会議 ［'92～；アジア地域の公共事業担当部局及び研究所］	日本を含むアジア地域諸国の適正な社会資本整備の推進と技術・開発の促進に資するための関係当局間の技術研究交流及び恒常的なネットワークづくりを目指している。　'93年2月に新規発足した会議である。
天然資源の開発利用に関する日米会議（UJNR）－耐風・耐震構造専門部会－ ［'69～；米国国立標準技術研究所（NIST）他］	土木・建築構造物の耐風・耐震技術の発展に寄与することを目的としている。　四半世紀の長い歴史を有している。
地球環境変化が流域レベルの水文、水資源に及ぼす影響に関する日米委員会 ［'91～；米国地質調査所（USGS）他］	地球環境変化が河川の流域規模の水文、水資源に及ぼす影響の調査、把握と評価手法の開発及び技術研究交流を目的としている。　'92年2月に発足した会議である。
日米道路科学技術に関するﾜｰｸｼｮｯﾌﾟ ［'92～；米国連邦道路庁（FHWA）］	道路分野全般にわたる研究開発のための技術研究交流を目的としている。　'92年11月に新規発足した会議である。
日米下水処理技術委員会 ［'71～；米国環境保護庁他］	水質汚濁防止、下水の高度処理、合流式下水道の改善等の課題解決を目的としている。
日独環境保護パネル －排水及びｽﾗｯｼﾞ処理に関するﾜｰｸｼｮｯﾌﾟ－ ［'82～；カールスルーエ核研究所他］	排水及びスラッジ処理に関する技術研究交流を目的とし、隔年で日独相互にワークショップを開催している。
寒冷地舗装の設計施工に関する日加会議 ［'82～；オンタリオ州交通省他］	寒冷地における舗装維持管理、新材料および新工法に関する技術研究交流を目的としている。

学技術会議について紹介する。

第１回日米道路科学技術会議は、平成４年１１月３０日から１２月２日まで、建設省土木研究所において、米国運輸省連邦道路庁より１０名、日本から８４名の道路行政、道路研究の専門家が参加し、道路科学技術に関する７つの分野（道路行政、道路交通安全、ＩＶＨＳ、道路環境、舗装、道路橋、トンネル・地震・地盤工学）について、技術の現況と将来展望が議論された。その結果、新しい舗装設計法の確立を目指した舗装データベースの構築への協力、ＩＶＨＳに関するワークショップの定期的開催、耐震性向上に関する日米の設計基準に基づく比較設計や長大橋の風洞実験に関する共同研究等を実施することにした。また、今後各研究分野における交流を定期的会合を含めて実施していくこととした。

多国間及び二国間協力等に基づく会議、研究集会等への参加、国際協力事業団等を通じての技術協力では図－７及び表－１３に示すとおり、毎年100名前後の研究者が派遣されている。地域別にみると東南アジアが最も多く、次いで米国、欧州となっている。この内、国際協力事業団による技術協力には毎年50名前後が派遣されている。



図－７　土木研究所職員の外国出張

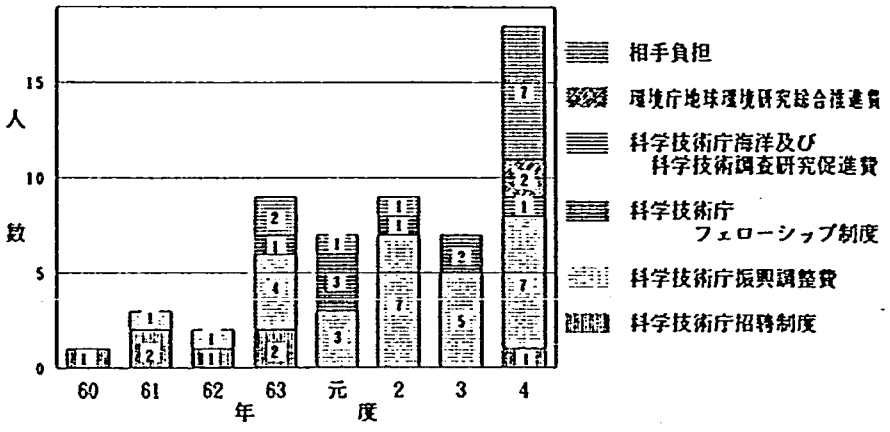
表－１３　土木研究所職員の地域別外国出張状況

年度	米国	欧州	東南アジア	その他
59	9	5	34	8
60	12	3	22	9
61	11	4	35	9
62	10	11	36	18
63	11	15	38	30
元	18	21	35	43
2	13	13	47	11
3	17	21	23	10
4	43	28	47	40

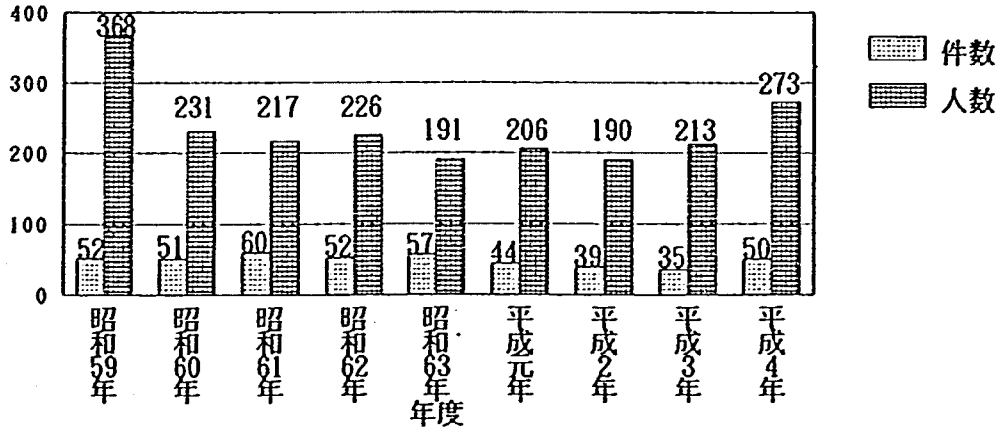
注）訪問国ののべ数で示している。

また、土木研究所では、人的交流の一環として、外国人研究者の招へい、受け入れも行っており、図－８に示すとおり、米国、中国、タイ、英国等から、毎年10名前後の外国人研究者が土木研究所で研究を行っている。

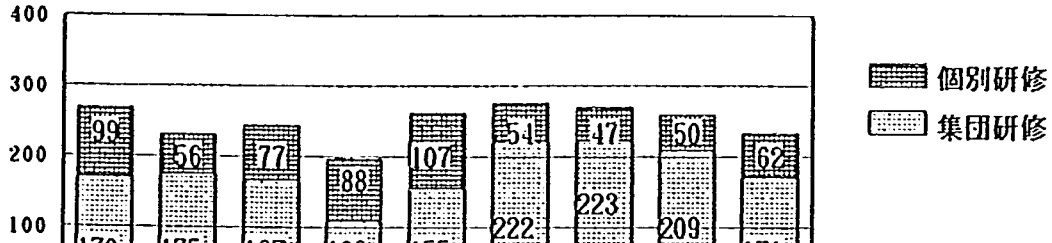
さらに、外国人研究者、技術者の見学も多く、図－９に示すとおり、毎年200名程度の見学者がある。国際協力事業団等の依頼による外国人研修員についても、図－１０に示すとおり、毎年250名程度の研修員を受け入れている。



図－８　外国人研究者・技術者の招へい



図－９　外国人見学者の受け入れ



図－１０　外国人研修員の受け入れ

III. 日本における研究について
—土木工学を中心として—

筑波大学構造工学系教授　椎　貝　博　美

日本における研究について
－土木工学を中心として－

椎貝博美
工学博士　筑波大学構造工学系　教授

1　日本の科学技術の特色

西欧を中心とする科学技術の関する評論家の多くは、日本の科学技術は応用面に力を入れており、基礎的な科学については研究が遅れている、と言い続けてきました。このいいかたは、なかなか刺激的であり、また第二次大戦後の日本だけを見るならばあたっている面も確かにありますから、世界にはこのように信じている人が多いと思います。

実際問題として、西欧社会の言う、「基礎的」いうことは、アジアで考える「基礎的」とは少し違っているように私には思えます。例えば、核物理のような、それが発展していけば疑いもなく人類全体を滅ぼすようなものに発展する理論は、そのような意味では「基礎的」であるかもしれませんが、私どもは、人間にとって基礎的なものであるとは考えません。

皮肉なことに、いわゆる「発展した国々」が「環境の危機」にきがついたのは、ここ２０年ほどのことでありますが、これは「発展した国々」が「基礎的」という言葉を、人類との関係においては、完全に誤解していたことにほかなりません。そして不幸なことにこの傾向は今後も尾をひくかもしれません。

明治維新のあと、これは１８６８年に徳川将軍が天皇に大政を奉還した１８６８年をふしめにしていますが、日本政府は日本の近代化に大変な努力を払いました。当時の日本の人口は３０００万人程度が４つの大きな島に住んでおりました。当時の、そして現在も日本の国土面積はその他の小さな島も含めて、３７．７万平方キロほどでありあります。ですから、当時の人口密度は１平方キロあたり、８０人ほどであり、現在のキューバくらいです。

当時の日本は自給自足の食料生産と経済が可能であり、これは当時のイギリスの外交官、アーネスト・サトウが、当時の日本は驚くべき安全性の高い国で、例えば若い女の子がたった一人で東京から京都まで旅行することができる国であり、イギリスであれば、ロンドンから外へでることすらおぼつかない、ということと同時に指摘しています。

新しい明治政府は、日本の当時としての近代化に力を注ぎました。明治政府のスローガンは「富国強兵」でありました。したがって土木技術は、富国を作り上げるのに、近代化された大学の中で、物理や科学と並んで最も重要視された「科学」のひとつでありました。

ちなみに、科学者になることは、陸軍、海軍の大将になることと同様に若い男の子の夢でありました。　そのような意味合いから、日本最初の近代型の大学、東京大学に土木学科が置かれたのは、理学部でありました。工学部が設けられたのはかなり後になってからです。

話は変わりますが、日本は大変多くの自然災害を抱え込んでおります。地震、津波、高水、旱魃、台風、フェーン、豪雪、高潮、噴火、地滑りなどがまずあげられます。近代型

の政府が誕生する前は、日本の発展はこれらの自然災害によってかなり阻害されていました。それを見越して徳川幕府は人口の増加をうまく押さえたのかも知れません。とにかく、これらの自然災害の中で洪水の影響は最も大きかったといえるでしょう。それは洪水は非常に頻繁に起こったもので、春には雪解け水、６月には梅雨、９月から１０月にかけては台風というような具合です。当時の日本はたしかに３０００万人の人口を抱えて、自給自足が可能ではありましたが、それ以上の成長は洪水に代表される自然災害が制約条件となっておりました。日本の国土の約７０％が山地であり、住民と資産は残り３０％ほどの平野に集中している点も見逃せません。そのような理由から、明治政府がまず洪水対策に取り組んだのは賢明であったということができます。

このような意味からすれば、洪水防御はその当時の日本にとって、「基礎的」なことでありました。そして現在でもそうであります。洪水防御は、物理的な意味では、基礎的ではないかも知れませんが、社会経済的な意味からすれば、非常に基礎的なことであります。防災技術、あるいは科学もそのような意味で日本にとっては基礎的であります。

西欧社会は、例えば原子物理学を長い間基礎的な学問としてとらえ、環境科学をそうとは考えませんでした。もちろん、この２つの基礎的なこと、には大きな隔たりがありますが、日本に限らず、多くのアジアの国々が、１９世紀にすでに、持続する成長、の技術を身につけていたことと無関係ではありません。

日本の場合、当時の教育の主体は自然科学に重点が置かれ、工学全般には置かれていなかったことにも注目する必要があります。　第２次大戦が終わるまで、日本の大学の理学部の多くは相当な水準に達していましたが、工学部は比較的小さかったのです。第２次大戦後がおわって初めて、日本全体として、実験の重要性に気が付き、日本の今後の発展のためには、科学とバランスのよく取れた工学分野を発展させることに気が付いたのです。

2　土木研究所の役割

明治維新後、日本政府は比較的短期間、高い給料を払って大勢の外国人を雇用しました。オランダの河川技術者は日本の治水に大きく貢献したことでよく知られています。１９世紀後半の日本の発展はこれらのオランダ人技術者によるところが大であります。同時に日本政府は何人かの留学生をフランスのエコール・ド・ポリテクニークに送っています。オランダの技術者は、主要河川の治水の延長上に低水工法、すなわち舟運を考えましたが、フランスで学んだ日本の河川技術者は、一層治水を強化することを考えていました。従ってオランダ人の技術者が任期がきて帰国したとき、この食違いは表面化しました。結果として、江戸時代に伝統をもつ高水工法が引き続き行なわれることになりました。これは現在でも受け継がれています。

日本の土木技術者は、第２次大戦が終わるまで、内務省に属しており、法律を専攻したものが先にたって計画を定めていたようです。１９２９年になって内務省自体が、治水とか水資源の開発などの土木事業については、技術者の判断は大変大事であることに気が付きました。その時代に内務省の土木研究所が発足しました。この第２代目の所長であった、物部長穂博士は、東京大学の教授も兼任しておりました。この人は、１９３３年に日本で最初の大著、物部水理学を書き、この本は改訂されてはいますが、現在でも読まれています。この時代には世界でも水理学の教科書はわずかに３冊を数えるのみであり、それらは、

は、ドイツのフォルヒハイマー、フランスのフラマン、オーストリアのショックリチュであります。この物部博士は、耐震を考えた高い構造物は、柔構造であることが有利であるという論文を書き、学士院賞を１９２９年に受けました。現在でも日本の高層建築物の設計はこの物部理論がもとになっています。

なお物部水理学は大変大きな影響を与え、当時の日本の水理構造物設計の基準になりました。この教科書の背水理論の部分は英文でＡＳＣＥに発表され、それがアメリカに影響を与え、有名なベン・テイ・チョウの　Ｏｐｅｎ　Ｃｈａｎｎｅｌ Ｈｙｄｒａｕｌｉｃｓ　という教科書になりました。この本もドーバー版で用いられていることはご承知のとおりです。

第２次大戦後、日本の内務省は解体され、土木事業の多くは、新しい省である、建設省へ移管されました。その後も土木研究所は大きな役割をつとめ、研究面のみならず多くの人材を教授として大学に送り込んだことも重要であります。

３　研究の意義

私は大変運のよいことにタイ王国のＡＩＴで６年ほど教える機会を持ちました。この６年の間に大変多くのことを得ることができましたし、東南アジアの友人もたくさん作ることができました。

ＡＩＴは４０から５０ヵ国の国から学生がきています。また教員は１５くらいの国々からきています。ですからＡＩＴでの意見の交換はいつも活発で実りの多いものでした。面白いことにかなりの学生が、もし理論的という言葉が使われているならば、それは実用的ではない、と考えているようでした。例えば、私が、流体の理論、という講義をすれば、すべてではありませんが、何人かの学生は、この種の講義で教えられるような現象は、現実の世界では決して起こらないもので実用的な設計はこれとは違った方法で行なわなくてはならない、と考えていたようでした。そうかと思うと、何人かの学生は、理論がすべてであると信じていたようでした。

このような経験から、私は土木工学においては、３つの大事な”ｍ”がある、といつも教えることにしていました。それは　ｍａｔｈｅｍａｔｉｃｓ，ｍｅａｓｕｒｅｍｅｎｔ，ｍａｉｎｔｅｎａｎｃｅ　の３つです。

この場合、ｍａｔｈｅｍａｔｉｃｓは理論を表します。数学はこれを利用できる能力をもっていれば、工学にとってすばらしい武器になります。

なにか設計するためには、ｍｅａｓｕｒｅｍｅｎｔ、すなわちデータを取る、ということが必要です。データがなくてはよい設計をすることはほとんど不可能です。

最後に、ｍａｉｎｔｅｎａｎｃｅは費用のかかる土木構造物を長期間利用することはほとんど不可能です。

私は多くの土木工学に関する多くの研究所が、とくにそれが政府機関の場合、この点をもっと強調していただけたら一層よいと考えています。

４　結論

もし私が現在の日本の土木技術を評価するならば、それは科学によってよく支えられている、ということであると思います。実際のところ、第２次大戦までの日本の指導者は、

科学こそが強い軍隊を作ることができると考えていたようです。戦後になって初めて、将来の日本の発展のためには、工学も必要である、ということを悟りました。比較的強力な理学部を持っていたために、工学部を強化することはそれほど難しくはなかったのです。

土木工学に関していえば、防災技術が特に発達したといえるでしょう，これは日本の経済発展には大きく寄与いたしました。土木研究所がこのようなことに大きな役割を果たし、大学の発展にも大きな寄与を行なったのは特筆されてよいでしょう。

このような意味合いから私は、技術的発展のためには、よい理学部とよい工学部を作ることが最も重要であると考えております。

（D）カントリー報告

Ⅰ．中華人民共和国

中国科学院成都山地災害及び環境研究所長　呉　　積　善　Wu Jihan

1．中国の概要

1.1. 国土

中国はアジア大陸東部に位置し、960 万㎢の広大な領土を持つ。高原、山岳、丘陵を主な地形的特徴とし、これらは国土の約66%を占める。国土は西から東へ向かって３段階に下傾している。現在、国土のおよそ５億6400万ヘクタールが利用されており、これは中国の利用可能な土地面積の72.2%に相当し、国土全体の58.8%に相当する。

1.2. 気候

中国では、１年を通じて温暖な地域もあり、冬が長く夏が短い地域もある。年間降雨量は、東南の沿岸地域（平均1,000 ミリから2,000 ミリ）から、北西の内陸（100 ミリから200 ミリ）へ向かって次第に少なくなる。しかし、モンスーン気候が主な特徴の１つである。モンスーンの影響により、冬は乾いた冷たい北西の風が内陸から海へ向かって吹くことが多く、夏は海から熱い湿った南東の風がしばしば吹く。国土の大部分は四季のはっきりした気温帯に位置する。

1.3. 人口

1990年の中国の総人口は11億3000万人であり、年間人口増加率は1.48%である。平均人口密度はおよそ118人／㎢であるが、人口分布は極めて不均一である。人口密度が非常に高い地域は南東の沿岸部に集中している。例えば、人口密度が全国で最も高い江蘇省は、僅か10万㎢に6700万人という大きな人口を支えている。15万㎢の面積を持つ山東省の人口は8400万人である。これに対して、中国北東部の人口密度は低い。チベット自治区は1200万㎢の広大な面積を持つが人口は僅か220 万人である。中国の総人口の26.23 %が都市部に住んでおり、73.77 %が農村部に住んでいる。

1.4. 経済と社会

国民経済は急速に成長した。1992年度の国民総生産（ＧＮＰ）は２兆4000億元（4140億ドル）であり、12.8%の率で成長してきた。工業総生産は平均年率15%で上昇し、農業総生産は平均年率4.9 %で上昇した。主要工業製品の生産高は、石炭11億トン、鉄鋼8000万トン、電力１億6500万キロワット・アワー、石油１億4200万トンであった。1992年度は、総輸出入額も1656億ドルに達し、1987年以来２兆6000億元（4485億ドル）が社会資本に投資された。

2．公共事業の現状

2.1.　国土開発に関する基本計画

中国における国土開発の規制を緩和する法律として、下記のような重要な法律がある。国土管理法（1986年）とその修正法（1988年）、国家草原法（1985年）、国家鉱山資源法（1986年）、国家森林法（（1984年）、国家水資源法（1993年）、国土建設法（1982年）。他に関連法として、水土保全法（1991年）、環境保護法（1979年）等がある。

2.2.　建設投資の予算

1995年までに建設投資の年間成長率は5.7 %に達し、総額２兆6000億元となる。これには国有企業による１兆7000億元が含まれており、これは年成長率5.5 %に相当する。後者には資本建設のための8400億元が含まれており年成長率は2.1 %である。

2.3.　公共土木事業に関する機関

水利部: 水保全プロジェクト及び小規模水力発電所の建設を職務とする。
能源部: 水力、火力、原子力発電所の建設を職務とする。
交通部: 水路、港湾、幹線道路の建設を職務とする。
建設部: 都市及び都市インフラストラクチャーの建設を職務とする。
鉄道部: 鉄道建設を職務とする。

2.4.　主な社会資本整備の歴史・整備状況と課題

例として浸食防止について述べる。

1950年代の統計によれば、水及び土壌の流出面積は150 万km^2に及んだが、これは中国の国土全体の1/6に相当し、黄土高原、揚子江南部の丘陵地帯、北部の土と岩の丘陵地帯、北東部の黒土地帯に浸食は分布していた。この中、黄土高原の丘陵及び高原雨裂（ガリー）は最も深刻で、およそ25万km^2が浸食に曝されており、土壌浸食は年間１km^2当たり4000トンから5000トンであった。

40年間の努力の結果、50万km^2が利用され、26万km^2が水と土壌保全の為に植林され、台地７万7000が造成され、１万5000km^2が沈泥や堤防建設により開墾された。これらの中、黄土高原の重要な利用地域の中に70km^2の土地が保全されている。

2.5.　実施中の主要なプロジェクト

代表的な例として三峡ダムプロジェクトについて述べる。プロジェクトの実施は３段階に分けて行われる。プロジェクトの主要部分の総合実施期間は15年であり、これには実施準備のための３年間が含まれる。

実施開始から９年後に常設運航システムの使用が開始され、第一発電装置が発電を開始する。1990年の価格で計算すると、プロジェクトの実施、住民の移住、電力伝送のための投資を含めて、570億元に達する。

３．ＩＭＨＥの概要

3.1.　中国科学院（ＣＡＳ）水利部（ＭＷＣ）山地災害および環境研究所（ＩＭＨＥ）は山地科学の総合研究施設である。研究課題は山地災害（土石流、地滑り等）、山地生態学と環境、山地開発、山地資源の利用、山地リモートセンシング、コンピュータによる地図作成である。

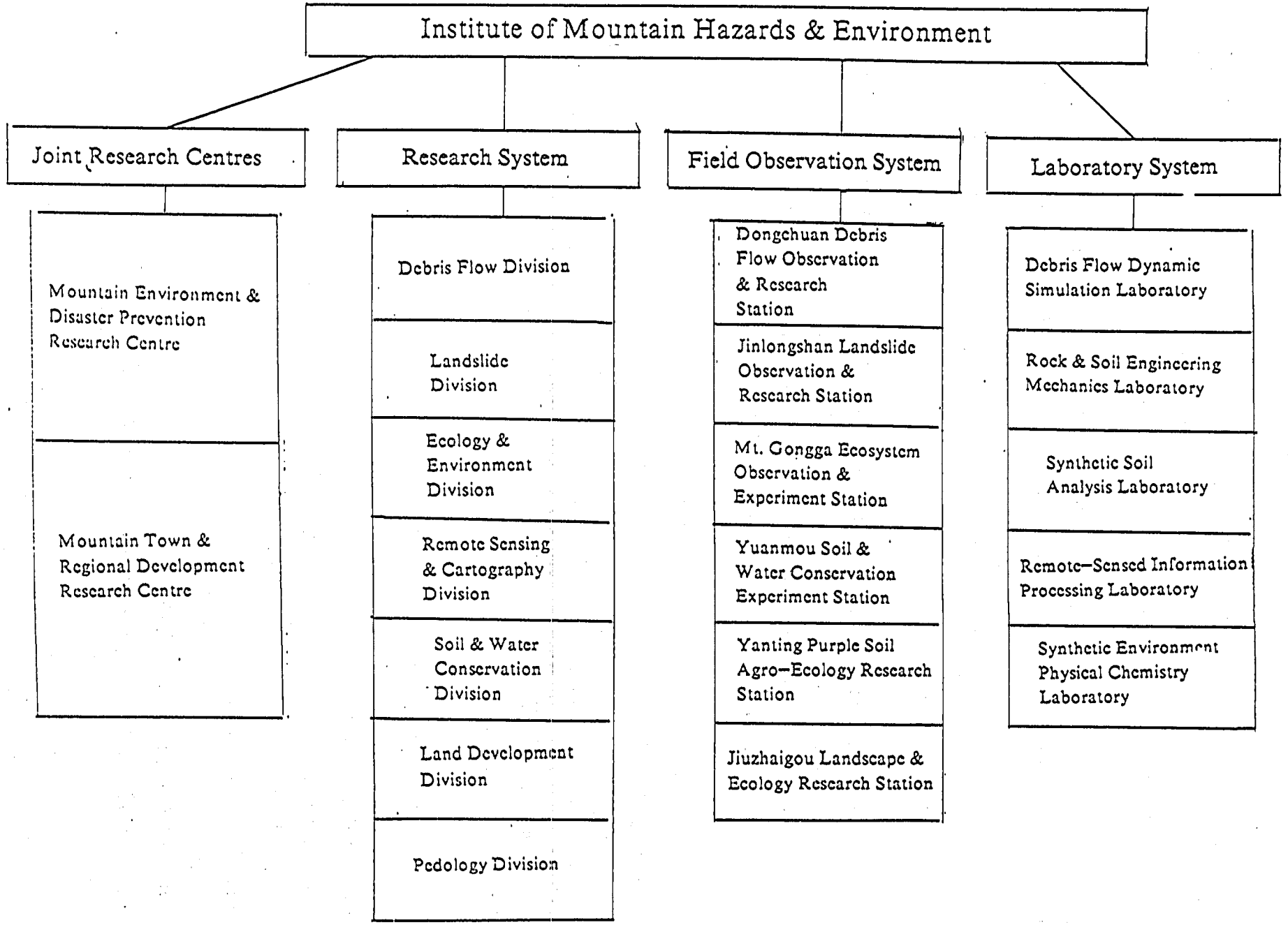
3.2.　研究所は1965年１月26日に設立され、中国科学院地理研究所西南支所と通称された。1971年、四川地理研究所と改称された。1978年、研究所は中国科学院に返還されて中国科学院成都地理研究所と呼ばれた。
1987年、中国科学院山地災害および環境研究所と改称された。1989年、中国科学院と水利部の指導下に置かれ、現在の名称となった。

3.3.　研究所には現在382 人のスタッフがおり、その中80人が上級特別研究員、119 人が中堅研究員、88人が若手研究員とエンジニアである。７つの研究部門がある。土石流及び地滑りシミュレーション研究室が２つと、総合技術及び専門技術研究室が１つある。有能な専門家が新しい研究方法で取り組むこの研究所は山地科学の主要な研究機関となっている。

3.4.　持続可能な山地開発のニーズに応える為、研究所は下記のような研究活動を重点的に行っている。山地地帯における災害（土石流、地滑り、土壌浸食等）の分布、形成、防止に関する研究、山地環境の形成、発達、保護、及び山地環境に人間が与える影響に関する研究、山地資源－特に土壌資源－の開発・利用、山地地帯の生産力の配分に関する研究、リモート・センシングとコンピュータによる地図作成。創設以来研究所は410 件の研究或いは生産的課題を完成させ、その中128 件で重要な成果をあげ、81の賞を獲得した。

3.5.　研究所の年間予算は450 万元である。

3.6.　最近の主な成果
・雲南省東川における土石流の発生、発達、流下機構と総合防災対策
・揚子江上流の生態環境と社会経済状況の研究と評価
・揚子江三峡の生態・環境地図
・中国の農業地理に関する一連の論文
・揚子江三峡貯水地域の貯水能力に関する研究
・土石流に関する力学的シミュレーションの実験・研究工学


Institute of Mountain Hazards & Environment
Joint Research Centres
Research System
Field Observation System
Laboratory System
Mountain Environment & Disaster Prevention Research Centre
Mountain Town & Regional Development Research Centre
Debris Flow Division
Landslide Division
Ecology & Environment Division
Remote Sensing & Cartography Division
Soil & Water Conservation Division
Land Development Division
Pedology Division
Dongchuan Debris Flow Observation & Research Station
Jinlongshan Landslide Observation & Research Station
Mt. Gongga Ecosystem Observation & Experiment Station
Yuanmou Soil & Water Conservation Experiment Station
Yanting Purple Soil Agro-Ecology Research Station
Jiuzhaigou Landscape & Ecology Research Station
Debris Flow Dynamic Simulation Laboratory
Rock & Soil Engineering Mechanics Laboratory
Synthetic Soil Analysis Laboratory
Remote-Sensed Information Processing Laboratory
Synthetic Environment Physical Chemistry Laboratory

４．ＩＭＨＥにおける主な研究開発

4.1.　主な研究開発プロジェクト

ＩＭＨＥの設立以来、410 件以上の研究及び開発課題が完了している。現在、およそ200 のプロジェクトが進行中である。

4.1.1.　土石流の研究

・土石流の分布、分類、地域的特徴
・土石流の発生、移動、堆積の機構
・土石流の基本的特性と力学的特徴
・土石流の観測と実験
・地域計画と土石流の総合防災
・土石流の予測と警報システム

4.1.2.　地滑りの研究

・地滑りの分布、分類、地域的特徴
・地滑りの形成メカニズムと移動の法則
・シミュレーションによる地滑り試験と土砂崩れの力学的特徴
・地滑りの監視と予測
・地滑りの危険の緩和

4.1.3.　山地浸食と保護に関する研究

・山地浸食のメカニズム、分類、分布
・土壌浸食の観測と実験
・放射性同位元素（137Cs, 232Th）を用いた土壌浸食率の測定
・山地地帯における土壌浸食防止対策

4.1.4.　生態学と環境に関する研究

・生態学と環境の地域的総合評価と開発戦略
・大規模プロジェクトが環境に及ぼす影響の総合評価
・地域の生態学的経済学と都市生態学及び環境に関する研究
・天然資源の利用と保存

4.1.5.　地域開発に関する研究

・地域開発の総合評価と環境影響評価
・山地総合開発の戦略と方式に関する研究

・山地人口、都市と農村開発
・経済の地域化、地域計画と生産の配分

4.1.6.　土壌科学研究
・山地土壌資源と生産性理論
・山地農業・生態システム

4.1.7.　リモート・センシングと地図作成法の研究
・山地災害と環境の監視及び資源開発と保護へのリモート・センシングの応用
・コンピュータによる山地災害地図と環境地図作成
・テーマ別地図作成、連続地図作成、及び地図帳作成の理論と方法
・山地地帯における都市・町の建設へのリモート・センシングの応用

4.2.　進行中の研究開発の代表例
4.2.1.　プロジェクト名と研究内容
プロジェクト名は「土石流と地滑りの発達の機構、運動の過程、及び災害軽減の理論」であり、下記の４つの研究課題が含まれている。中国における土石流と地滑りの一覧表、データ・バンク、地域的特徴、土石流の力学的特性、地滑りの過程と移動及びそのシミュレーション、地滑りと土石流災害軽減の理論。

4.2.2.　背景と目的
中国は、土石流や地滑りにより最も深刻な被害を被る国の１つである。その危険は中国の29の省と地方自治体に広く分布し、郡レベルで200 の都市、１千万ヘクタールの耕地、鉄道１万キロが危険に曝されており、経済的損失はおよそ平均10億元にのぼり、毎年500 から1000の人命が失われている。当プロジェクトは、過去の成果に基づき、中国における土石流と地滑りに関するデータ・バンク、理論体系と防止システムの確立を目的としている。

4.2.3.　組織と運営
当プロジェクトは中国科学院が特別に支援する基礎研究の１つであり、専門委員会の指導の下にＩＭＨＥ及び中国科学院の他の機関が後援している。

4.2.4.　期間と成果
当プロジェクトは1993年６月に開始され３年間継続する。主な成果は下記の通りである。中国における土石流の一覧表とデータ・バンク、中国における地滑りの一覧表とデータ・バンク、下記に関する論文：中国における地域別土石流、中国における地域別地滑り、土石流の力学、地滑りの力学、土石流防止及び地滑り防止。

4.3.　研究開発実施上の課題

資金不足と時代遅れの技術的環境が課題である。

5．ＩＭＨＥの国際研究交流プログラム

1987年から1992年までに、国際会議、科学的調査、共同研究、講演、研修のため、27の国と地域から294 人の科学者と学者がＩＭＨＥを訪れた。1979年以来、客員研究者或いは高等研究のための大学院生として43人の科学者が海外に派遣されている。

ＩＭＨＥはおよそ20か国の60を超える組織や機関と出版物の交換を行っている。

5.1.　現況

進行中又は計画中の国際研究交流プログラムは下記の通りである。

5.1.1.　チベット高原青海東部における気候変化と山地災害に関する中国－ドイツ科学調査。協力パートナーはゲッチンゲン大学地理学研究所とホーエンハイム大学植物学研究所である。このプロジェクトは1989年に開始され、４年継続している。

5.1.2.　山地地帯における農業従事者人口の流出に関する研究。国際山地総合開発センターの委託を受けたこのプロジェクトは1990年９月に開始され、２年継続している。

5.1.3.　水田から発生するメタンの実験。このプロジェクトは、中国科学院と米国エネルギー省の共同研究プログラムである「大気中の微量気体の観測」の４番目の課題である。プロジェクトの第一段階は1988年から1990年までに完了した。第二段階は1993年現在継続中である。

5.1.4.　土石流のメカニズムと防止に関する中・日共同研究。協力パートナーは京都大学防災研究所と京都大学農学部である。このプロジェクトは1991年に開始され、３年継続している。

5.1.5.　民江川上流域環境保護総合プログラム。協力パートナーはオランダ王立熱帯研究所である。

5.2.　実施上の課題

国際研究交流を更に進めるには、下記の点で国際的援助が緊要である。外国の専門家を中国に招き、中国のカウンターパートを海外に派遣して進んだ技術的ノウハウを学ばせ、中国の旧式の研究設備を改善し、より広い分野で共同研究を行うこと。

5.3.　アジア地域での国際研究交流の必要性と実施上の課題

ＩＭＨＥは山地災害予防と防止に関して28年に及ぶノウハウと経験を有する。アジアのより多くの

国や組織にＩＭＨＥとその事業について知ってもらわなければならない。それと同時に、人的交流、研修、会議、他のアジア諸国との興味ある共同プロジェクト実施のため、国際的財政援助が必要である。

６．「災害・防災」に関する取り組み状況

6.1.　要旨

中国は、主として洪水、旱魃、台風、雹や霜、地震、土石流や地滑り等の自然災害にしばしば見舞われる国である。災害に起因する経済の損失は1950年代に年平均80億元ＲＭＢ、1980年代は410 億元であった。1989年には災害による損失は525 億元にのぼり、1990年には災害に直接起因する経済的損失は全国で616 億元にのぼった。毎年、およそ300 の郡、２億から３億の国民、47万㎢の農地が、様々な程度に災害の影響を受けている。1991年度は洪水関連の災害が最も深刻であった。経済的損失は1992年には779 億元に達し、5130ヘクタールの農地が自然災害の影響を受け、その中2530ヘクタールが損害を被った。合計430 ヘクタールが破壊され、２億4000万人が影響を受け、5000人が被災し、直接的経済損失は総額854 億元にのぼった。

[6.2.～6.4.省略]

７．「環境と社会資本整備の調和」に関する取り組み状況

7.1.　要旨

中国は、960 万㎢の広大な国土と11億の膨大な人口を有する発展途上国である。1949年に新中国が建国されて以来、中国は国家経済の発展と国民の生活改善に著しい成果をあげてきた。しかし中国では、環境とインフラストラクチャー整備の調和を顧みなかったために、1958年から80年にかけて環境汚染と生態学的環境の劣化が深刻化した。政府はこれらの問題を認識し、環境整備と経済発展の調和を重視してきた。1980年以来環境保護は国家の基本政策となっている。中国のこうした状況に基づき、「環境保全第一主義」、「汚染の原因となった者が汚染を防止すべし」、「環境管理の強化」が環境汚染に対する３つの重要な国家原則として実施されてきた。従って、過去10年間の持続可能な経済発展は、以前のような深刻な環境汚染をもたらすことはなかった。一方、中国では大規模な国土改造が行われてきた。沿岸、川岸、砂漠のはずれ地帯に保護林が設けられた。生育計画（１人子）政策の実施により環境に与える人口爆発の圧力を著しく軽減することが出来た。国民総生産は倍増したが、環境の質は劣化することなく、1978年以来環境の質が向上した地域もある。過去10年間の実績は、中国独自の経済及び環境開発戦略が中国の実情に適したものであり成功であったことを示している。しかし、中国は依然発展途上にあり、他の発展途上国と同様に国の経済力は限られているため、経済開発と環境改善の実施は中国にとって困難な長期的作業である。

[7.2.～7.4.省略]

8．今後論議したい課題

8.1.　生態学的環境の劣化と自然災害の関係

森林破壊、急峻な斜面の開墾・耕地化、川や湖の洪水常襲地の開墾等、人間の不合理な経済活動は、生態学的環境の劣化をもたらし、土壌浸食や地滑り、土石流災害を加速させ、旱魃と洪水災害の発生頻度と規模を増大させ、持続可能な農業開発を妨げ、大きな経済的損失をもたらす。例えば中国南西部の一部地域では、過去40年間に地滑りと土石流災害は２倍になった。旱魃と洪水災害の発生頻度と損害を受けた面積はそれぞれ殆ど３倍と４倍になった。これらの災害は気候の変化によって起こったのではなく、主として環境の劣化によって起こったものである。同じような現象がアジアの他の発展途上国にも見られる。従って、下記の問題について論議することが非常に重要である。

（１）生態学的環境の劣化と洪水・土石流の発生・発達の関係
（２）生態学的環境の劣化と洪水・旱魃災害発生の主な関連
（３）資源利用と環境保護の調和の上に成り立つ開発
（４）環境劣化に起因する自然災害の防止策

8.2.　地すべり、土石流、洪水による交通と水資源開発の被害

中国の山地地帯では、鉄道、幹線道路、舟運にはしばしば不通になる。その85%が土石流、地滑り、洪水が原因である。中国では、建設中の大規模な水力発電プロジェクトや水保全プロジェクトの一部が様々な度合いで地滑り、土石流、洪水の被害を受けている。アジア諸国の大部分は同じような状況にある。従って、下記の問題について論議することが必要である。

（１）地滑り、土石流、洪水の発生機構と運動機構
（２）古い地滑り、土石流、洪水の再活性化のメカニズム
（３）貯水池の斜面安定に与える影響
（４）地滑り、土石流、洪水の観測、予測と総合的予防及び対策

中国における道路法面崩壊制御対策

1．道路法面崩壊の被害状況

中国における道路の法面崩壊は主として地滑り及び土石流による。山岳部における道路の、雨期の交通阻害時間の85%は地滑りと土石流である（これにはきわめて多量の送流土砂を含んだ洪水も含まれる）。年間の直接被害額は1億元を越え、交通阻害に伴う間接被害額は1億元はおろか10億元を越えるものとなっている。中国の山岳部、特に南西部及び北西部においては、頻発する土石流及び地滑りによる交通阻害は数時間から場合によっては数ヵ月にも及び、雨期などには半年以上交通不能の場合すらある。たとえば、スーチョワン(四川)-シーザーン(西蔵)ルート沿い等は3,428箇所の法面崩壊が起きているが、そのうちの1,036箇所は土石流によるものであり、1,525箇所は地滑りによるものである。これらの法面崩壊のほとんどはヤーアン(雅安)ーリンズー(林芝)区間で起こっている。その交通阻害時間は年間2ヵ月に達しており、およそ半年間に及んだ例もある。その災害のほとんどはきわめて大規模でかつ突然発生する。たとえば、1973年のトンチウにおける壊滅的な被害では4千万トンの土石塊が流れ出して交通阻害は半年間にも及び、20人の犠牲者が出た。トンミアン近くのペイロン(北竜)溝の1986年における大規模な土石流は80台以上の車両をのみ込み、交通途絶は半年間にも及んだ。ユンナン(雲南)省の道路沿いの法面崩壊は当該道路の延長が延びるに従って増加してきている。1949年、ユンナン(雲南)省の道路は2,783kmであったが、1990年には46,230kmにまで延長された。その山岳部の道路のほとんどが土石流と地滑りの被害を受けており、いくつかの低クラスの道路の交通は雨期になるとまったく途絶してしまう。その応急的復旧工事に要した費用は1952年から1987年にかけて1億6,500万元にも達しており、1986年の単年だけでも1,400万元に達した。その他の山岳部に位置する省でもしばしばきわめて甚大な被害を受けている。たとえば、1989年7月9日に発生したスーチョワン（四川）省、ホワイン(華釜)のチコウチェン地滑りでは100万トンの土砂が崩れ落ち、道路、輸送団、人家を押しつぶした上犠牲者は221人に達し、被害額は数百万元にも上る。1985年6月12日に発生したフーベイ(湖北)省のツーコイ(秭帰)県のシンタン（新滩）地滑りは旧道路とシンタン（新滩）市街を壊滅させてしまった。この時は迅速な予報が幸いして犠牲者は出なかったが。また、1983年3月に発生したカンスゥ(甘粛)省トンシャン(東郷)のシャレシャン地滑りは3,100万トンの土砂をもたらし、3本のハイウェイを埋めつくしたうえ、3つの村を破壊し去った。そして260人の犠牲者が出た。1970年は以前、スーチョワン(四川)ーユンナン(雲南)線の西ルートがスーチョワン(四川)省のシーチャン(西昌)のヘイシャ（黒沙）河を横切っていた。当時、土石流による扇状地が3kmにわたって広がっていた。この土石流が道路をも通行車両をも破壊してしまうので、雨期においてはここは交通不能の場所だった。

2．道路法面の土石流及び地滑りの制御状況

中国における交通運輸は主として道路に頼っている。スーチョワン(四川)ーユンナン(雲南)線の西ルート、カンスゥ(甘粛)ースーチョワン(四川)ルート、シーアン(西安)ーラーンツォウ(蘭州)ルート、及びスーチョワン(四川)ーシャーンシー(山西)ルート等、山岳部における輸送事業を確実なものとするためには、土石流及び地滑りを制御することがきわめて重要な課題のひとつであった。というわけで、道路を建設し、遅かったり早かったりということはあったにせよ、ともかくもそれら土石流及び地滑りを防御、ないしは制御してきたことが今やめざましい効果をあげている。土石流及び地滑りの被害は目に見えて減少してきているのである。ルート変更を含む設計変更と新規開設によって通信・運輸はわが国の基幹建設事業の第1位を占めるまでになった。道路沿いの土石流及び地滑りによる災害に対する制御事業への投資は間違いなく増加してきている。たとえば、スーチョワン(四川)省行政府は土石流と地滑りが問題となっているチェンドゥ(成都)ーチュチャイコウ（九寨溝）・ルートのルート変更を含む設計変更及び改良に5億元を投じた。またその後、中国交通部はスーチョワン(四川)ーシーザーン(西蔵)ルートの路盤被害を調査した。1993年、議会は「中国西北地域開発計画」を承認した。また近々「中国西南地域及び南部地域の開発計画」を承認するはこびとなっている。これらの計画は地域的に重要な場所に道路と鉄道を敷設しようとするものである。中央政府及び地方行政府は今後とも山岳部の道路の建設と改良の予算を分担してこれら道路沿いの法面崩壊制御事業を継続していくことになっている。

3．高速道路沿いの土石流及び地滑りの制御

中国は道路沿いの土石流及び地滑り制御に関する国情にあった一連の方法をこれまでの40年間の現場体験を通じて見つけだしてきた。中国はいまだ開発途上にある国であり、予算も十分ではないので、それは効率的な、無理のない、経済的でかつ確かなものでなければならず、その計画及び技術的手法もより少ない予算で高い効果が期待できるものを選択せざるを得なかった。

3.1 制御計画の選択

計画が妥当なものであるかどうかはダイレクトに技術的効果と費用に関係してくる。従って、土石流や地滑りがおこる場所においては、時間をかけてルート選択を行った上で妥当と思われる制御の方法を選択しなければならない。

3.1.1 計画の採否

活動度が高い（重大な潜在的危険性をも含む）大規模な土石流及び地滑りが発生しやすい小峡谷を避けた計画であれば採用が可能である。もし、そうした場所を避けることが可能で、路線を変更した計画を実行するのに多額の予算が必要なら、やや被害の発生についてはこれを黙認せざるを得ない。土石流の発生する危険性の高い渓流で橋脚の高い橋梁計画とピアーの単一断面（たとえばスーチョワン(四川)ーシーザーン(西蔵)ルートのチャマチメイ峡谷の例）、トンネルもしくは覆工(open-out tunnel) 等を採用する。また、フィル方式(絶対に法面下部の掘削を行ってはならない)、高架橋もしくは覆工等の計画は地滑り箇所には有用である。

3.1.2 個別的な制御計画の選択

道路沿いにある土石流峡谷及び地滑り頻発箇所には必ず防御対策を講じなければならない。かりに土石流及び地滑りの規模が小さい場合や重要な建造物がない場合もしくは広い地域にわたる農地がないような場合はそれぞれ個別の抑制・管理計画を選択することができる。土石流峡谷には排水路、排水溝、水路橋等の排水工事を行うことができるが、地滑り箇所には擁壁、浚渫等を用いることができる。

3.1.3 統合的な防災計画

大規模な土石流や地滑りが起こるような、またその発生原因がきわめて複雑な場所で、重要な建造物があったり広大な農地があるような場所にはそれらを守るために統合的な対策計画をたてなければならない。土石流の生成メカニズム及び地域的な状況によってはいくつかの統合防策計画を複合的に選択する必要がある。

例1：総合対策：土石流の発生を制御し被害を防ぐために流域全体を保全し管理するための計画。たとえば、シーチャン(西昌)におけるスーチョワン(四川)ーシーザーン(西蔵)ルート上のヘイシャ川ではダム高22m、容積5,400m³の貯水池を設けた。同様に、上流側に800haの砂防林を設け、中流部には7ヵ所の砂防ダムと5ヵ所の谷止工、7つの縦断堤防もしくは擁壁及び400kmの保全林を設けた。さらに下流側には5.8kmの流路工、一本の排水路、及び39ヵ所のグリーンベルト(森林帯)を設けた。

例2：送流土砂を抑制するための総合防災計画：この例として四川省ミャンニン(冕寧)県のカンルオ(甘洛)ールークー(瀘沽)ルート上のヤンチン(塩井)溝があげられる。中流部に基本となる工事ー擁壁を設け、その後、土石流を惹き起こす元凶となっている土石、土砂等をコントロールするために400mの分流堤と2基の砂防ダムを設けた。

例3：洪水制御のための総合防災計画：甘粛省ウートゥ(武都)県のカンスー(甘粛)ースーチョワン(四川)ルート上のクオチア峡谷の例があげられよう。ここでは上流部に土石流を惹き起こす洪水を分流させるために洪水分流堤を設けた。

例4：排水・分流を考慮した総合防災計画：四川省シーテ(喜徳)県のカンルオ(甘洛)ールークー(瀘沽)ルート上の喜徳東溝では、下流域に幅20mの直線的な分流溝を設けた。

例5：保全林を設けた総合防災計画：スーチョワン(四川)ーユンナン(雲南)ルート上のシーチャン(西昌)の西溝では、上流部と中流部の約70%の地域を保全林で覆った。

以上述べた諸計画は道路を守るばかりではなく鉄道、市街、工場群、農地をも保護するものである。

3.2 工法の決定

土石流及び地滑り対策工には多くのものがある。ここでは比較的実施しやすくかつ建設費も安く、しかも高い効果が期待できる4種の工法について紹介しておきたい。

3.2.1 多目的重力ダム

中国の土石流対策工においては砂防ダム（谷止工ダムを含む）がもっとも受け入れられていて、全土石流対策工事のおよそ50%を占めている。重力式粗石コンクリートダムが主で、砂防ダムの70%以上を占める。この種のダムは構造が単純ながら安定しており、材料入手も容易であり、低資金

で建設できることが特徴である。近年ではこのダムのほとんどは大暗渠（ディスチャージ・オリフィス）を備えた砂防ダムとなっている。たとえばヤンチン(塩井)溝の第３ダム、クラックダム(破砕ダム。チュチコウの左側砂防ダム)、スケットダム(櫛型ダム)等であるが、これらのダムは洪水をコントロールすることができる上、土石を堰止め、峡谷の法面基礎を安定化することができる。

土石流渓床の堆積層がきわめて厚いため、ダム基礎はこの不安定な堆積層の上に設けられることになる。土石流が通過した場合、ダムの基礎は洗掘を受けて深く掘られてしまう。従って基礎はダム本体を支えきれないほどに不安定になってしまう。中国では、重力ダムの60%がこうして破壊されてしまう。そのためダム基礎の安定化の方法を見つけだそうと試行錯誤が繰り返されている。たとえば、1.コンクリート打ち：ダム下部の堆積層を固めるもの（塩井溝第３ダム）、2.杭打ち基礎：ダム基礎に鉄筋コンクリート杭を打つか、もしくは大口径のパイルを鋳込むもの(ユンナン(雲南)省、淨水溝)、3.アーチ型基礎：ダム下部にアーチ型基礎を鋳込むもので、例としてはシングルアーチ（スーチョワン(四川)省の黒沙河と八歩里溝）とダブルアーチ（スーチョワン(四川)省、黒沙河）等、4.桁張り基礎：下流側に鉄筋コンクリート桁を鋳込むもの(黒沙河川)、5.敷桁基礎：ダム基礎そのものに鉄筋コンクリート床盤を用いるもの（黒沙河）等々が考えられている。これらの基礎はすべてダム基礎をきわめて安全なものにする。かりにダム基礎の下部がもぎ取られても、あるいは洗掘を受けて深く掘りこまれてもダムそのものは被害を受けない。

3.2.2 Ｖ型排水流路工

断面Ｖの角度と幅は土石流の流量、土礫の粒経及び河床勾配によって決定する。通常、流量が小さい場合は粒経は大きいので断面Ｖの角度は小さくする。またその河床勾配は少なくし、幅も小さくしなければならない。過去の経験では台形型の流路工では沈砂が多かったが、Ｖ型流路工を採用して以降はほとんど堆砂は起こらなかった。

3.2.3 リブ付き床固工を施した排水溝

一般的に、排水溝の両側は堤防と呼ばれており、その基礎は土石流と洪水によって形成されたやわらかい堆積層からなっている。従って洗掘により堤防の基部や、堤防本体が破壊される。袖付き床固工はたとえば適当な間隔で河床を横切る横工を施して洗掘を防御しようとするものである。その間隔と根入れ深さは、たとえば下流側の床固工の天端を上流側の基礎よりも高くする等、谷の河床勾配によって決定する。全区間に床固工を建設する場合（トンシュアン、タチャオ川）と、特に大きな洗掘が起こる場所に建設する場合（シーテ(喜徳)市、トンコウ(東溝)）とがある。

3.2.4 アンカー工

アンカー工は新しい地滑り対策用の構造物である。決められた角度で、決められた位置にアンカーケーブルを挿入し、アンカー体に強力な圧縮応力（プレストレス）を与えることにより、滑動力を減少させる。この際、地滑り面より奥にアンカー体を挿入する。原材料の節約になり、資金も少なくてすむ。これはかなりよい効果を発揮しており、現在中国ではかなり広く用いられるようになってきている。

II．インドネシア共和国

インドネシア公共事業省研究開発庁次長　Soedarmanto Darmonegoro

1．インドネシアの概要

1.1 国の概要

インドネシアは、子午線95度から141度および北緯6度から11度の間に位置する、総数13,500以上の島で構成された広大な群島である。島の中でも、Kalimantan、Sumatera、Irian Jaya、Sulawesi、Javaが、面積1,000km²を越える大きな島とされている。国の総面積は5,000,000km²を越えるが、その内およそ2,000,000km²が陸地で、残りは海洋である。

群島の中でも、特にJavaとSumateraは豊かな鉱物物資に恵まれ、その土地は非常に肥沃である。また、ほとんどの島には活火山が見られる。

国は、行政上27の地区に分割されている。

1.2 気候

インドネシアの気候の特徴は２種類の熱帯季節、すなわち雨季と乾季である。雨季は通常10月から3月まで、また乾季は4月から9月までである。年間降雨量は、1,500mmから2,500mmまでの範囲である。低地の平均気温は27℃、高地では22℃である。インドネシアは熱帯に位置するため、その相対湿度は75%から85%の間で変化し、最低値は50%、最高値は100%である。

1.3 人口統計

1993年現在、インドネシアの人口は1億1800万人を越えると予測される。したがって、中国、インド、米国についで、世界で4番目に人口の多い国となる。実際には、インドネシアの人口増加率は過去数十年の間に大幅に減少している。1970年には3.6%であった増加率が、1990年には2.08%にまで減少したのである。

人口は群島内で不均等に分散され、面積が全体の7%に満たないJavaとBaliに全人口の50%が住んでいる。一方、総面積が国全体の25%であるIrian JayaとMalukuの人口は、全体のおよそ2%にすぎない。

調査によると、都市の人口は過去20年間でほとんど倍増している。1980年から1990年の間の年間の人口増加率は、都市部では5.1%であったものの、国全体では1.8%にすぎない。

1.4 経済と社会

世界銀行の分類によると、インドネシアは中収入国である。労働人口のおよそ半分である4000万人を越える国民が、生産高の割合がGDPの2割をわずかに越える農業に従事している。一方、製造業に従事している人口は、全体の1割に満たないおよそ700万人にすぎないが、この分野は生産性が比較的高いため、GDPの14%を負担している。

第1回目の5ヵ年計画（FYDP1）開始時に、インドネシアの国民一人あたりの総収入額はおよそ50米ドルであったが、現在では600米ドルを越えるものと予測される。

2．公共事業の現状

2.1　国土開発総合計画

過去20年の間、米、砂糖、とうもろこし、タピオカなどの国内の穀物物資の60%以上はJava諸島で生産されていた。しかし、最近では土地が住宅や工場などの非農業利用に転換されているため、この割合は減少しつつある。一方、他の島では農業地域が開発され、国の需要に対する食糧の供給は、産業の発展と平行して維持されている。それと同時に、貧困や無学の排除、また地域間に経済的あるいは社会的なバランスをもたらすという全体目標の達成を促すために、国内各地で公共事業の基幹施設の開発が行なわれてきた。

2.2 建設投資の予算

社会基盤整備を行うためには、莫大な量の資金が必要である。国際基金によって入手できる金額が限られているため、国外からの援助もまたここで重要な役割を果たしている。国外援助は、主に国際復興開発銀行（IBRD）とアジア開発銀行（ADB）、あるいは海外経済協力基金（OECF）を通して得られるものである。

2.3 公共事業に関する機関

社会基盤整備に関する全国的な調整は、公共事業省が行なっている。公共事業省には、運営上3つの総局が存在する。つまり、道路総局、住宅総局、および水資源総局である。それに加えて、公共事業研究開発庁が道路事業や住宅事業、水資源開発に関する研究開発および調整を行なっている。

2.4 主要な社会資本整備の歴史、整備状況および課題

島内の交通は、道路の基幹施設に重く依存している。道路網は現在、全長が250,000kmを越えると予測され、このうちおよそ10,000kmが1970年代初期から建設されたものである。道路のおよそ50%は未舗装なため、移動施設としての機能を考慮すると集中的なメンテナンスあるいは改良工事が必要とされる。また、道路の基幹施設に被害を与える自然現象としては、地滑りや洪水をあげることができる。

2.5 現在進行中あるいは計画中の主要プロジェクト

道路関連のプロジェクトでは、主に既存道路のメンテナンスや改良工事が重視されている。しかし、Cikampek-Padalarangのような新設道路のプロジェクトも予定されている。

計画中の有料道路プロジェクトのルートはWest Javaの山岳地帯を横断するため、良質の道路を完成させるためには、掘割や盛り土あるいはトンネル工事が必要である。

この有料道路プロジェクトはきわめて重大ではあるが、15億米ドルを越える投資を必要とする。完成時には、この道路は140kmにわたってJakartaとBandungを結ぶ、国内で最長の有料道路となる予定である。

3．公共事業省研究開発庁の概要

3.1 組織の名称

前出のように、公共事業の研究開発を行なう機関の名称は、公共事業研究開発庁である。この機関は公共事業省の下にある3つの総局と同等の地位にある。公共事業研究開発庁の下では、道路研究所、人間居住環境研究所、水資源開発研究所が、それぞれ道路事業、住宅事業、水資源開発の研究開発を行なっている。

3.2 歴史

インドネシアの公共事業の研究開発は第二次世界大戦以前、West JavaのBandungにおけるDienst van Verkeer en Waterstaatの創設とともに開始された。この施設には、道路地盤、建設資材、水理学のための3つの研究所が設けられていた。

1958年に、公共事業・エネルギー省の下に総局が設けられたとき、3つの研究所の運営は、順に道路事業、住宅事業、水質開発の総局に任された。

公共事業省研究開発庁は、公共事業に関する研究開発の調整およびその監修を目的として1984年に設立された。それ以来3つの研究所は研究開発庁に付属され、それぞれの名称が道路研究所、人間居住環境研究所、水資源開発研究所に変更された。（組織構成に関しては付表－3.参照のこと）。

3.3 研究開発庁の組織

公共事業省研究開発庁の組織は、以下の機能を果たすものである。

a. 省内の研究開発政策の作成および調整。
b. 研究開発プログラムの発展のための指導、調整を行い、またそれを履行する。
c. 省の業務を支援するために、公共事業の研究開発を行なう。
d. 機器、資材、建設の検査を行なう。
e. 研究開発の成果を広め、出版する。
f. 技術基準やガイドラインを設定する。

3.4 スタッフ数および予算

1990年に、公共事業省研究開発庁には1700人以上のスタッフがいる。そのうち、およそ370人が研究職である。1992/93会計年度には、16兆ルピーア、すなわちMPWの予算の0.71%を越える金額が本庁に割り当てられた。道路研究所、人間居住環境研究所、水資源開発研究所には、所属するの総局予算のそれぞれ0.26%、0.66%、1.28%が割り当てられた。

4．主要な研究開発プロジェクト

4.1 主要な研究開発プロジェクトの名称

公共事業省のもとに行なわれている主な研究開発プロジェクトの例を以下に示す。

a. 道路研究所

(1) 舗装および橋梁建設の際の基準材料以外の地元資材の利用。

(2) 舗装工事における古い資材の利用など、リサイクルの活用。

b. 人間居住環境研究所

(1) 低所得者を対象とした住宅建築。

(2) 過密地域の住宅の質を向上させるための居住地。

c. 水資源開発研究所

(1) 堆積物の制御。

(2) 水力構造物の建設。

(3) 水質汚濁の制御。

4.2 現在進行中の研究開発

・名称

インドネシアにとって理想的と思われる村の基本型の開発。

・背景および行政

インドネシアの住民のほとんどは、公共工事による施設が相応に提供されていない郊外地域に住んでいる。政府はこのような村の住人たちに、施設の需要を満たすためにも、自立した社会になることを促している。もちろん、他者の手を借りることなく施設を建設し、維持する方法を住人に理解させるためには、正しい技術の実演と伝達が必要である。委員会は、理想村の設立のために、West Javaのある村を選択した。ここで、地元で入手できる資材と簡単な技術を用いて公共事業の基幹施設を建設することによって、プロジェクトが執り行われている。

・期間

このプロジェクトは当該年度1992/93に開始され、予定では3年以内に完成することになっている。

・方法

上記のように、このプロジェクトで採用された方法は、技術を直接適用することである。それは、以下のように分けることができる。

－有効な施設の定義。

－土壌等の地域状況調査。

－履行。

－監視。

この調査は、公共事業省のもとに3つの研究所が合同で行なっている。

・期待される成果

インドネシアにとって理想的な村の基本型の誕生。

・課題

研究の履行の際に資金不足などの問題に直面するといった事態が発生している。

5．国際研究交流プログラム

5.1 国際研究交流の現況

インドネシアは下記に示す国際機関あるいは諸外国との間では、国際協力を行ってきた。

a. 国連下の国際機関：UNDP、UNIDO、WMO、WHO、UNEP、FAO。

b. 国際金融機関：IBRD、ADB。

c. 諸外国：米国、日本、イタリア、デンマーク、カナダ、米国、フィジー、フィリピン、ブルネイ。

現状は、上記の状況とほぼ同じである。

5.2 プログラムの実施上の課題

プログラムに実施上の課題とは、主に資金面のものである。その他にも、プログラムの質と効率の向上のために研究開発が果たす役割の重要性が十分に理解されていない、などの課題も生じた。

5.3 アジア諸国間の研究交流の必要性および実施上の課題

・必要性

研究交流が緊急に必要とされる理由として、下記のものがあげられる。

－定期的な情報交換の実施。

－研究成果の共用。

－問題の共用。

－情報の共用。

－経験の共用。

－労働能力の向上。

－研究施設の改善（研究所内あるいは現場における試験や調査の機器など）。

－研究員の一時的な交換。

－共同研究の実施。

－アジア諸国間の研究交流のための調整員あるいは事務局の任命。

・課題

課題としては、下記のものがあげられる。

－コミュニケーション不足。

－調整不足。

－資金不足。

6．「災害および防災」に関する取り組み

6.1 概要

インドネシアでは、いつどこで自然災害が発生してもおかしくはない。その規模は、小さなものから大きなものまで多様である。その主な要因とは、洪水、地震、地滑り、海や川での浸食などである。インドネシアは非常に活発な地震地域に位置するため、ほとんどの島には活火山が見られる。また、Irian Jaya、Maluku諸島、Nusa Tenggara諸島、Java、Sumateraなどの島を地震帯が通過している。

インドネシアは熱帯気候の赤道上に位置し、一年は雨季と乾季のふたつの季節に分かれている。雨季には、長期にわたって強い雨が降ることが多い。このため、洪水や地滑りが生じる。また、波や流水が沿岸や崖地帯を浸食するため、近辺の公共事業施設が危険にさらされることもある。

このような災害は、家屋の損失、交通機関や遠距離通信施設の切断、その他の構造物の破壊、あるいは人命の損失までもをもたらすことがある。長期にわたる乾季もまた、広範囲にわたる土の地域に建設された道路などの舗装に被害をもたらす。これは、舗装の下部の土が収縮するために、舗装にひびが生じるからである。

6.2 現状および課題

下記にいくつかの災害例を示す。

・South Kalimantan

MartapuraとBantau間の道路の地滑りおよび変形。これは、洪水によって生じたものである。

・Irian Java

JayapuraとSentani間の道路に地滑りが生じ、その結果Harapan橋が切断された。

・Central Sulawesi

PosoとTambarana間の道路とMasani橋に沈下が生じた。これは川の研磨作用によるものである。

・Flores

ここでの災害では、非常に多くの人命および物資が失われたため、国レベルの問題であるとみなされた。原因は地震と津波である。周辺の基幹施設および人や家畜が、高潮に流されたのである。

6.3 対策

災害が公共事業施設に及んだ場合、研究開発庁の専門家が現地を訪れ、問題点の解明および調査を行った。必要に応じて技術員が派遣されることもある。調査結果および対策が記載された報告書が関連機関に提出された。通常これらの作業には、研究開発庁が参加している。

6.4 洪水および道路のり面災害に関する総合対策

調査研究機関である研究開発庁は、問題に対応するための対策を作成する際に参加することが多い。複雑な事態が生じた場合、最適な成果を得るために、3つの研究所がそれぞれの関連機関とともに問題を取り扱うことになる。

6.4.1. Mount Semeru近郊に生じた雨による地滑り

Mount SemeruはJava東部に位置する山である。これは、Javaの活火山の中では、現在最も高いものである（海抜およそ3676メートル）。斜面は急勾配である。傾斜が非常に急なため、特に雨季の期間に、斜面は水の影響を受けやすくなる。周辺の地帯は山とは対照的で、地域の農作物の需要を支えるための肥沃な農園や農場が広がっている。

1981年5月14日まで3日間連続した集中豪雨の降雨量は、およそ164mmに達した。この雨のために、Mount Semeruの東斜面の森に地滑りが生じた。およそ250,000cuメートルの飽和土と岩屑が、重力荷重によって滑り落ちたのである。滑り落ちた土と岩屑は小さな川を浸食し、このために流されたおよそ400万の泥が、川を埋つくし周辺の地帯を覆った。土や岩、岩屑などは、灌漑用の溝を埋め、道路を覆い、構造物や家屋に被害を加えながら、急速に流された。

・対策

地域の公共事業と政府事務局は、3段階にわたる対策を行った。

1. 緊急処置－1.
   a. 郊外へ向かう道路に切断が生じた部分は、3日以内に交通の通過が可能になるよう補修工事を行う。
   b. 灌漑用の溝は、10日以内に農場や農園への給水が可能になるように修復を行う。
   c. 水を制御するために、緊急の堤防を構築する。
   d. 遠距離通信施設の修復を行う。
2. 緊急処置－2.
   a. 損傷を受けた情報伝達システムの修復を行い、通常の状態に戻す。
   b. 損傷を受けた家屋の修復あるいは再建を行う。
   c. 灌漑用の溝への開口部分を設ける。
3. 恒久処置
   a. 将来的に発生し得る災害に備えて、灌漑システムの改良を行う。
   b. 道路および橋の再築工事を行う。
   c. 住民をより安全な地域へ移住させる。
   d. 総合計画に従って、溝の標準化を行う。

今回の地滑りで生じたものと同様の災害が、地質や地形の条件、あるいは気候条件が類似する場所で再び発生することが予測される。

この洪水（1981年5月14日）で流された泥は完全には除去されず、途中で沈殿した何百万もの泥は干上がってしまった。高地で沈殿した後に干上がった泥は、豪雨の際に低地にとって致命的な被害をもたらすことになる。そのための処置としては、制御溝や砂防ダム、圧密ダム、擁壁、あるいは川の流れを制御するための枠堰などの建設を行なうべきである。その他の処置としては、斜面の土の除去、地表あるいは地下の排水施設の造成、地下水の制御、安全設備の建設（アンカー、擁壁など）、木々の移植、情報伝達の方法の改善などがある。

6.4.2. Wangon（Java地区中心地）における地滑り

Cilacupが大きな港に発展したため、West Java地区の境界とWangon（Java地区中心地）間の道路の重要性が増した。したがって、この区間では常に通行可能な状態を維持することが要求される。しかし、この道路が通過する地区の内数ヵ所には不安定な状況が見られる。場所によっては地層が不都合な状態に傾き、起伏のある地形を作っている。そのため、幾何学的にも安定性が不十分であり、地滑りが年中生じている。これは、克服しなければならない。

通常、地滑りは斜面上に造成された道路で、舗装の一部が切り開かれた斜面に位置する部分に生じる。舗装された上部が斜面に面するように、地面が回転しながら滑り落ちるのである。また、表面水あるいは地表下の水が、状況を悪化させることもある。

対処方法の中でも擁壁の造成、排水の管理などに関しては、地質学的調査のデータや、地滑りが生じた部分の深さ、地下水面の高さなどに基づいて、最新の注意とともに設計しなければならない。

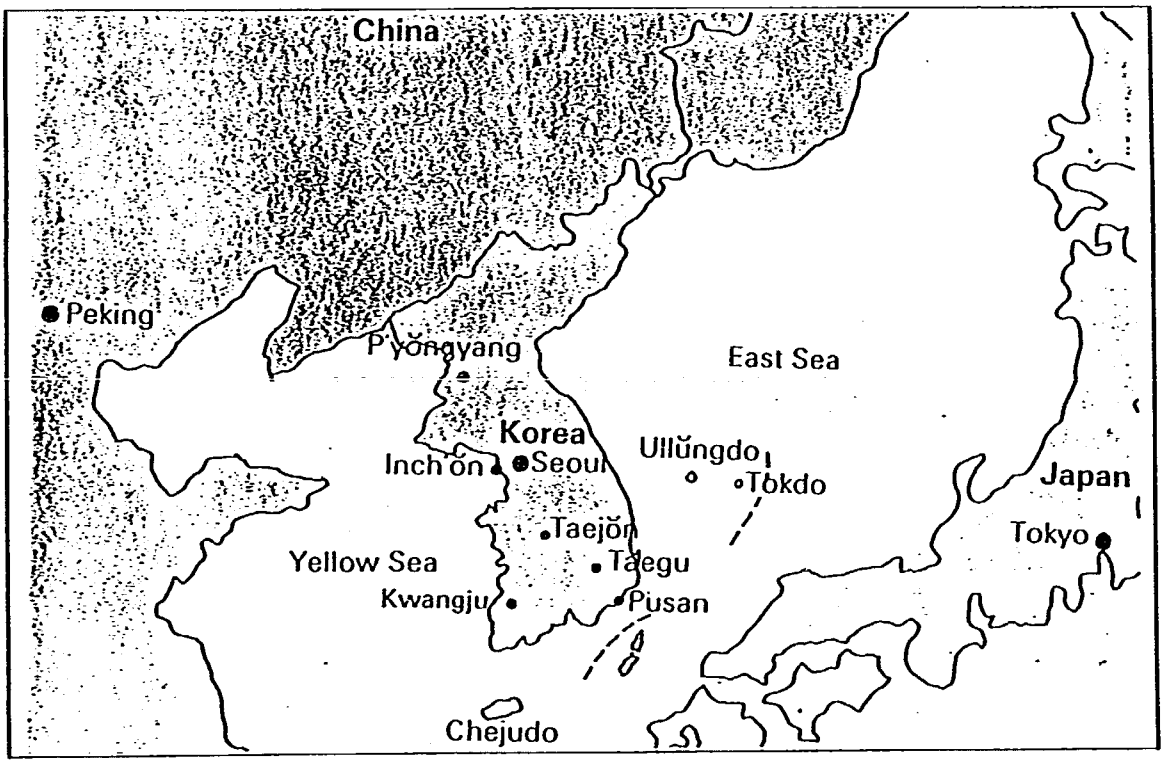
Ⅲ. 大 韓 民 国

韓国建設技術研究院企画調整室長　金　　亘 煥 Kim Keuug Hwan

１．韓国の概要

１．１　国土の概要

朝鮮半島は広大なアジア大陸の北東部から南方に延びている。北から南へ１，０００㎞広がっており、半島の面積は約２２１，０００ｋ㎡である。北部国境の大部分は中華人民共和国であり、ロシア共和国にも接している。３方は東海、黄海、南海に囲まれている。１９４８年以来半島は２つの部分に分けられており、南部は大韓民国、北部は朝鮮人民共和国である。韓国は多様な地形でその大部分は山岳（７０％）で、小さな谷と狭い沿岸平野がある。壮大なテベク山脈が東海岸の全長を走り、東海の激しい潮が切り立った崖や岩の多い小島をうがっている。ハン、クム、ナクトンのような主要河川は全てテベク山脈にその源を持ち、流域を潤す。西方と南方の斜面はたいへん緩やかで、平野を形成し、沖合いには入り組んだ入り江の小島が数多く浮かぶ。不規則な海岸線に沿って３，０００以上の島が点在している。



１．２　気候

朝鮮半島は北緯３３°～４３°に位置し、テベク山脈が北から南へ走っているので、東西南北の間の温度差は取るに足らない。温帯で大陸の影響があるので、季節の変化は韓国でははっきりしている。暑くて湿度の高い夏と長く乾燥した寒い冬がある。春と秋はやや短いがさわやかな天候と日照量が多くて大変快適である。温度は冬の－１２℃という低温から夏の３７℃という高温に及んでいる。６、７、８の３ヶ月には激しい雨が降り、７月は通常１年でもっとも湿度が高い。冬は１１月終わりから

３月初頭まで続く。シベリアからの寒気団が吹き込み高気圧帯が発達する。降雨はほとんどなく、空は通常晴れ渡っている。韓国の冬は北朝鮮ほどは一般に厳しくない。湿潤気候帯に属するので韓国は雨が多い。降雨量は南部沿岸で１，４００～１，５００㎜、中部で１，２００㎜、北部で８００～９００㎜である。季節変化もまた著しく、年間降雨量の７０％は６月から９月に集中している。雨期の降雨量と８月の台風が夏季の全降水量を決定する。雪は一般に１１月から２月にかけての主要降水である。

１．３　人口

大韓民国は１９９１年には人口４，３３０万人おり、人口密度は４３７人／ｋ㎡である。北朝鮮の人口は１９９１年に約２，１００万人であった。急速な人口増加は他の多くの発展途上国と同様に、大韓民国でもかつて深刻な社会問題であった。しかし、家族計画キャンペーンの成功と状況の変化により、人口増加は近年著しく抑制されたが、なお十分に低くなっていない。年間人口増加率は１９９１年で0.92％である。人口構成の顕著な傾向は年々若年化していることである。１９８５年の人口調査では全人口の55.7％が２５才以下であった。生産年齢、即ち１４才及びそれ以上の人々の数は、１９７５年の２，０９１万８千人から１９９１年の２，９６４万８千人へと増加した。もう１つの特徴的ではあるが歓迎できない現象は引き続く農村人口の都市への流出である。これは高い都市集中を引き起こす。現在、韓国人の１／４がソウルに住んでいる。専門家は２０００年までには都市化率が現在の６９．９％から７７％へ増加するであろうと予測している。このようなアンバランスに起因する増大する都市問題に対処するため、政府は長期労働力開発計画を策定した。本計画は経済活動の再配置と均衡のとれた国土開発により人口の地方分散を目指している。小数民族はほとんど韓国には存在しないが、約3万の中国人は別で、大部分は首都圏の長期定住者である。

図　面積と人口

Area km², Population in thousand

YEAR	WHOLE AREA	ESTIMATES OF MID-YEAR POPULATION			RATE OF INCREASE
		Total	Male	Female	
1989	99,262.63	42,380	21,359	21,021	0.97
1990	99,273.70	42,869	21,568	21,301	0.93
1991	99,299.80	43,268	21,775	21,493	0.92

１．４　歴史

韓国は、５０００年の歴史を持つ鎖国王国で１９世紀における外交、通商関係に対する西側の要求に対してかたくなに門を閉ざしていた。韓国は中国との同盟を固守したが、中国は西側の侵略に対抗して自国の生存のために戦っており、韓国を助けることができなかった。日本は、新興工業国として勃興し、結局力の真空地帯につけ込んで韓国を合併した。朝鮮王国は１９１０年に倒れた。第２次世

界大戦終結前、同盟国はヤルタで密かに朝鮮をドイツ同様、同盟国の信託統治とすることを決定した。この独専的協定に基づき、アメリカとソ連は戦後朝鮮を占領し、冷戦構造を持ち込み、後に半島は分割された。１９４８年に普通選挙が半島の南半分で実施され、スンマンリーを大統領として大韓民国が建国された。北朝鮮では共産主義体制がキムイルソンの下に設立された。大多数の韓国人は悲劇的な朝鮮戦争（１９５０－５３）をもたらし自国の分割に憤りを感じている。戦争中、全国土が荒らされ、何百万人の人々が家を失い、家族から引き離された。停戦決議は１９５３年７月に調印され、以来両国とも復興への努力を続け大変貌を遂げた。再統一は厳しい防衛の下にある軍事境界線の両側の人々にとって神聖な目標であり続けている。にもかかわらず、半島をめぐる超大国の利権の絡み合い、韓国人相互間の深い思想的相違が相伴って武装境界線を依然不可侵なものにしている。

１．５　経済

過去四半世紀にわたって、大韓民国は世界の喝采を浴びた「世紀の経済的奇跡」を達成した。韓国は１９６２年に本格的な経済発展に乗り出して以来、世界で最も早いペースで経済成長を遂げてきた。その結果、長い間世界で最貧の農業社会であった韓国は、中流の上の所得で、急速に工業化社会になりつつある。１９６２年から１９９１年までのわずか３０年間に、韓国のＧＮＰは、２３億ＵＳドルから２，０７５億ＵＳドルへ増加し、一人あたりＧＮＰは、８７ＵＳドルから６，４９８ＵＳドルへ上昇した。この成功の鍵は、輸出を成長の原動力とする、外志向の発展政策の採用であった。この政策は、不十分な天然資源、限られた国内市場、勤勉で、教育レベルの高い豊富な労働力を反映している。経済構造は数次の社会経済開発５ヶ年計画の成功の結果、根本的に変化した。製造部門のＧＮＰのシェアは14.5%から１９９１年には39.3%に増大した。貯蓄率は同じ期間に、3.3%から36.1%へ上昇した。韓国が１９８６年に史上初めて国際貿易黒字を記録して以後、鉱工業部門における経済は急速に進歩した。輸出指向製造業は、政府の強力な支援を受けて成功し、国家収支は近年改善された。もちろん、取り組むべき難問もいくつか存在する。一つは、韓国製品の競争力を脅かす労働賃金の上昇である。もう一つは、工業国、特に主要貿易相手国の保護主義の高まりである。しかしながら、これらの問題は高付加価値技術と知識集約製品への産業調整の加速と、それに伴う市場拡大により解決されよう。技術開発に対する政府の支援は着実に高まっている。韓国は工業国の地位を得、進歩と繁栄のための国際社会においてより重要な役割を果たすため、多大の努力を続けている。

2．公共事業の現状

2．1　総合国土開発計画

• 計画のベース

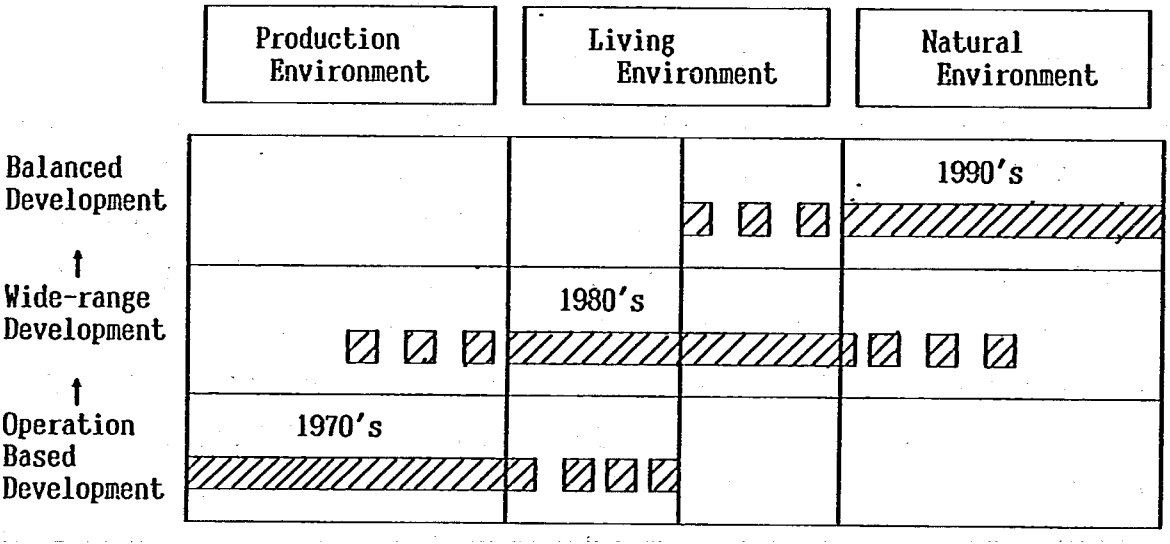
－１９６３年法律を発布

－１９６８年基本計画の確立

－国連開発計画－減債基金チーム２年間にわたって計画を調査

－第一期計画実施のための大統領令第２６号（１９７１年１０月２６日）

• 計画段階



A．第一次総合国土開発計画（１９７２－１９８１）

分野	成果（達成事項）
工業団地	• 工業地帯　１０２k㎡2 → ３３２k㎡2 • 工業用水施設　648,000㎥／日 → 1,903,000㎥／日 • 工業団地建設 －全国レベル：Pohang, Ulsan, Changwon, Yucheon －道レベル：Chungju, Kunsan, Kwangju, 他
交通	• 交通容量 －旅客：３２０億人／k㎞ → ８６７億人／k㎞ －貨物：１６０億トン／k㎞ → ２３２億トン／k㎞ • 高速道路建設：７路線（京城－釜山間等） • 国道建設及び舗装：３，２５０k㎞
水資源及び土地利用	• ダム（Soyang, Andong, Dacheong他）：４１億㎥ • 環境保全のための「グリーン・ベルト」設置

B．第二次総合国土開発計画（１９８２－１９９１）

分野	成果（達成事項）
人口分散政策	• 特別地域の指定（Jeju Island, Tebaek Mt. 他） • 農業地域の設定（２４．３k㎡２） • 首都圏整備のためのマスター・プラン立案
交通、国土利用	• 1988年オリンピック高速道路を含む６つの高速道路の拡張： 整備済 491.3 k㎞ 計画中 679.7 k㎞ • 国道の建設及び舗装： 589 k㎞ • 排水による土地干拓 • 大規模工業地帯の設定
国民福利厚生	• 水供給能力 1,570 万トン／日 普及率：全面積の78%、５２４都市 • 住宅建設：２２０万戸 • 新都市建設 • 電話網拡張：1,170 万回線
環境保全	• 国立公園拡張：2,794 k㎡２ → 6,440 k㎡２ • 河川改修 30.6% → 54.1% • 国土保全地域の設定： 52,138 k㎡２ • 多目的ダム建設（Chungju等） 水需要： 294億トン 水供給： 276億トン

C．第三次総合国土開発計画（１９９２－２００１）

分野	計画
新工業地帯の設定	• 西部海岸地域開発に関連して次の３地域を集中的に工業化 －Asan Bay, Daejeon, Cheongju －Kunsan, Janghang, Iri, Junju －Kwangju, Kwangyang Bay • 小規模工業団地の設定 • ハイテク工業地帯の設定
交通	• ×型道路網建設 • 高速道路建設（1,500 k㎞） • 鉄道複線化（27% → 54%） • 鉄道電化 （17% → 50%） • 新空港建設（Yongjondo, Chongju他）
南北朝鮮統一準備	• 非武装地帯開発 • 鉄道及び国道修復 • 非武装地帯の経済協力地帯の共同開発

分野	計画
環境保全	• 環境保全基準の強化 • 環境のための投資：2001年までにＧＮＰの0.15% →1.5%
住宅建設	• ５４０万戸建設：供給率92.8% • ２１５万戸の賃貸し住宅建設（新建設住宅の40% ）
上下水道	• １８の広域上水網整備 • １８０の下水処理施設建設 • １０の多目的ダム建設
財源	• 投下資本総額：３２０－３７０兆ウォン（１９８５年価格） またはＧＮＰの16-18% －政府： 27% －地方自治体：19% －民間： 50% －その他： 4%

２．２　建設投資の予算

unit : bil. won

Year	GNP	Increase Rate(%)	Budget for Constrution	Increase Rate(%)
1973	32273.8		3331.4	
1974	34903.6	8.2	4001.0	20.1
1975	37143.3	6.4	4251.7	6.3
1976	42001.6	13.1	4789.6	12.7
1977	46135.4	9.8	5969.8	24.6
1978	50645.6	9.8	7591.4	27.2
1979	54289.5	7.2	8093.6	6.6
1980	52260.8	-3.7	7793.5	-3.7
1981	55354.3	5.9	7035.6	-9.7
1982	59322.2	7.2	8443.1	20.0
1983	66803.0	12.6	10657.7	26.2
1984	73004.0	9.3	11436.4	7.3
1985	78088.4	6.9	12011.1	5.1
1986	88173.5	12.9	12338.2	2.7
1987	99611.6	13.0	13761.8	11.5
1988	111979.9	12.4	16106.5	17.0
1989	119534.8	6.8	19429.1	20.6
1990	130373.5	9.1	25199.4	29.7

note) 1985 fixed price

２．３　公共事業に関する機関

プロジェクト主体	機関名
政府	• 政府及びその付属機関、立法府、司法、軍隊、国立学校等
地方自治体	• 京城、釜山及び４市、各道及び県、郡部教育委員会、公立学校等
政府出資団体 －特殊銀行 －組合 －株式会社	• 国立銀行、国有会社等 • 韓国銀行、韓国興業銀行 • 韓国電力会社、韓国高速道路公団、韓国石油開発公社、韓国放送協会等 • Pohang　鉄鋼株式会社
その他の公共機関 －政府研究機関 －地方自治体出資機	• 韓国高等科学技術研究所、韓国計量標準研究所等 • Seoul Kangna■ 病院等

２．４　主な社会資本と公共事業

２．４．１　総社会資本の現状

• １９８７年の総社会資本は７０兆２千億ウォンでこれは１９７７年の４倍であった。
しかし産業資本金の割合はある時期に２４％から２２％に減少した。

• 水資源と電話通信の資本は毎年２０％増加した。

• 高速道路、鉄道、港湾設備等は毎年１１．９％増加し、株式の割合は１９７７年の４９％から１９８７年には３８％に減少した。

２．４．２　高速道路

• 道路総延長：５６，７１５ｋｍ（１９９０年現在）
　－１９８６年以降車両は２．６倍、道路建設は１．２倍増加
　－未舗装道路は16,170k■（総延長の28.5%）

• 激しい交通渋滞のための経済的損失が顕著である。

２．４．３

• 鉄道総延長：３，０９１．３ｋｍ（１９９０年現在）
　－鉄道電化率：１７％
　－鉄道複線化率：２７．４％

the Social Overhead Capital Stock

(Unit : bil. won, %)

	1977		1987		increase '77-'87	
	amount	ratio of GNP	amount	ratio of GNP		annual increase rate
· Traffic	3,594 (48.8)	20.2	26,697 (38.1)	25.2	3.1	11.9
Highway	2,163 (29.4)	12.1	15,119 (21.5)	14.3	2.9	11.3
Railroad	1,286 (17.4)	7.2	9,859 (14.1)	9.3	3.2	12.3
Harbor	125 (1.7)	0.7	1,376 (2.0)	1.3	4.6	16.4
Airport	20 (0.3)	0.1	343 (0.5)	0.3	7.1	21.7
· Living Facilities	2,020 (27.4)	11.3	18,225 (26.0)	17.2	3.8	14.1
Water Supply and Sewage Treatment	374 (5.1)	2.1	2,971 (4.2)	2.8	3.3	12.7
Electricity and Gas	1,646 (22.3)	9.2	15,254 (21.8)	14.4	3.9	14.4
· Telecommunication	745 (10.1)	4.2	10,545 (15.0)	9.9	5.9	19.4
· Water Resources and Flood Control	1,005 (13.7)	5.6	14,697 (20.9)	13.9	6.1	19.8
Social Overhead Capital(A)	7,364 (100.0)	40.4	70,164 (100.0)	66.1	4.0	14.8
Industrial Total Stock (B)	30,314		312,412		4.3	15.7
(A/B)	(24.3)		(22.4)			

* Notes : fixed price

２．４．４　港湾及び海運

• １９９０年に港湾で取り扱われた貨物は３億６千４百万トンで年増加率は１０．２%である

－コンテナは１９９０年に２，３９３ＴＥＵで、年に１５%増加している。

ton equivalent unit?

－現在の貨物取り扱い能力は１億８千９９０万トンで毎年９．７%増加している。

２．４．５　空港

• １９９０年の国内旅客数は１億１千百万人で毎年１３．３%増加している。

国内貨物は１８万２千トンに達し、年増加率は２０．１%である。

• 国際旅客数は約９３６万人

－金甫空港は１９９５年に、Kimhae空港は１９９３年かそれ以降にその能力限界を越えると予測されている。

２．４．６　電力

- １９９０年の電力消費量は９４，３８３ギガワット時で平均増加率は１４．９％である。
  －１９９０年の最大電力消費量は１千７２５万１千キロワット時であった。
- 電力需要はより大きな規模で増加すると予測されている。

２．４．７　水資源

- 現在蔚山，Chungju 等を除いては水資源の需給バランスが取れている。
- 広域上水道網は首都圏に集中している（全供給量の７５％）。
- 水道料金は比較的安いので水道施設建設の予算が制限されることになる。
- １９９２年から２００１年までの間に３兆９千億ウォン投資される予定である。

主要な社会資本のストック

Unit : km, thousand ton/day

Year	Highway	Railway	Harbor Capacity	Water Supply	Sewage Treatment Capacity
1982	53,936	6,113.4	87,423	8,076	822
1983	54,600	6,128.7	95,512	8,386	822
1984	51,004	6,168.1	100,317	9,498	822
1985	52,264	6,299.0	112,778	10,214	822
1986	53,654	6,323.6	118,413	11,505	973
1987	54,689	6,339.9	150,676	12,613	4,262.5
1988	55,778	6,456.2	168,774	14,442	4,644.5
1989	56,481	6,436.6	184,739	15,725	4,945
1990	56,719	6,434.6	189,926	16,274	5,097

2．5　現在実施中または計画中の主要プロジェクト

Unit : trillion won

Section	Main Works	Investment		
		Total	1992-1996	1997-2001
Highway	· highway [new construction 1,500km [extension 700km · national road [new construction 1,100km [extension 5,500km	39.3	18.5	20.8
Railway	· rapid-transit railroad 915.7km	18.9	6.092	5.588
	· metropolitan area electric railway 269.4km		1.737	0.159
	· subway in large city 536.4km		1.71	1.043
Harbor	· container, freight	7.5	3.088	4.401
Airport	· new airport	3.2	2.725	0.489
Distribution	· construction of complex terminal	0.7	0.434	0.3
Water Supply	· multipurpose-dam, wide range water supply, industrial water, etc.	3.9	2.826	1.045
Total		73.5		

* Notes : Nongovernmental 2.5 trillion won was excluded in habor project.

３．公共事業に関する研究開発

３．１　建設技術の現状

韓国の建設業は多くの種類の建設プロジェクトを成功させ、国の主要産業となり、ＧＮＰへの貢献は９％になっている。しかしながらこの成長は主に労働集約型の建設工事によって達成されたものであり、建設技術水準は先進国に比べて遅れている。

種類別プロジェクトや建設の各段階での韓国の建設技術水準は、先進国との比較で評価されている。下の表は先進国の現在の技術水準を100 として代表的な建設工事を数量的に表したものである。

この表で見られるように、簡単な建設の技術水準はプロジェクトの種類にかかわらず一般に高いが、計画、運営、維持、監督といった集約的な段階における技術水準や、技術集約的建設工事の技術水準は今だに低い。

建設業界は高速道路や主要道路、また子孫への遺産として残せる芸術的建築物などの社会総資本施設の建設プロジェクト実施に向けて最善の努力と技術を惜しまない。

建設技術水準

（指数：先進国の水準＝100 ）

Facility	Stage of construction activity				
	Planning Investigation	Design	Construction	Supervision	Maintenance
Bridge	66	68	73	62	62
Nuclear Power Plant	45	45	60	45	55
Road & Airport	72	75	85	75	80
Railway	68	70	85	70	75
Tunnel	65	68	83	65	68
Dam	64	62	77	62	65
Building	59	78	73	61	60
Highrise Building	58	60	73	58	58
Water and Sewerage Facilities	57	57	67	58	56
Hydroelectric Power Plant	71	69	72	53	45
Building Facilities	73	63	76	56	63

３．２　建設技術改善のための政策と戦術

韓国の建設技術を先進国の水準まで引き上げ、韓国建設会社の競争力を高めるべく韓国政府は研究開発と技術開発のための長期計画を打ち立てた。

1987年に韓国建設技術研究院(KICT)は建設省の後援で研究プロジェクトを実施し、「建設技術研究開発の長期指導令」を提案した。KICTによってプロジェクトは実施されたが、官、産、学各界から約400 人の専門家がプロジェクトに参加し、経験を分かち合った。

建設技術の多くの局面がこのプロジェクトで見直された。提案された長期計画の主な内容は次のとおりである。

1) 建築物に対するより高度なニーズに対応できるような21世紀の建設技術需要の予測と、その需要を満たすような研究開発の目標と指導令の提案。

2) 建設技術開発促進政策やシステムの提案。

3) 建設技術の様々な関連研究分野での必要な研究課題の決定による、研究開発の長期、短期計画の方向の決定。

4) 研究開発のための施設や労働力とその財源を含む必要資源確保のための適切な機構や戦略調査。

5) 建設技術の情報管理システム開発の長期計画の確立。

建設技術管理法が1987年に公布され、1988年に施行されたが、その法律は革新的な建設技術の保護機構や、KICT及び建設技術情報センターの設立を含めて様々な技術開発の局面を対象としている。

この法律と建設技術研究開発の長期方策令を基にして10か年基礎計画が1991年4 月に作られた。この計画は様々な政策と様々な分野の基本的技術開発計画から成る。様々な政策とは　1)技術開発の支援システム　2)技術者の管理　3)研究所の支援　4)技術開発への投資の拡大　5)技術情報管理システムの確立、そして　6)国際的技術協力の拡大、である。技術開発とは、技術開発の主な分野の決定、各分野の研究開発計画の立案、必要な財源額の決定を含む。

建設技術促進の10か年計画の次のステップは、そこに挙げられている項目の各々に対して詳細な執行計画を立てることである。建設技術の研究開発 5か年施行計画が1993年1 月に建設省によって公示されたばかりで、それは大学、研究所、民間、政府が推進すべき建設技術関連の全ての研究開発を含んでいる。

３．３　建設分野における公共の研究開発機関

Unit : million won, %

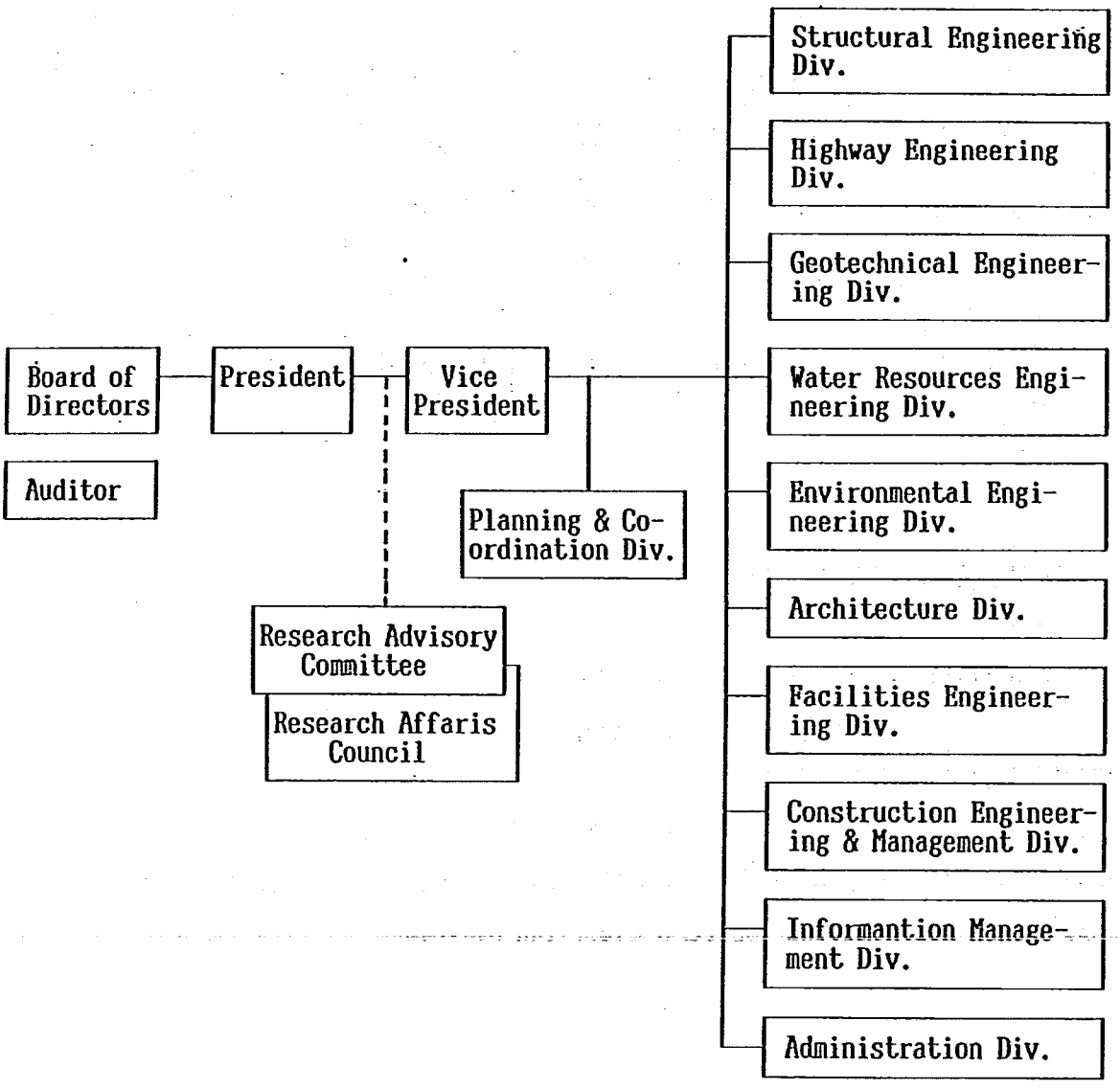
	Foundation Date	Number of R&D Staff	Net Scale	R&D Exp.	Ratio of R&D Exp.
Korea Highway Corp.	'69. 2.15	41	4,274.7	34.2	0.80
Korea Water Resources Corp.	'67.11.16	42	2,131.1	55.7	2.63
Korea National Housing Corp.	'62. 7	121	27,266.2	132.1	2.23
Korea Land Development Corp.	'79. 3.27	44	11,825.6	26.0	0.10

３．４．　韓国建設技術研究院（KICT）

３．４．１　歴史

- 1983年 5月17日　重役会の就任と定款の制定
  KICTの初代院長としてAhn, Kyung Mo 博士を選抜
- 1983年 6月11日　法人組織の財団としてKICTを開設
- 1986年 9月 1日　KICTの第２代院長としてYoon, YongNam 博士就任
- 1988年 1月 8日　「建設技術管理法」第７条により、政府支援の機関に組織変更
- 1989年 1月24日　KICT第３代院長としてLee, Yun Sik氏就任

３．４．２　組織図



３．４．３　スタッフ数

• 常勤スタッフ

Executive	Research Technical Staff	Administrative Staff	Technician	Total
2	142	21	30	195

• 臨時スタッフ：約70人

３．４．４　予算（1992）：　78億4,800 万

- 人件費　：　25億1,000 万ウォン
- 研究活動　：　23億6,000 万ウォン
- 管理費　：　22億7,800 万ウォン
- 研究室建設費　：　7億ウォン

３．４．５　最近の成果

KICTは1983年から1992年の間に 302の研究プロジェクトを完成させた。その内訳は

- KICTの研究　141
- 後援者付き研究　140
- 基礎研究その他

Research Field	Number of Project			
	KICT research	sponsered research	others	Total
Structural Eng.	17	23	1	41
Highway Eng.	8	10		18
Geotechnical Eng.	17	15	3	35
Water Resources Eng.	16	24	2	42
Environmental Eng.	16	32	2	50
Arcjotectire	23	15	1	39
Mechanical and Electrical Eng.	23	11	2	36
Construction Eng. and Management	13	5	8	26
Information Management	2	4		6
Common	6	1	2	9
Total	141	140	21	302

4．韓国建設技術研究院の主要研究開発プロジェクト

4．1　1993年度の主要研究開発プロジェクトの題目

- 粉砕された骨材の科学反応に関する研究
- 地震で損壊した構造物の復旧
- 長スパン橋の設計及び建造法に関する研究
- 韓国における連続鉄筋コンクリート舗装（C．R．C．P）の初期挙動と亀裂パターン
- 自動交通識別に関する研究
- 内国海底粘土の工学的特性の評価
- 繊維強化土壌に関する研究
- 凍土の特性及び永久凍土中の杭基礎の特性に関する研究
- 韓国における地下水の管理及び保全に関する研究
- 水文モデルの評価に関する研究
- 下水用材料の改良に関する研究
- 処理済み廃水の再利用に関する研究
- 汚水処理場における臭気コントロール用のエアレーションタンク及び土壌吸着濾の使用に関する研究
- 住居用アパートメントのエネルギー節約方法の開発
- 既存建造物の保守と近代化のための指針
- 低温廃熱を用いた住居用ビルの暖房システムに関する研究
- 事務所用ビルにおける電力需要コントロールシステムに関する研究
- 公共施設に対するＧＩＳの適用に関する予備的研究

4．2　プロジェクトの概要

■構造学的部門

1．研究プロジェクト：長スパン橋の設計及び建造法に関する研究

2．期間：1993．1．1．～1995．12．31．

3．背景及び研究のニーズ

最近、多数の長スパン橋（ケーブル支持橋、吊り橋）が韓国において建造されている。しかしそのようなタイプの橋の設計及び建造に関する技術は韓国においては未発達の段階に止まっている。従って建造法のみならず設計に関する研究も長スパン橋の技術を向上させるために必要である。

4．目標

第1ステップ（1993）
- 研究資料の調査、分析
- 設計荷重に関する研究
- 解析手法に関する研究

第2ステップ（1994）
- 風洞テスト及びその基準に関する研究
- 耐風力設計に関する研究

第3ステップ（1995）
- 耐震設計に関する研究
- 建造法に関する研究
- 解析用コンピュータプログラムの開発
- 耐風力及び耐震設計用コンピュータプログラムの開発
- 前、及び後処理システムの開発

5．手法
- 設計データ及び設計者の経験
- 諮問委員会の設立
- 開発済みプログラムの分析
- データベースシステムの調査と使用

6．予期される結果
- 長スパン橋に関する設計基準の素材として適用
- 長スパン橋技術の韓国における普及
- 長スパン橋に対する有効なパッケージソフトの普及
- 韓国における長スパン橋の技術の全般的な向上

■高速道路部門

1．研究プロジェクト：韓国における連続補強コンクリート舗道（C．R．C．P）の初期挙動と亀裂パターン

2．期間：1993．1．1～1993．12．31

3．背景及び研究ニーズ

韓国においてC．R．C．P．を広汎に使用するためにはC．R．C．P．が韓国において設計通りに機能するかどうかを確認し、また韓国産のC．R．C．P．の性能を他国のものと比較することが必要である。

4．目標

この研究の目的は、韓国におけるC．R．C．P．の施工手順と設計標準をレビューし、適切な施工を推薦することである。

5．手法
- テスト砕片の作成とモニター
- テスト砕片から集められたデータの分析と評価
- 結果の他国のものとの比較

6．予期される結果
- 韓国におけるC．R．C．P．の設計と施工に関する勧告の提供
- C．R．C．P．の性能に多する初期データベースの作成
- 韓国におけるC．R．C．P．の性能に関する基礎データの提供

■土質工学部門

1．研究プロジェクト：内国海底粘土の工学的特性の評価

2．期間：1993．1．1．～1994．12．31

3．背景及び研究ニーズ

21世紀に向けての戦略的国土開発計画として、朝鮮半島の西南海岸沿岸ベルト地帯の組織的土地利用が、第3次国土開発計画における主要なプログラムの一つとして企画された。このプログラムは、沿岸部近隣の軟弱な海底粘土層上に新都市、工業団地、空港、港及び廃棄物処理場のような様々な大規模インフラストラクチャーの建造を含み、内国海底粘土の土質的特性に関する包括的研究は軟弱海底粘土質の沿岸地帯に建造される構造物の設計、建設及び保守の適切にして効果的な計画策定の必要要件である。

4．目標

この研究の目的は内国海底粘土の工学的特性に関する系統的データベースを作り上げることである。

5．手法

- 海底粘土地盤の基礎的な挙動に関する理論的研究及び海底粘土の工学的特性評価の方法の提供
- 海底粘土の種々の工学的特性間の相関関係に関するデータベースの作成と研究

6．予期される結果

- 内国海底粘土の工学的特性の評価のための組織的データベースの提供
- 堤防及び基礎に関する最適設計と建設計画
- 破壊予測及び安定性解析のための手法の開発

■水資源工学部門

1．研究プロジェクト：安定河川断面の決定手法の開発

2．期間：1993．1．1．～1993．12．31

3．背景及び研究ニーズ

- 安定河川断面を決定する現行の方法は信頼性及び公式化の正当性を欠く。
- これらの方法は河川の維持事業及び立案に用いられている。
- 河川の過度の洗掘及び堆積など重大な問題は、このような不確かな方法の採用により発生することがある。
- 従って、安定河川断面を決定する新しい方法の開発が必要である。

4．目標：安定河床勾配用の新種法の開発

5．方法

- 安定河床勾配の計算に河川工学上慣行的に用いられてきた方法の調査
- 現状技術のレビュー
- 構造上及び論理上の観点における現行方法の分析
- 幾何学的及び水理学的データの収集と整理

• 安定河床勾配のための新種法の開発
• 数学的モデルの結果との比較
6．予期される結果
• 現行手法に取って代わる、安定河床勾配用新種法の開発
• 河道改良あるいは河川計画のための安定河床勾配を評価する信頼性ある手法の提案

■環境工学部門
1．研究プロジェクト：汚水処理上における臭気コントロール用のエアレーションタンク及び土壌ろ過吸着層の使用に関する研究
2．期間：1992．1．1～1993．12．31
3．背景及び研究ニーズ
• 汚水処理場は水質管理に取って必要な施設であるが、快適な施設とはみなされていない。
• 現行処理場における臭気問題は作業者の健康と安全を脅かし、地価と環境的価値の低下を招き、他の社会的問題を引き起こす。
• 臭気制御設備の設計及び運転に関する基礎データの不足。
• 現行汚水処理場における臭気問題の予備的研究から、臭気コントロールの最良の代替案は、エアレーションタンク及び土壌ろ過吸着層の使用であることが提案された。
• 従って、エアレーションタンク及び土壌ろ過吸着層を用いた臭気コントロール法の詳細な確立のための研究を実施することが必要である。
4．目標
• 汚水処理場における処理工程毎に臭気生成物質を立証すること。
• 微生物による臭気制御技術の採用の実現可能性調査。
• エアレーションタンク及び土壌ろ過吸着材採用臭気コントロール施設の設計及び操業の構成要因の確定。
• 汚水処理場における臭気コントロール施設の設計工程の開発。
5．方法
• 文献調査
• 現地施設のサーベイによる実態調査
• ベンチ・スケールテスト及びプラントの実験的運転による研究段階の分析
6．予期される結果
• 汚水処理場従業員の労働条件及び健康環境の改善
• 住民の不満解消、生活環境を改善し、処理場近隣の快適度の回復
• 臭気コントロール施設の設計のための基礎データとしての結果利用
• 経済的な制御プロセスの開発と一体化した臭気コントロール施設の普及

■建築部門

1．研究プロジェクト：既存建造物のメンテナンスと近代化のための指針

2．期間：1993．1．1．～1995．12．31

3．背景及び研究ニーズ

既存建造物は経済的資源のかなりの部分を占めるとの認識の高まりから、その耐用寿命の延長を図るような方法での維持管理が求められる。このため、建物のメンテナンスと近代化の活動により大きな注意が払われるようになった。この認識の高まり、既存建造物の増加し続けるストック量にも関わらず、このテーマに関しては、ほんのわずかの研究成果しか発表されていない。

4．目標：本研究プロジェクトは主に以下の3つの目標をねらいとしている。

A部－建物劣化の評価のための基準

B部－建物補修のための技術的手法

C部－メンテナンスプログラムの開発

5．手法

上記の目標を満たし、メンテナンス作業のコンピュータ化を図るために、以下の調査方法を用いて関連データを収集する。

• サーベイ1は、建物補修、維持及び管理に関する現慣行に重点をおく。

• サーベイ2は、補修作業のコンピュータ化とメンテナンス活動の先行開発についての事例調査とする。

6．予期される結果

• 建造物劣化の評価に関する実戦的指針

• 建物のメンテナンス及び近代化のための技術と方法

■機械及び電気工学部門

1．研究プロジェクト：低温廃熱を用いた居住用建造物の暖房システムに関する研究

2．期間：1993．1．1．～1993．12．31

3．背景及び研究ニーズ

従来の廃熱利用は産業分野における高温廃熱を利用するものであった。しかしながら、大量の低温廃熱が現実に都市施設、オフィス及び居住用建物から排出されている。都会生活におけるエネルギー需要の著しい増大割合に応じて、低温廃熱の回収技術の研究が緊急に必要とされる。

4．目標

都市部における未活用エネルギー源であった低温廃熱量を捕集し、有効利用の可能性を追求するのが究極の目標となる。最終的には、本プロジェクトの結果は居住用建造物に対する革新的なエネルギー節約システムを開発する一助となるであろう。

5．方法

種々の選定されたシステムとその運用法に関して期待される熱エネルギー消費量をシミュレートするため、小型の居住用建造物の模型を建造する。

6．予期される結果

本プロジェクトは、居住用建造物でのエネルギー節約のための改造あるいは新しい暖房システムの設置を望む設計者、コンサルタント、及び建物の所有者あるいは管理者のための一般的な指針として利用されることを意図している。

■建設工学及び管理部門

1．研究プロジェクト：公共施設へのＧＩＳの適用に関する予備的研究

2．期間：１９９３．１．１．～１９９３．１２．３１．

3．背景及び研究ニーズ

- ＧＩＳ利用による公共施設の効果的なメンテナンスと管理
- 公共施設情報を統合する必要性
- 公共施設の環境及び交通へのインパクトの軽減

4．目標

- 公共施設管理情報の基本的なリストの探索
- ＧＩＳ利用による公共施設のメンテナンス管理に関する予備的研究
- 環境及び交通へのインパクト評価のためＧＩＳ適用に関する予備的研究

5．方法

- 海外の事例調査
- 公共施設の管理運営の分析
- パイロットシステムの建造

6．予期される結果

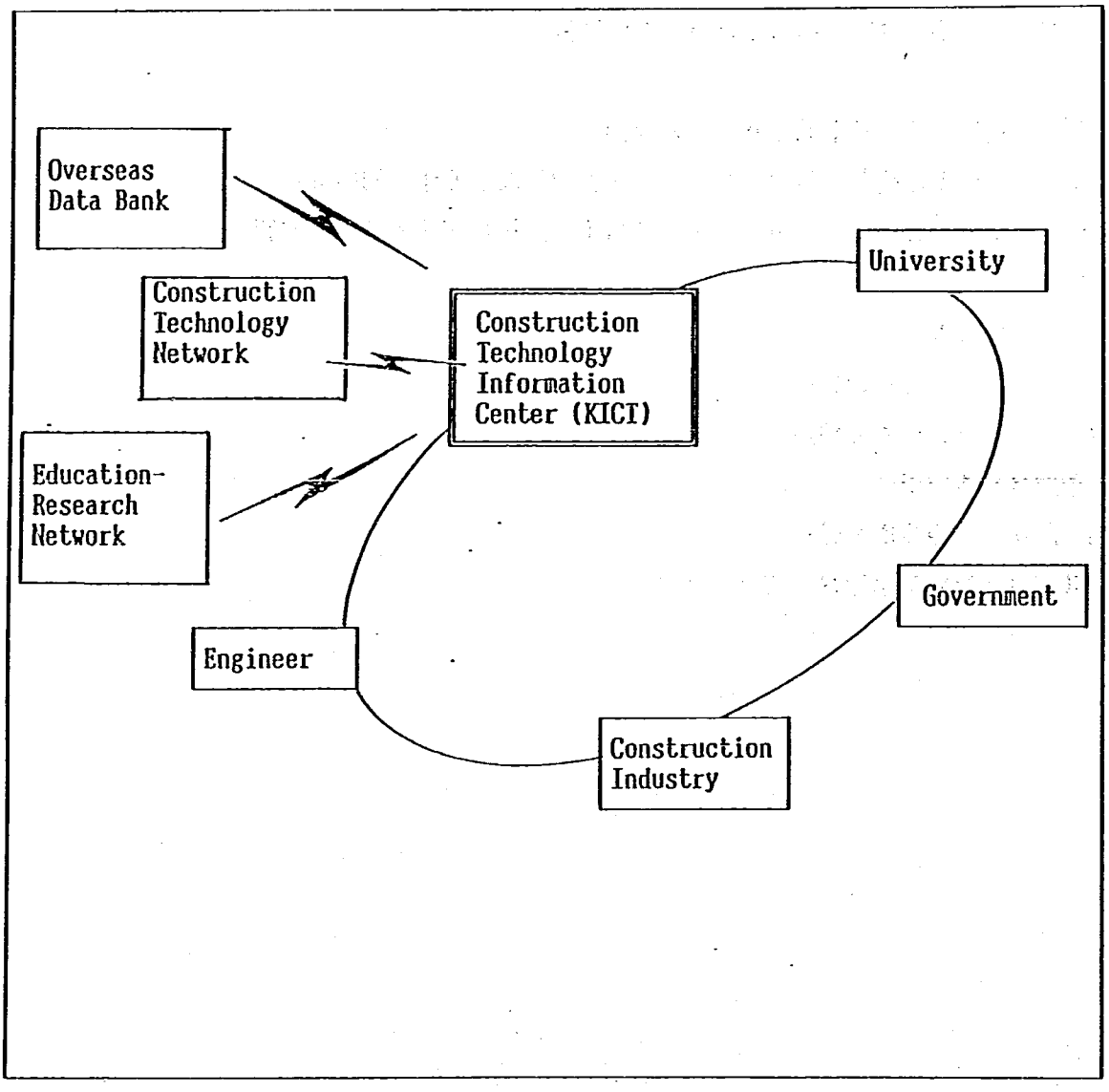
- 効果的な公共施設情報管理
- 公共施設に対する迅速な補修サービス

４．３．　建設技術情報センター

１．目的

建造物全般の品質を改良し、２１世紀に向けて国際競争力を高めるべく、建設産業は建設技術のための明瞭に定義された情報システムを確立し、韓国及び海外の情報を収集する必要がある。情報システムは、主として以下のものにより構成される；データ収集及び管理、データベースの構築、情報の普及と伝達、コンピュータシステムの管理。

２．情報管理の基本戦略



３．技術情報システムの開発計画

情報管理システムの開発は、表－２に示すように２００１年を目標年次として３段階で完成させる。

表－２：技術情報システムの開発

Phase Ⅰ Preparation phase ('88 -'91)	Phase Ⅱ Establishment of information center ('92 - '96)	Phase Ⅲ Operation and further development ('97 - 2001)
・ Investigate the sources of construction technology information	・ Systematic management scheme for informations	・ Establishment of On-line service system through information communication network
・ Internationa cooperation & Exchange	・ Development and expansion of D/B system	・ Commencement of full service
・ Extablishment of joint exchange and utilization between related organization	・ Commencement of information service to government, construction industry and other related organization	
・ Development of D/B system	・ Participate in international information Service Network and test run	

5．国際研究交流

5．1　現状

ＫＩＣＴは建設技術に関して先進諸国の５８の主要な機関と協力関係を維持してきている。ＫＩＣＴは情報交換、研究者交換、共同研究、国際セミナー、等相互に関心ある分野においてこれらの機関と密接に連絡を取り、数々の協力プログラムの促進を続けていくつもりである。

■建設技術に関する国際セミナー

第1回セミナー	１９８３年１１月２２日	韓国ソウル
第2回セミナー	１９８４年　１月２７日	ソウル
第3回セミナー	１９８４年　６月２２日	ソウル
第4回セミナー	１９８４年１０月３０－３１日	ソウル

■ＮＩＳＴとの共同研究

共同研究合意	１９８４年１０月４日	米国
共同研究	１９８４年－１９８８年	

■ＫＩＣＴ／ＭＩＴ共同ワークショップ

研究交換の合意	１９８４年１０月５日	米国
ＫＩＣＴ／ＭＩＴ共同ワークショップ	１９８５年８月２７－２８日	ソウル

■沖積河川特殊問題に関する国際シンポジウム

１９９１年９月１６－１９日　ソウル

5．2　ＪＩＣＥ（国土開発技術研究センター、日本）

- １９８９年６月　３日　ＪＩＣＥ－ＫＩＣＴ研究交換の合意
- １９９０年９月　５日　第１回韓国－日本建設技術セミナー　ソウル
- １９９１年８月２７日　第２回韓国－日本建設技術セミナー　東京
- １９９２年９月２－３日　第３回韓国－日本建設技術セミナー　ソウル
- １９９３年８月３１日　第４回韓国－日本建設技術セミナー　東京（予定）
  －９月　１日

5．3　ＰＩ（永久凍結土研究所、ロシア）

- １９９０年２月２１日　寒冷地域における国際セミナー主催　（ソウル）
- １９９０年９月２５日　ＫＩＣＴとＰＩの協力合意
- １９９１年９月－１９９２年９月　共同研究にＫＩＣＴ研究者をＰＩへ派遣
- １９９２年１１月１７日　永久凍結土地帯における建設課題セミナー主催

（ソウル）

5．4　ＶＩＴ（フィンランド技術研究所）

- １９９１年１２月　　韓国建設大臣フィンランド訪問
  ２国間の技術協力に合意
- １９９２年９月　　ＫＩＣＴ所長ＶＩＴ訪問。技術協力について討議

5．5　ＰＷＲＩ（土木研究所、日本）

- １９８７年１２月２０日　韓国建設省とＰＷＲＩが日本韓国間の技術協力について討議
- １９８９年１２月　　ＫＩＣＴ研究者をＰＷＲＩに１ヶ月派遣（環境問題）
- １９９０年８月　　ＫＩＣＴ副院長ＰＷＲＩを訪問。技術協力について討議
- １９９０年９月　　ＫＩＣＴ研究者をＰＷＲＩに１ヶ月派遣（高速道路）

5．6　ＫＩＣＴと連絡のあるその他の機関

機関名	国名	協力分野
建築と資材の実験研究に関する国際学会	フランス	建築
国際建築研究 文書評議会	オランダ	建築
国際水資源学会	アメリカ	水資源
アメリカ土木学会	アメリカ	建設
アメリカ地球物理学会	アメリカ	水資源
アメリカ水道設備学会	アメリカ	水資源
アメリカ機器学会	アメリカ	建築
アメリカコンクリート学会	アメリカ	建築
アメリカ加熱、冷却、空調工学会	アメリカ	土木
国際水質汚濁研究予防学会	イギリス	環境
水資源研究センター	イギリス	水資源
日本土木工学会	日本	土木、建築
建設省建築研究所	日本	建築
土質工学会	日本	土質工学
水文工学センター	アメリカ	水資源

機関名	国名	協力分野
ウォーターエンジニアリング研究所	アメリカ	水資源
建設、産業研究所	アメリカ	建設
水資源研究センター	アメリカ	水資源
建設工学研究所	アメリカ	建設
農業研究サービス	アメリカ	水資源
土壌保全サービス	アメリカ	土質工学
国立建築技術センター	アメリカ	建設
交通研究所	アメリカ	高速道路工学
マサチューセッツ工科大学	アメリカ	土木工学
テキサスA&M大学	アメリカ	土木工学
テキサス大学（オースティン）	アメリカ	土木工学
清水建設研究所	日本	建設
大成㈱研究センター	日本	建設
鹿島建設研究所	日本	建設
国土開発技術研究センター	日本	建設
京都大学防災研究所	日本	建設
水文学研究所	イギリス	水資源
交通、道路研究所	イギリス	高速道路
連邦物性試験所	ドイツ	建築、材料
連邦高速道路研究所	ドイツ	高速道路
連邦水文学研究所	ドイツ	水資源
国家建築研究所	ドイツ	建築
国立中央科学研究所	フランス	建築
国際水資源管理訓練所	フランス	水資源
デンマーク建築研究所	デンマーク	建設
中央建築研究所	インド	建築
セメント及び建築材料評議会	インド	建築
Ret-Ser工学院	台湾	建設管理
住宅開発庁	シンガポール	建築
ハンガリー建築研究所	ハンガリー	建築
ブタペスト工科大学	ハンガリー	土木工学
建設研究所	カナダ	建設

6．韓国の「災害と防災」に関する取り組み状況

6．1　序論

韓国では洪水により大きな自然災害が引き起こされる。雨季には極端な豪雨が頻繁に降るため、平野部に洪水が起こる。また、年に２～３度朝鮮半島を襲う台風により深刻な被害がもたらされる。さらに韓国では、ときおり豪雪やひょう(雹)、高潮、雷雨、地震などにも見舞われる。

中央政府と地方政府はこれらの災害防止のために、以下の対策・予防策に取り組んでいる：

－　気象と洪水予測、河川の改良、低地における堤防建設と排水施設の建設、住民と関係スタッフに対する教育計画の実施である。

こうした努力にもかかわらず、ここ数年間、死者数と資産被害額が大幅に増えている。過去１０年間で２８３人の人命と約５億５０００万米ドル相当の資産が失われ、災害救難と復旧作業に４億５０００万米ドルが費やされた。

6．2　韓国の自然災害

6．2．1　水文学的状況

a．年間平均降雨量は１，２７４mm(５０．２インチ)である。

b．年間降雨量のおよそ ２／３は夏季(６、７、８月)に起こる。その要因はモンスーン性の雨である。

c．最近、地域的に突発的な洪水が多発している。

d．朝鮮半島の地理的な条件により、暴風雨による雨水は短時間で河川に流入し、低地に洪水を引き起こす。

6．2．2　社会経済的背景

a．人口増大と都市開発によって都市近郊の洪水の起こりやすい低地と地滑りの起こりやすい丘陵地帯の利用が広がった。その結果、深刻な問題を引き起こす可能性が高まった。

b．急速な都市化と森林利用によって表面流水の量と速度が高まり、過去に比べて洪水のピーク出水量が増えた。

c．河川の堤防工事と改良工事は行なわれてはいるが、十分ではない。

d．支流の多くは洪水調節構造物と施設を十分に備えていない。

6．2．3　災害の直接的原因

災害の原因の半分以上は大雨と台風である。災害の主な原因を下記に簡単に紹介する。

a．洪水

韓国の河川は比較的短く傾斜が急なので流速が速く、洪水の量水曲線は勾配が非常に急である。

b．台風

北緯５度ないし１５度近辺で発生し、最大風速１７m/秒の熱帯性低気圧を台風と呼ぶ。台風はふつう、１年間に３０個ほど発生し、その７０%は７月から１０月に集中する。７～１０月に発生する台風は朝鮮半島に接近する可能性がある。毎年２ないし３個の台風が暴風雨、雨前線、及び大量の雨量をもたらす。

c.土石流と地滑り

朝鮮半島には砕けやすい土壌の存在する区域がたくさんある。そのうえ山岳地帯や丘陵地区でさえ開発が推進されているので、土石流による災害の発生件数が年々増えている。土石流の原因は地滑りと急峻な斜面の崩壊である。

d.高潮と津波

韓国の海岸線は非常に長く、かなりの資産が海岸線に沿って集中している。そのため高波による被害が広い地域にわたって発生しやすい。そういった被害を与える波は台風による高波、火山活動に起因する津波、高潮、及びその他に分類される。

6.2.4自然災害の統計的データ

表－１は１９０４年から１９９１年の間に起こった自然災害の発生件数を原因別に示したものである。最近の１０年間の自然災害の年間の被害を表－２に示す。

Table 1. Numer of natural disasters occurred in Korea (1904-1991).

Cause	total	typhoon	heavy rain	heavy snow	hail	tidal waves	storm	earth-quake
No. of strike	1,568	263	429	224	89	49	435	79
Annual average	17.8	3	4.9	2.5	1	0.6	4.9	0.9
Percent (%)	100	17	27	14	6	3	28	5

Table 2. Damages occurred from natural disasters (1981-1990).

Year	Loss of Life (person)	Suffer-rers (person)	Inunda-ted Area (ha)	Property Damage (in million U.S dollars)					
				Build-ing	Farm-land	Crops	Public Facili-ties	Others	Total
1981	216	18306	149583	5.29	17.67	26.74	130.26	18.93	198.89
1982	121	6609	37008	1.25	6.85	42.32	62.69	14.03	127.14
1983	91	1355	24851	3.21	0.14	15.44	6.61	4.73	30.13
1984	265	364236	140199	13.67	28.39	96.80	186.21	54.82	379.89
1985	250	72257	126291	1.83	2.42	109.12	67.45	28.67	209.49
1986	156	99114	86701	2.99	2.55	268.47	60.81	31.08	365.90
1987	1022	272277	300453	21.29	104.70	350.08	836.69	327.34	1640.10
1988	143	5053	17988	0.89	15.95	20.48	124.93	21.81	184.06
1989	307	92593	121060	8.80	21.76	342.68	303.80	141.34	818.38
1990	257	203314	124276	13.17	64.19	829.02	394.66	246.46	1547.50
Total	2828	1135114	112841	72.39	264.62	2101.2	2174.1	889.2	5501.5
Arith-matic Mean	283	113511	112841	7.24	26.46	210.12	217.41	88.92	550.15

Note: The property damage does not cover the losses of materials for production, products and household goods.

6.3 ＫＩＣＴの１９９３年度の“災害及び防災プロジェクト”

標　　題	期　　間
・地震被害を受けた構造物の復旧	９３．　１～９４．１２
・既存の構造物の地震被害予測方法の開発	９３．１１～９３．　７
・ダムの安全性評価とダムの保守のための指針	９２．　９～９３．　３
・水文学的モデルの評価の研究	９２．　１～９３．１２
・河川形状の決定手法の開発	９３．　１～９３．１２
・川の中に水文学的構造物を設計するための指針	９２．　４～９３．１２
・２１世紀の水資源の方向づけ	９２．１１～９３．１１
・漢江流域における洪水予測プログラムの改良	９２．１１～９３．１２
・水資源管理方法の開発	９３．　５～９３．１２
・Anseong 川と Hyungsan 川における洪水予測と警報システムの基本設計	９３．　５～９３．１２
・河川環境の管理手法の研究と開発	９３．　５～９３．１２
・Nak-Dong 川流域の流れ予測と警報システムの改良	９３．　６～９４．　３

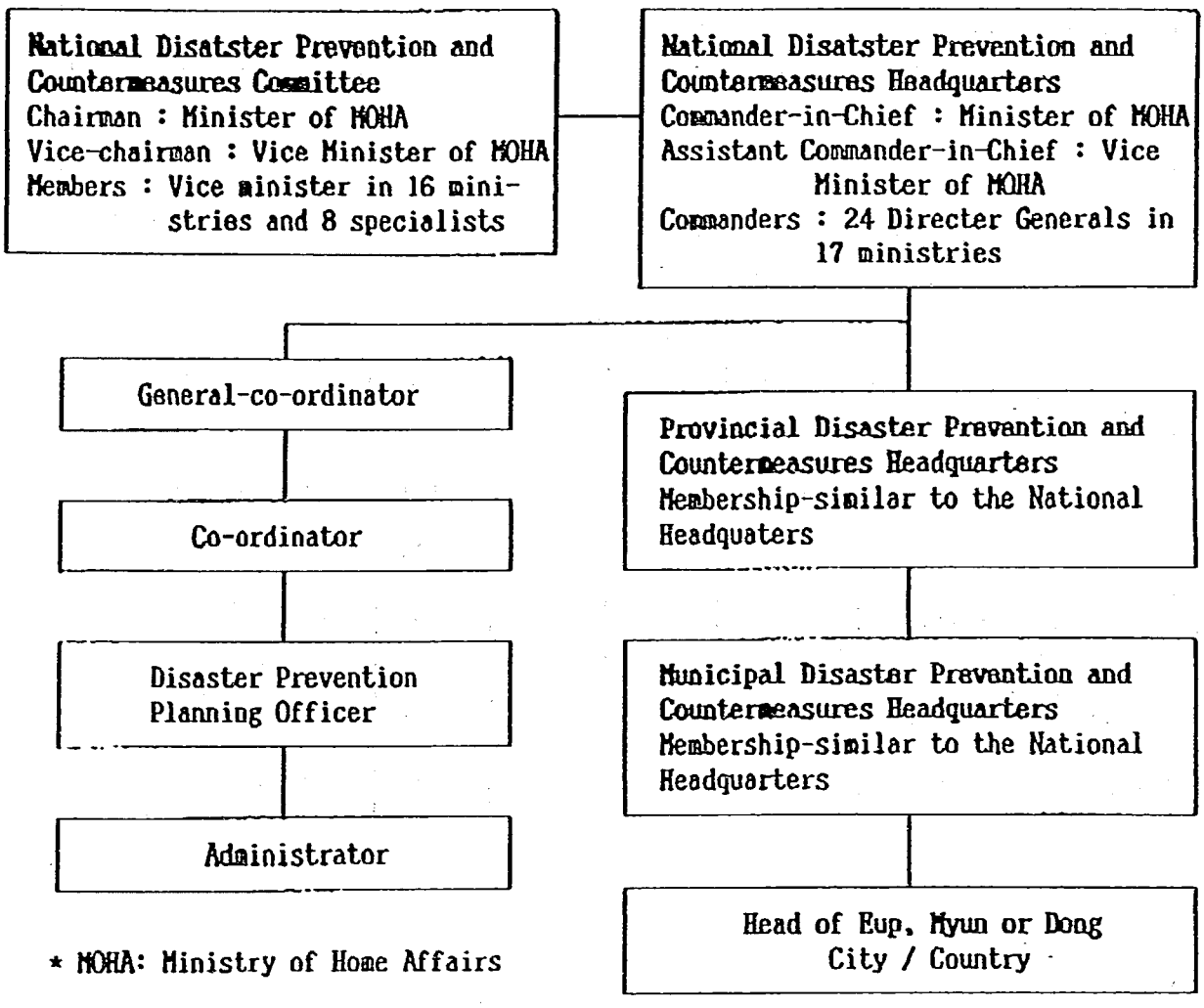
6.4　自然災害に対する対策、防災

6.4.1　組織的な取り組み

全国災害防止と対策本部(現在は自治省の管轄下にあるが、１９９１年４月２３日までは建設省の管轄下にあった)は全国の自然災害の防止とそれへの備えを任務とする中央組織である。全国災害防止と対策本部は政府レベルのプラン、自然災害に対する各種の活動、及び国際協力に責任を負っている。

さらにこの本部は中期的、長期的全国災害軽減プログラムを作成して実行している。

図－１は韓国における災害防止組織の体系を示す。全国災害防止と対策本部は全国災害防止と対策委員会の支援を受けている。同委員会の委員長は自治大臣であり、副委員長は自治省(ＭＯＨＡ)次官である。同委員会は省の次官１７人と専門家８人で構成される。



さらに、作業実行レベルの最高執行委員会として全国災害防止と対策委員会の下に本部委員会が設けられている。本部委員会の委員長は自治大臣がつとめ、２人の副委員長(ＭＯＨＡ次官とＭＯＣ次官)の補佐を受ける。本部委員会のメンバーには１７の省と韓国気象庁の長官２４人が含まれる。いったん大規模災害が発生すると本部が活動を開始し、省庁と“その災害に関与し、省庁を支援する部署”の活動を調整する。県、自治体、及び郡のレベルでは災害防止と対策本部に似た構成と責任を持った組織が設定される。

6．4．2　長期的な防災対策

様々な災害によって引き起こされる国土、人命及び財産に対する被害を防止、または軽減する対策は次のように分類される：

防止策；すでに発生した災害に対する緊急対策；災害後の修復/復旧事業；予防科学と技術の開発に向けての研究。

a．河川の改良

洪水による浸水を防ぐため、政府は河川の幅の拡張、堤防の強化、洪水水路と減勢池とポンプステーションの建設などの河川改良工事を実施している。政府はここ５年間に約３億３０００万米ドルを河川改良事業に投入した。その結果、総河川長さ（３０，２２２ｋｍ）に対する改良済みの河川距離（１９，６９０ｋｍ）の割合は５５％に達した。表３は最近５年間の河川改良への投資額を示す。

Table 3.　Government's investment for river improvement in　recent 5 years

(In million U.S. dollars)

Fiscal　Years	Average	1986	1987	1988	1989	1990
Length of rivers improved in kilometers	204	230	202	189	201	200
Investment in million U.S. dollars	66.0	59.4	51.2	62.1	70.2	86.9

b．多目的ダムの建設

多目的ダムは韓国では大きな役割りを担っている。これらのダムはふつう川の水源地に設けられて様々な用途への給水や水力発電などに利用されている。多目的ダムの現状と将来計画は次の通り。

－ 現在供用中のもの：８基（洪水調節容量は１７億ｍ３）

－ 現在建設中のもの：２基（洪水調節容量は３億５０００万ｍ３）

－ 計画段階中のもの：７基

２０１１年以後は多目的ダムの個数は１７で、その総洪水調節容量は２７億ｍ３ となる予定。

c．急斜面の崩れに対する予防工事

都市部または密集市街地の急斜面の崩壊を防ぐため、擁壁やその他の斜面構造物の建設が進められている。

d．復旧工事方法の改良

復旧工事のやり方の改善が進められている。これは被害を直して元の状態に戻すことだけを目

的として復旧工事を行なうと同じ場所で再び同じような災害が起こるおそれがあるので、これを防ぐために実施されるのである。

6.4.3 短期的防災計画と被害軽減プログラム

a. 短期計画/プログラム

雨季を主眼としてさまざまな短期的被害軽減計画とプログラムが作成されて実行されている。これには次のような事業がある：

－危険な施設や構造物を修理し、職員の中から担当責任者を指名する。
－川の流れを妨げているものを除去する。
－洪水を起こしやすい河川を観測する担当者を指名する。
－重要な発電設備と構造物の管理担当者を指名する。
－自然災害の予防に関する高度技能と知識を関連スタッフ向けに教育する。
－災害を受けやすい地域社会に対して避難計画を作成し、教育する。
－各種マスコミ媒体を利用して災害に対する弱さについて一般住民の認識を深める。
－自然災害に対する予行演習を強制化する。

b. 災害低減のための暫定的処置

危険な状況または場所が分かっている場合、これに対応して(とくに差し迫った状況の予測及び/またはそれに対する警報に対応して)数多くの緊急方策が計画され、実行されるのがふつうである。これには次のものが含まれる：

－２４時間ＴＶ放送
－災害に対して弱い地域での住民と財産の避難
－貯水池にたまっている水の予備的放出
－漁船と外洋航行船の出入港禁止処置
－洪水対応隊と民間防衛隊と国、県、自治体及び郡の災害防止と対策本部のスタッフを待機状態に置く。

7．水質保全対策

7．1　はじめに

過去３０年間、６段階の５ヶ年経済社会開発計画の進展により、韓国は急速な経済成長と生活水準の向上をみた。しかしながら急速な工業化と都市化は、深刻な環境問題である水質汚濁をもたらした。

各種発生源からの水質汚染の増加にもかかわらず、最近まで下水道施設の建設は制限されている。多くの都市ではいまだ十分な下水道施設を有しておらず、下水道普及率も低い。先端産業では近代的な下水道処理プラントを有しているが、これらの処理機能が受け入れられていない。

韓国は水資源に乏しい。年間の降水量は世界の標準を上回ってはいるが、年間総雨量の３分の２が約４カ月の期間に集中しているので、雨の降らないときは水質汚濁が深刻となる。その反面、降雨期には表流水が洪水となって海へ流れ出す。

この問題に対処するために巨大なダムを多数作って流水を貯留し、洪水を防ぎ発電に資する事が行われている。しかしながら、人口湖では長期にわたって水を蓄えておくため、水質低下の深刻化、貯水の富栄養化が問題となってきた。水質汚濁は当初、主に大都市の近郊や工業生産地域で問題となっていたが、そのうちいたるところで水質問題が出始め、今や全国的なものとなっている。

最近、韓国では飲料水に下水が混入するという事態が発生するに及んで、環境問題は政府、官公庁が重大な関心を持つところとなった。このような状況をふまえて、ここに韓国における水質汚濁の現状及び水質改善に対する今後の方策を述べる。

［7．2～7．6　省略］

８．今後議論したい課題

第１回会議及び第２回会議のプログラムからみて、本会議について以下の事項を提案する。

８．１　会議の開催期間

第１回会議の開催期間は２週間で、第２回会議は３週間であった。各機関の責任ある地位の者が海外に滞在するには長すぎる。会議スケジュールの調整を行うことを勧めたい。１つの案としては、７～１０日間が、従来の国際会議と比べて妥当な期間だと思われる。

８．２　プログラム構成

本会議の現プログラムは、主として 1)カントリー報告、2)特定課題討論、3)視察旅行の３部門より構成されている。

８．２．１　カントリー報告

現カントリーレポートのフォーマットは、第１回あるいは第２回会議の資料としては、十分なものである。しかし次回の会議には、それを修正することを提案する。というのは、カントリーレポートの大部分が繰り返されているからである。ある特定の関心分野に絞ったレポートが良いと考える。

８．２．２　特定課題討論

特定課題は、第１回会議においては災害あるいは環境に関するものであった。今後は、第１回会議のカントリーレポートで提案されている他の課題についても選択することができるであろう。また、研究投資計画あるいは研究マネージメントに関する課題が考えられる。。

特定課題の選定に当たっては、今会議中に次回の課題を討論および決定してはどうか？

８．２．３　視察旅行

８．１で述べたように、視察旅行の期間が長いように思われる。１～２の建設現場と１～２の研究所の訪問が妥当だと考える。

Ⅵ. マレーシア

マレーシア農業省灌漑排水局河川部長　Teh Siew Keat

1．マレーシアの概要

1.1　国土の概要

マレーシア国は２つの地域、即ち半島部マレーシアとサバ、サラワクの２州から成り、この２つの地域を南シナ海が５４０km隔てている。首都クアラルンプールは北緯３度１２分、東経１０１度４３分に位置する。国土の総面積は 329,758km²である。面積 131,598km²の半島部マレーシアは、北はタイと、南はシンガポールと国境を接し、面積73,711km²のサバ州とおよそ 124,449km²のサラワク州はインドネシア領カリマンタンと接している。半島部マレーシアは北のペルリス州から南のジョホール海峡まで７４０kmにわたっている。サバ州はおよそ４３０km、サラワク州はおよそ７６０kmにわたっている。図－１を参照されたい。

1.2　地形

地形的特徴としては、半島部マレーシアは中央に山脈がありそれを沿岸の平野が囲み、総面積の半分以上が海抜１５０m以上である。河川は殆ど全部この主山脈から始まり、マラッカ海峡或いは南シナ海へ流れ込んでいる。サバ州とサラワク州は主に沖積層平野から成り、なだらかに起伏しながら次第に高くなり内陸の山脈に達している。海岸近く平行に連なるクロッカー山脈がサバ州を２つの地域に分けている。サラワク州では、幾つかの山脈が同州とインドネシアを分けている。サバ州で最大のキナバタンガン川は内陸高地を分け北西海岸へ流れ込む。サラワク州では、マレーシア最長の川であるラジャン川が中央山岳地帯から発し、海岸線の南部に広大な氾濫原を発達させている。マレーシアの河川の上流部は比較的短く勾配が急であり、下流は平坦に蛇行している。半島部マレーシアの西岸沿いでは、勾配が非常に緩い幾つかの川が広大な潮湿地及び淡水湿地を発達させている。東海岸の湿地は浜堤が排水を妨げている所で発達している。多くの小河川はこれらの湿地へ流れ込んでいる。

1.3　気候

マレーシア国は赤道地方の気候に属し、気温と相対湿度が常に高い。毎月の平均気温は一年中殆ど変わらず、沿岸の低地では２５°Ｃから２８°Ｃである。毎月の平均相対湿度は通例高く、７５%から９０%である。雨は主に南西及び北東のモンスーンが吹く間に降る。北東モンスーンは１１月から２月にかけて半島部マレーシア東岸、サバ州東部、サラワク州西部に雨をもたらし、南東モンスーンは５月から８月にかけて半島部マレーシア西岸に吹く。局地的雷雨は年間を通じて起こり、特に４、５月と９、１０月のモンスーンとモンスーン間の月には非常に激しいことがある。平均年間降雨量は半島部マレーシアで 2,420mm、サバ州で 2,630mm、サラワク州で 3,830mmである。

1.4　人口

マレーシアの人口は1992年現在 1,860万人であった。人口の約８２%が半島部マレーシアに住み、１０%がサラワク州に、８%がサバ州に住んでいる。全国民の内、マライ人とその他の先住民グループが６１%を占め、中国人が３０%、インド人が８%、その他の民族グループが１%足らずを占めて

いる。平均年間人口増加率は 2.6%で推移してきた。

半島部マレーシアの都市部の人口は1990年現在６５０万人と推定されており、都市人口は年率およそ 4.3%で増加している。2000年までに半島部マレーシアの都市部の人口は 1,070万人に達すると予測されている。サバ、サラワク両州についても都市部への人口流入の傾向が見られ、それぞれ 6.1%と 4.3%の率と推定されている。

人口の男女比は女性 1,000人に対して男性 1,020人である。１５歳以下の人口は３７%、６０歳以上の人口は６%を占める。

1.5　経済と社会

1957年にマレーシアが独立した当時、半島部マレーシアは世界最大のスズ産地、世界第二の天然ゴム産地であった。サバはその経済の大部分を木材に依存し、サラワクは石油、ゴム、こしょうに依存していた。これらの商品を支配する立場にあったことはマレーシア国繁栄の源泉であり、この繁栄をマレーシア国は享受し第三世界各国の中で抜きんでた存在であった。同時にマレーシア国は、特にスズとゴムの世界市場の変動に翻弄もされた。これを克服するために歴代政権は独立以来農業部門の経済を多角化し、特定地域の工業化を促進してきた。工業化傾向は1990年代に特に顕著であった。

国家経済開発において政府は直接的、間接的に指導的な役割を演じる。一連の５か年計画と1971年以来の新経済政策（ＮＥＰ）に従って、経済発展への道筋は既に示されている。ＮＥＰは第二次マレーシア・プラン（1971年から1975年）の導入と同時に発足した。これには、「人種に関わりなく所得水準を高め雇用の機会を増やすこと」と、「経済的機能の人種による特定化を減らし最終的には除去するために、経済的不均衡を正してマレーシア社会の再構築を促進すること」により、貧困を軽減して最終的には根絶するという戦略が明言されていた。これらの目標達成の期日は1990年とされていたが、ＮＥＰの根底にある概念は、最近策定された国家開発政策に受け継がれている。

1988年以来マレーシアは８%を超えるＧＤＰの成長を伴う経済拡大を享受してきた。これは1993年も継続するものと期待されている。1992年度の輸出構造を第２図に示す。一人当たりのＧＮＰは1991年の 6,796ＲＭから1992年には 7,554ＲＭに増大した。1993年には 8,318ＲＭに増えると予測されている。

マレーシアの労働力はおよそ７５０万であり、この中１８３万人が農業に従事し、１４５万人が製造業に、８６万人が政府部門に従事している。失業率は1991年の 4.3%から1992年には 4.1%に低下し、1993年には更に 4.0%に低下すると予測されている。

2．マレーシアの公共事業の現状

2.1　国家開発政策（ＮＤＰ）

国家開発政策は、貧困を根絶し社会を再構築することにより、バランスの取れた開発を達成することを目的とする。全マレーシア国民の経済活動の本流への参加を可能にするための公平な成長を重視する国家開発政策は、政治的安定と国民の統一を確実にする。ＮＤＰは下記を包含する。

1)　経済成長の目標と公平のバランスを最適にすること
2)　最適な成長のため互いに補足しあうことが出来るよう、経済の主要部門のバランスの取れた発展を確実にすること
3)　国内の社会的経済的不公平と不均衡を軽減し最終的に除去して、全マレーシア国民が経済成長の利益を公正でより公平に分かち合うことを促進すること
4)　州間、都市と農村間の経済発展の大きな隔たりを縮小することにより国民の統合を促進・強化すること
5)　全市民がより大きな物質的繁栄を享受することが出来、それと同時に明確な社会的精神的価値観を持ち、国民としての誇りと意識を高揚させる、向上する社会を作ること
6)　構築目標を危うくすることなく産業開発における挑戦に対応しうる、生産的で規律ある熟練労働力の創造を含む人材開発を、長所と卓越を伸ばすことを通して促進すること
7)　科学技術を社会経済的企画・開発の不可欠の構成要素にすること。これは戦略的で知識に基づくテクノロジーの能力を確立し近代的産業経済確立の過程において科学技術の振興を促進することを伴う。
8)　経済開発を続ける中で、マレーシア国の発展を長期にわたり持続可能とするため、環境と生態系に対して十分に配慮すること

2.2　建設投資の予算

第６次マレーシア・プラン（1991年から1995年）に基づき、運輸通信部門に 108億3,200 万ＭＲが配分されている。これはインフラストラクチャー設備に対する需要の増加を満たすためのインフラストラクチャー・ネットワークを改善するという目的に沿ったものであり、連邦政府の予算総額の19.7％に相当する。この中、75億8,500 万ＭＲが道路と橋の拡張と改良に使われているところである。車両購入、複線化、信号・通信システムの近代化のため、13億8,600 万ＭＲがマレーシア鉄道に配分されている。新空港建設と既存空港改善のための予算は総額９億9,700 万ＭＲとなるであろう。

水資源部門へは総計40億8,300 万ＭＲが配分される。この額の大部分である23億500 万ＭＲが水供給方式の開発と改善に向けられる。下水道開発向けは12億4,800 万ＭＲに増額される。治水には合計５億3,000 万ＭＲが配分されている。

エネルギー部門では、ＰＥＴＲＯＮＡＳとＴＮＢの開発支出の大半は内部資金から供給されている。しかし９億7,900 万ＭＲが連邦政府から配分されており、その中７億6,500 万ＭＲが農村地域の電

力開発向けである。ＰＥＴＲＯＮＡＳは石油・ガス部門に 108億ＭＲの予算を計上している。主要プロジェクトへの投資額は次の通りである。マラッカの精油プロジェクトに42億6,000 万ＭＲ、ビントゥルのＬＮＧプラント拡張に16億5,000 万ＭＲ、石油化学プロジェクトに14億8,000 万ＭＲ。Tenaga Nasional Berhad は主として発電、伝送、配電ネットワークに約１１０億ＭＲを支出している。

2.3　土木分野における公共事業関連組織

公共事業省	：	道路、幹線道路
		空港
		港湾
		水供給
農業省	：	洪水調節（治水）
		河川管理
		海岸保護
		治山
		農業インフラストラクチャー
		都市幹線排水路
エネルギー電気通信郵政省	：	電力供給改善
住宅地方行政省	：	下水道
		公園、緑地
		都市基幹排水設備
保健省	：	公衆衛生設備
運輸省	：	鉄道

2.4　水資源開発と治水の歴史・整備状況と課題

水資源

マレーシアでは平均年間雨量はおよそ 9,900億m^3であり、この中 5,660億m^3は地表水となり、640億m^3が地下水を補充し、残りは蒸散して空気中へ戻る。5,660 億m^3の地表水の内訳は、1,470 億　が半島部マレーシア、 1,130億m^3がサバ州、 3,060億m^3がサラワク州である。

マレーシアにおける水資源の主な用途は家庭用及び工業用水、潅漑、水力発電である。計画的な水の供給は、全ての主要な町に水処理プラントが建設された1800年代初頭に開始された。1959年、クラン川上流にダムが建設され、首都クアラルンプールに最初の主要な水供給施設が出来た。1990年までに、都市人口の９６%、農村人口の６６%が水道利用可能になっており、総水供給能力はおよそ7900 Mld であった。全水供給量の９７%が河川を、残りが地下水を源としている。

1900年代初頭からマレーシアの河川は大規模な米栽培のための潅漑用水の供給を開始した。1960年以降多くの米穀倉地帯が開発され、潅漑設備は進歩した。マレーシアでは農業設備は必ず統合的に供給されるが、これは潅漑設備の他に農道や農民開発センター等の施設も同時に供給されるということ

を意味する。今日マレーシアは米生産に関する国家政策に従い、米の自給率は７０％である。

上水及び潅漑用水の需要量は下表のとおりである（１０億㎥／年）。

Year	Water Supply	Irrigation	Total
1980	0.8	7.4	8.2
1993	2.0	9.6	11.6
2000	4.8	10.4	15.2

2000年においても、マレーシアの水の総需要量は利用可能な水資源に比べて小さい。しかし人口が稠密な地域やムダ潅漑計画などの特定の米生産地では水の非常事態を経験したことがある。これは主に降雨の分布が時間的にも場所的にも不均一なことと、国内のインフラストラクチャー整備が不十分なことによるものである。

水力発電については、1930年に能力27,000kWの水力発電所が初めてチェンデロに建設された。以来多くのダムが建設され国民のエネルギー需要を河川が支え続けている。今日水力発電は国内のエネルギー全生産量のおよそ四分の一を占めている。

洪水調節（治水）

洪水は水資源の負の面である。洪水問題の大部分は、氾濫し易い海岸地域や内陸の谷に人口が集中し居住地域が発達したことによっている。森林の農地への転換と急速な都市化が多くの場合洪水の状況を悪化させている。洪水による被害額は、こうした氾濫し易い地域が繁栄し富が増すにつれて増大した。氾濫し易い地域は1982年現在29,000㎢と推定され、これは国土総面積の９％に相当する。この数字は、洪水軽減プログラムの実施や多くの水力発電用ダムー治水の目的にも適うーの建設により縮小している。クアラルンプールやその他の広大な地域が激しい洪水に見舞われた1971年の洪水の後、洪水を減らし農村と都市の洪水による損害を軽減するための予算配分が増やされ、洪水軽減措置は体系的に向上した。洪水軽減のための支出は、第二次マレーシア・プラン（1971年から1975年）の下での1,400 万RMから第三次マレーシア・プラン（1976年から1980年）の下での 5,600万ＲＭへ、第四次マレーシア・プラン（1981年から1985年）の下での１億4,100 万ＲＭ、第五次マレーシア・プラン（1986年から1990年）の下での１億4,200 万ＲＭへと増大してきた。第六次マレーシア・プラン（1991年から1995年）の期間には都市域と農村地帯の洪水軽減プロジェクト実施のために総額５億3,000万ＲＭがＤＩＤに配分されている。

2.5　実施中の主要なプロジェクトー（クアラルンプール洪水軽減プロジェクト）

大きな災害をもたらした1971年１月の洪水の後、政策を策定し全国の洪水軽減工事の実施を監視するため、常設治水委員会が設置された。「クアラルンプール洪水軽減」は、連邦政府が潅漑排水局を

通して行った最も初期の河川工事プロジェクトの１つであった。このプロジェクトは下記の要素から成る。

（i）ダム建設

洪水調節（治水）と水供給を目的とする、現クラン・ゲート・ダムの拡張と、バトゥ川及びゴンバク川の上流集水域に２つのダムの新設。

（ii）河道改修と護岸工事

現クラン、バトゥ、ゴンバクの各川の延長およそ４７㎞の河道改修により１００年洪水に備える。

（iii）都市排水工事

鉄砲水を軽減するための、クアラルンプール首都圏内の既存の都市排水システム約３６０㎞の改修と幹線排水路の新設。

クラン・ゲート・ダムの３m嵩上げ工事は1980年に完成し、クラン川上流の洪水制御に効果を発揮した。バトゥ・ダムの建設は1987年に完成した。ゴンバク・ダムの建設案は取り止めになり、採掘跡地の池を利用した洪水調節池案がそれに代わった。市中心地内のバトゥ、ゴンバク、クランの各川の河道改修は1978年に着手され、現在までに２億1,000 万RMを支出しておよそ３０%が完成している。

このプロジェクトの費用は概算７億6,000 万RMである。プロジェクトは2007年に完成する予定である。

４．ＤＩＤの主な研究開発プロジェクト

潅漑排水局（ＤＩＤ）は1932年の設立以来応用水理学研究に深く関わってきた。潅漑、排水、河川保全、洪水軽減、水文学、河川工学及び海岸工学を扱うからである。ＤＩＤは工学の組織であるので基礎研究は行わない。局の研究部門は1951年から活動しており、基本的水理構造物や河川港湾工事の模型実験の分野でかなりの活動を行ってきた。

しかし、各地方大学、特に国立工科大学はここ１０年間、水理学及び水資源分野で急速な成長を続けているものの、ＤＩＤでは、マレーシア全体として見てもそうであるが、複雑な研究支援業務については依然として外国の専門知識に大きく依存している。政府は国民のニーズに対応するため、国立水理研究所の設立を最近認可した。この研究所の第一の目的は、水資源プロジェクトの企画、設計、実施に必要な研究を行う専門家集団を育成することである。この研究所は、海岸工事を含む水理学分野のあらゆる活動を調整する全国的拠点ともなるものである。研究所の主な業務を下記に列挙する。

水理工学

- 水理学の研究とモデリング
- 堆積物の移動と形態学
- 河口水理学
- 水理学的構造物
- 河川工事と河川規制
- 塩水遡上
- 管路網の水理学的分析

海岸工学

- 波と海岸の力学
- 海洋学
- 沖合技術
- 港湾配置
- 浚渫技術
- 海岸浸食と防止
- 海岸地域計画

水資源管理

- 河川流域開発・計画
- 潅漑と排水
- 水文モデル
- 地下水モデル
- 貯水池設計と運用
- システム計画と最適化

水質と環境

- 水質モデル
- 海洋及び沿岸汚染
- 生態モデル
- 環境影響評価
- 処理技術

5．国際研究交流プログラム

ＤＩＤは他の機関や大学と共に国際水文学プログラムに積極的に参加してきた。このプログラムの下で下記のとおり多くのプロジェクトが実施されている。

a）水文学的過程に与える土地利用の変化
b）都市水文学
c）島しょの水文学
d）貯水池の運用
e）地下水汚染
f）河川水質監視
g）高地水文学

しかし都市水文学以外は援助供与国機関の財政支援を待っている状態であり、従って目下国内のみの関心事である。都市水文学に関する研究プロジェクトは間もなく開始されることになっており、スウェーデン国際技術経済協力事業団との協力の下で行われる。この研究の目的は、湿度の高い熱帯に位置する都市地域において、地域に適した経済的に効果的で生態学的に健全な水管理法の開発を助成することである。

6．「災害・防災」に関する取り組み状況

要旨

マレーシアの気候は赤道地方特有の気候であり、北西及び南西のモンスーンによる降雨量が多い。北西モンスーンは、半島部マレーシアの東岸諸州とサバ、サラワクの各州に大規模な洪水を起こしてきた。地殻変動が活発なインドネシアやフィリピンに囲まれているためマレーシアは地震の影響を受けることがある。

6.1 洪水

マレーシアでは洪水は頻繁に発生する。その最大原因は大雨とその結果生ずる渓流と河川の容量をはるかに超える集中的表面流水である。最近の河川の集水域で開発が急速に進んだ結果、水と土砂の運搬手段としての河川の効率が徐々に悪化し、これがしばしば洪水
の頻度と規模の増大をもたらしている。

6.2 洪水災害

地形が急峻であること、河川が短いこと、モンスーン性の大雨が主因となって洪水を引き起こし、一部の地域では毎年、洪水被害をこうむっている。１９２６年に記録上最大の洪水が発生してマレーシア半島のほぼ全域を洪水で水びたしにし、甚大な被害をもたらした。そのあと１９３１、１９４７、１９５４、１９５７、１９７１、１９７３、及び１９８３年の大規模洪水が広範囲にわたる被害をもたらした。これらの記録に残る大規模洪水による浸水区域は約２９，０００ｋｍ２ すなわち陸地総面積の約９％に達した。被害人口はおよそ２７０万である。年平均洪水被害金額は１億ＲＭと見積られている。資産価値が増大しているので、この数字はもっと大きくなるものと見られる。

6.3 洪水と灌漑排水局の洪水災害防止策

１９７１年の破滅的な洪水のあと政府は灌漑排水局の機能として洪水軽減業務を付け加えた。灌漑排水局は河川流域計画を策定するとともに、洪水軽減プロジェクトと予警報体制を実施するという責任を負うことになった。１９８０年以降、常設洪水調節委員会が農務大臣を委員長として機能し、灌漑排水局が事務局をつとめている。

6.4 対策

１９７１年の破滅的洪水のあとを受けて政府は洪水問題に対処するために幾つかの対応策を講じた。その一部を下に示す：

（ａ）常設洪水調節委員会の設置
（ｂ）洪水災害救援機構の設置
（ｃ）河川流域の調査
（ｄ）構造的対策（構造物の建設）の実行

(e)非構造的対策の実行

6.4.1　常設洪水委員会

常設洪水調節委員会は１９７１年１２月２１日の内閣決定にもとづいて設立された。その任務は洪水の繰り返し発生を防ぐための短期的対策の調査と、洪水軽減を狙いとする長期的対策の調査である。委員会は具体的な目標事項を次のように定めた：

(a)洪水調節の対策を構じ、洪水の発生頻度を減らす；

(b)万一、洪水が起こった場合は被害と人命と資産の損失を最小限に抑える。最初、委員会の委員長は情報大臣としての特命大臣がつとめ、事務局は首相府の社会経済調査計画部がつとめた。しかし１９８０年に洪水軽減という業務は農務省の灌漑排水局に任され、事務局は農務省に移された。

6.4.2　洪水災害救援機構

この機構は洪水被害者に対する救援を秩序正しく効率的に提供できるよう、救援のための連邦、州、及び地区レベルでの諸活動を調整することを目的として設立された。全体としては救援活動の調整は自然災害救援委員会が責任を負っている。自然災害救援委員会の議長は情報大臣で、事務局は国家保安評議会に置かれている。同委員会は地区、州、あるいはマレーシア全土に“災害事態”を宣言する権限を与えられており、これによって復旧事業のために連邦政府から財政支援を受けるとともに運用予算としてその資金を割り振ることができる。同委員会の構成員の多くは災害発生時に避難所を提供し、救難品と食料品を提供することになる政府省庁と社会組織である。少なくとも年１回(ふつう、北東モンスーン季の前に)、同委員会は全構成員を召集して救援機構が円滑に動いていることを確認する。

6.4.3　河川流域の調査

１９７２年以降、大規模洪水の問題を抱えている河川について数多くの流域調査が実施された。これらの調査の目標は水資源開発のためのマスタープランを作成することにあり、洪水軽減対策が調査の重要部分を占めている。今日までに完了した調査の対象河川はクアラルンプール(１９７４年)、パハン川(１９７４年)、ケランタン川(１９７８年と１９８９年)、テレンガヌ川(１９７８年)、リンバン川(１９７８年)、キナバタンガン川(１９８２年)、サマラハン川(１９８３年)、バツ・パハト川(１９８４年)、ジョホール川(１９８５年)、ゴロク川(１９８５年)、ベスト川(１９８８年)、クラング川(１９８９年)及びペナン島(１９９１年)である。

長期的な水資源開発の戦略とマスタープランの必要性を認識して政府は、包括的で調和の取れたマレーシアの水資源を作成するため全国水資源調査(１９８２年)を継続してきた。

この調査にもとづいてマレーシアの洪水の被害を受けやすいいろいろな地域での長期的洪水軽減事業計画が策定された。これには８５０ｋｍにわたる河川の改良、１２個の多目的ダムの建設、８２ｋｍにわたる洪水迂回路の設置、都市中心部を囲む環状堤防の建設、及び洪水の起こりやすい地域の住民１万人の移住などが含まれる。２０年に及ぶ計画全体の予算は２５億５０００万RMと見積

られ、１８０万の国民を保護するものとなろう。

このほかマレーシアのさまざまな地区で洪水問題を軽減するために数多くの調査が実施されてきた。その一部を挙げるとクカイ洪水軽減調査、ペラク下流洪水軽減調査、カンガール洪水軽減調査、さらに下記の町の排水マスタープラン調査：バターワース、ブキット、メルタジャム、クアラルンプール、アロール・セタール、サンダカン/コタ・キナバル、ビントゥル、ジョホール・バルー、ケラングとケラング港、メラカ、クアンタン、コタバル、クアラ・テレンガヌ、ディクソン港及びムアール。

6.4.4　洪水軽減対策

各種の調査結果から、洪水問題を軽減するため構造的対策と非構造的対策の両方が提案された。構造的対策としては流路の改良、堰堤建設、洪水迂回路、ポルダーの建設、洪水貯流ダムと洪水減勢池の建設などがあり、単独に実施したものと複数の手段を併用したものとがある。

非構造的対策は工学的方法が適用不可能、または効果が小さい場合、あるいは補完的手段が必要である場合に提案された。これには開発活動の抑制、土地利用の変更、住民の移住、耐水化、洪水予警報体制などが含まれる。

6.4.5　構造的対策

構造的対策には下記のような事項が含まれる：

洪水調節ダム

洪水調節ダムはダム下流域を保護するために洪水の水を貯留することを目的として建設される。洪水調節だけを目的とする貯留ダムの建設は一般に経済的には成り立ちにくく、給水など他の目的に利用されることが多い。水力発電のためのダムもその容量の一部を洪水貯留に利用できる。

河川改修と関連工事

河川改修には水路の拡幅と深さを深くする工事のほか、堤防の表面と川底のライニング補強が含まれる。さらに川幅に対して小さすぎる橋梁のような構造物の取り替えも含まれる。こういった工事は開発行為の進行に伴なう洪水流量の増大の結果として水路の幅や深さが小さくなるので必要となるのである。

堤防建設

河川堤防は越流を防ぐとともに低地に隣接する土地への浸水を防ぐ。この対策は築堤の結果として内部排水という問題を生ずることがある。都市部に堤防を建設すると、いったん洪水が起こった場合に大きな被害を引き起こす危険性がある。

洪水減勢池

廃棄された鉱山用池などの池を洪水貯留に利用することができる。その目的は洪水水流の向きを変えてこの池を通し、流出量を規制して洪水ピークを低くすることである。

ポルダーリング(環状築堤)

ポルダーリングとは防護対象区域を取り巻くように環状堤防を設けることである。ポルダーリングはふつう、ダメージポテンシャルが大きいが、流域全体を保護するには莫大なコストがかかるような場合に採用される。ポルダーリングでは保護対象区域に内部排水を設けること、川に流量が多いときは水をポンプで汲み出すことも合わせて行われる。

上述したような構造的洪水調節対策を用いるという戦略は洪水調節に効果があることが立証され、市街地ではふつう、利用可能な唯一の選択肢である。しかし構造的対策はふつう、ハードな工学的対策であり、出来あがる水路は大きく、したがって流量も増える。それゆえ建設費が高くなるとともに必要な水路用地もかなり大きくなる。

6.4.6 非構造的対策

洪水の被害を受けやすい区域での開発活動の抑制

洪水の被害を受けやすい区域であって構造的対策が経済的に成り立ちにくいところでは開発行為を規制することによって資産と工事及び公益事業に対する被害、ならびに人命の損失を最小限に抑え、あるいは避けることができる。この観点からマレーシアはパイロットプロジェクトとしてクラン川上流域について洪水危険性地図の作成に着手した。

土地利用の変更

作物被害を軽減する１つの対策は農地の用途を被害を受けにくい作物に転換することである。たとえば水田をオイルパーム栽培地に変えることである。

住民の移住

洪水被害を受けやすい地域であって構造的な対策があまり効果的でないところで被害と人命の損失を軽減する有効な方法の１つは住民を移住させることである。１９７１年以降、ケランタン州とパハン州にそれぞれ１，６７２家族と２，７１５家族が移住した。

耐水性

この対策は洪水の水が個人の住宅や特定の場所に侵入するのを防ぐために予防工事を行なうことである。そのためにたとえば建物を堤防で取り囲み、洪水の際にも冠水を防止して洪水被害を軽減する。

洪水予警報体制

洪水予報と警報体制を整備することは洪水被害を最小限に抑えるための重要で、実際的で低価格の方法である。洪水予報が早い段階で発せられれば洪水被害を受けやすい地域の住民が洪水が来襲する前に持ち物とともに避難できるよう警報を出すことが可能となる。これにより洪水被害を大幅に減らすことができ、なかんづく人命の損失を減らすのに役立つ。１９７１年の洪水のあと、遠隔計測予報システムが時折大規模洪水に見舞われる下記の場所に設置された：ケランタン、ペラク、サドング、キナバタンガン、クラング、テレンガヌ、ベスト、ダンガン、及びジョホール。これに類似したが最近ジョホールのムアール川流域に設置された。これ以外の２０の河川系にも設置することが計画されている。

狭い流域にはＶＨＦ洪水予測システムが設置された。突発的出水を起こしやすい流域では警報を効果的なものとするためのリードタイムが短い。したがって洪水水位が危険な高さに達したときに自動的に起動する洪水警報サイレンがそういう河川の重要地点に設置された。これが地元住民に洪水が差し迫っていることを知らせる。

１９８０年以降、洪水警報板が主要な河川系に設置されている。この警報板に記されたレベル上流にある観測所における水位と連動している。警報板は、下流の被害を受けやすい村に設置され、村の住民はラジオ放送、村長や警察からの情報を受けて自分で状況を把握することができる。

6.4.7　健全な流域管理と開発管理体制の採用

洪水に“直接的に”対処するためにこれまで多大の努力が払われてきたが、その一方で“間接的な”観点に立つ洪水被害を軽減する先行学習的方法は流域管理と開発管理である。大雨から小雨まで洪水を抑制するには効果のある方法である。

関連省庁間で効果的な調整を具体化するよう、マレーシア政府の機構が設けられた。それは首相府の中の経済計画部で、これがあらゆる局面の調整を図るとともに水に関するプロジェクトの立案と実施のすべての段階において調整を図る。地方政府省は構造計画の策定に先立ってその自治体議会または市役所を通じて公共機関と民間組織及び個人の参加、意見、見解を求める。排水マスタープランが構造計画の詳細を取り入れて作成され、灌漑排水局の洪水軽減総合プロジェクトの中に取り込まれる。

１９７７年に全国植林政策が国家植林評議会によって採用された。同評議会の業務は植林方法を調整し、統一化することである。この植林政策は技術開発政策と、とくに植林研究と森林の開発と管理のための戦略の基礎となっている。

6.4.8　マレーシアにおける地震の危険性

マレーシアはサバ州とサラワクの東端部を除き、その大部分は地殻的に安定なスンダ大陸棚の東端と西端に沿って位置する。しかしマレーシア半島の西海岸地区はスマトラ区域を震源地とする大きな地震の影響を受ける。一方、サバ州は中程度に地震活動が活発である。小規模ないし中規模の大きさの局部的地震が過去に何度も発生している。大規模地震

によって石造壁に中規模の亀裂が発生し、地面に幅の狭い割れ目を生じた。
国の経済が急速に発展するにつれて、高層建築物、大型発電所、橋梁、ダム、そのほかの危険な設備の数が増えてきた。人口集中のせいもあって地震による危険性は時間とともに着実に増大するものと予測される。
多数の地震観測所がマレーシアの地震活動を監視するためにマレーシア気象局によって設立された。

6.4.9 地震の危険性を軽減するための戦略の種類

マレーシアは地震の脅威にさらされている国である。そのための最良の解決策は備えを怠らないことである。そのためには国を地震の危険度にもとづいてゾーニング(区域分け)すること、建物の設計と建築に耐震性構造を取り入れること、そして地震の被害に強い構造を取り入れることが必要である。実施すべき戦略としては地震規則の取り入れ、土地利用計画と規則、及び災害計画が必要である。遠い地震の長い時間にわたる余波に最も弱い大都市と土木工事プロジェクトに対して地震危険度管理を行なうべきであろう。
マレーシア気象局は地震観測所をペタリン・ジャヤの局本部のコンピュータシステムをダイアル電話回線で結ぶ事業を推進している。これにより地震の震央値はただちに決定され、必要な救難活動を即座に開始することができる。

7．「環境と社会資本整備の調和」に関する取り組み状況

7.1 要旨

急速な都市化と工業化の直接的・間接的結果、マレーシア国民は多くの環境問題に直面している。その中には大気汚染、水質汚染、騒音がある。自動車、工場、焼き畑の排気により大気は汚染されている。主に家庭及び家畜の排出物などの下水の不適切な処分、工場からの重金属の排出、土地開墾や道路・住宅建設、鉱業、木材の伐り出し、一部の無秩序な開発から生じる沈泥により、河川水は汚濁している。

[7.2～7.6 省略]

８．今後論議したい課題

マレーシアにおいては、河川工事の主要な目的は洪水の軽減と、河川が期待される役割を果たすことを持続的に可能にする総合的河川管理である。河川の役割とは、水資源、自然排水、航行、漁業、レクリエーション、生態学的・歴史的・文化的財産としての役割である。これは他の参加国にも共通する事柄であると考えられる。従って下記の関連課題を論議の課題として提案する。

（ａ）洪水調節（治水）

都市化が河川の氾濫に拍車をかけている。さらに都市地域では、洪水による損失が大きくなる可能性があるため、高水準の洪水防護がしばしば必要になる。下記に関する論議が求められる。

（i）雨水の保水

（ii）計画規模

（iii）都市河川の管理、特に浚渫

（ｂ）水資源管理

水資源は限られている。需要は急速に増えており、各利用者間の競争や、各行政区域間の水資源需給の不公平をもたらしている。流域間、州間、さらに国際間の水の移転、関係機関の役割と関係、連邦－州の参加、これらは留意を必要とする事柄である。マレーシアには水資源開発のためのかなり効果的な調整・実施機構が存在するが、法律の改正の必要が認識されている。しかしまだ実現を見ていない事実が問題の複雑さを示している。

（ｃ）河川環境の向上

持続可能な開発は広く受け入れられた目的となっており、国家環境政策に反映されている。河川環境の場合、持続ではなく改善の問題であることが非常に多い。従って、河川環境の向上にも努力すべきである。２つの面が論議の対象となる。

（i）国民及び民間部門の参加なしには政府のいかなる努力も十分ではない。これは、河川に対する積極的態度を教え込む等、法律の行使を越えた問題である。皆（政府、民間部門、個人）による河川の保護を目的とすべきであるが、それにはどうするのが最も良いか。

（ii）ダム、堤防、運河や制御施設等の河川建造物の機能的側面ばかりでなく、景観や美化施設、生態学的配慮を取り入れ、環境に優しいデザインを実現することは可能である。この概念を参加国がどのようにして実践するか。

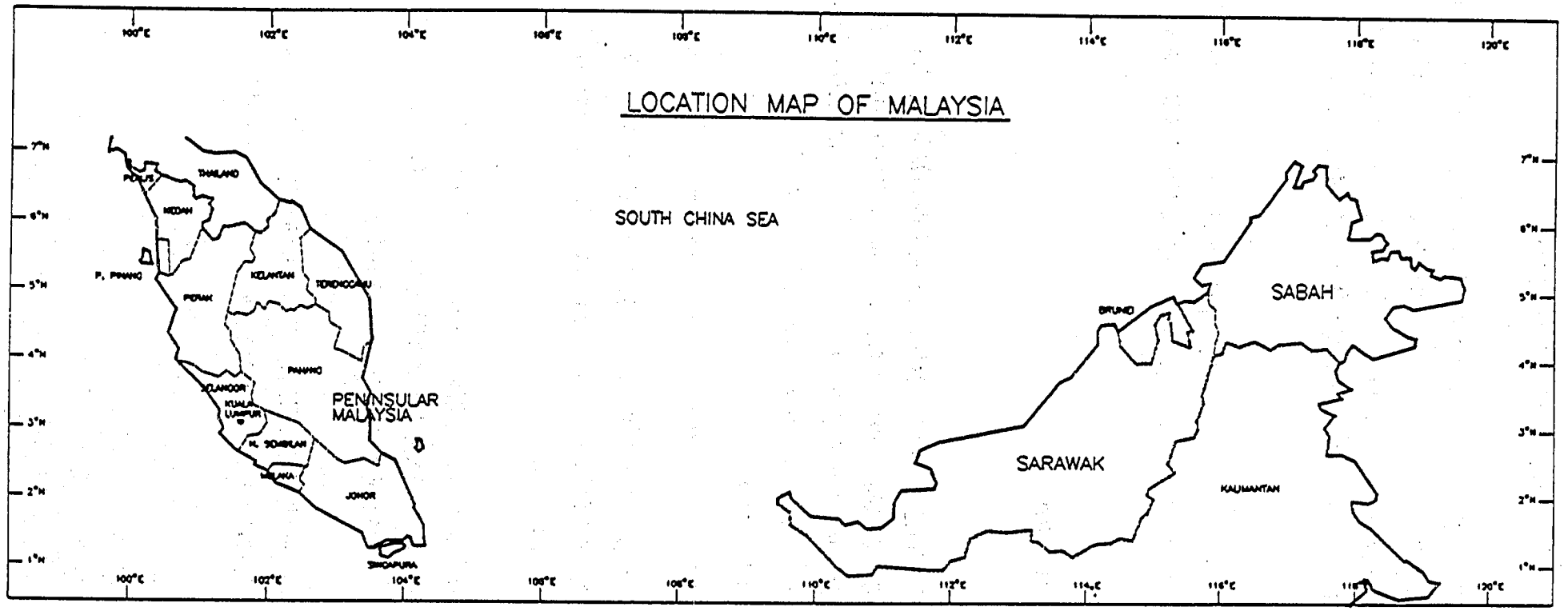


Fig. 1 : LOCATION MAP OF MALAYSIA

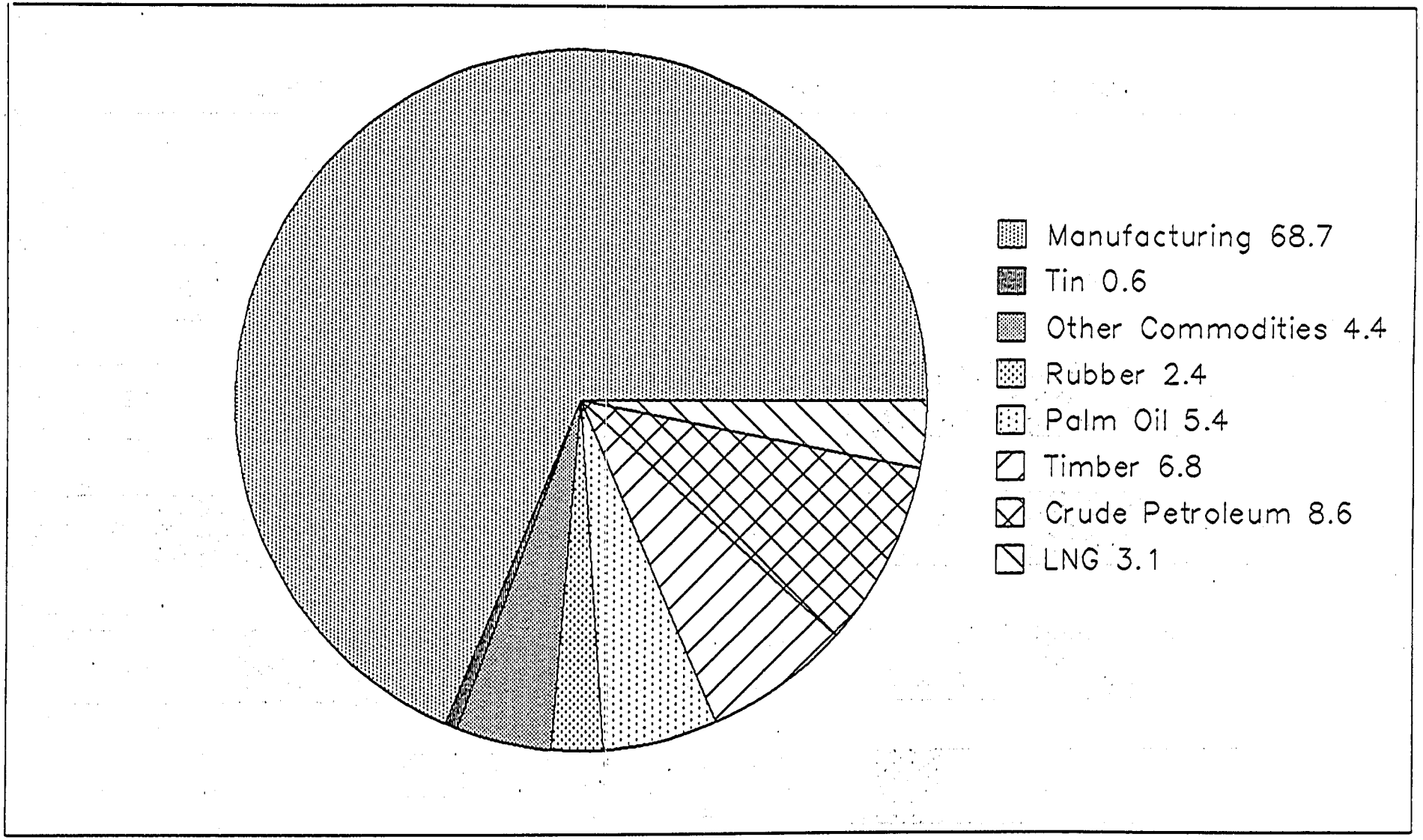


Figure 2 : Export Structure For 1992

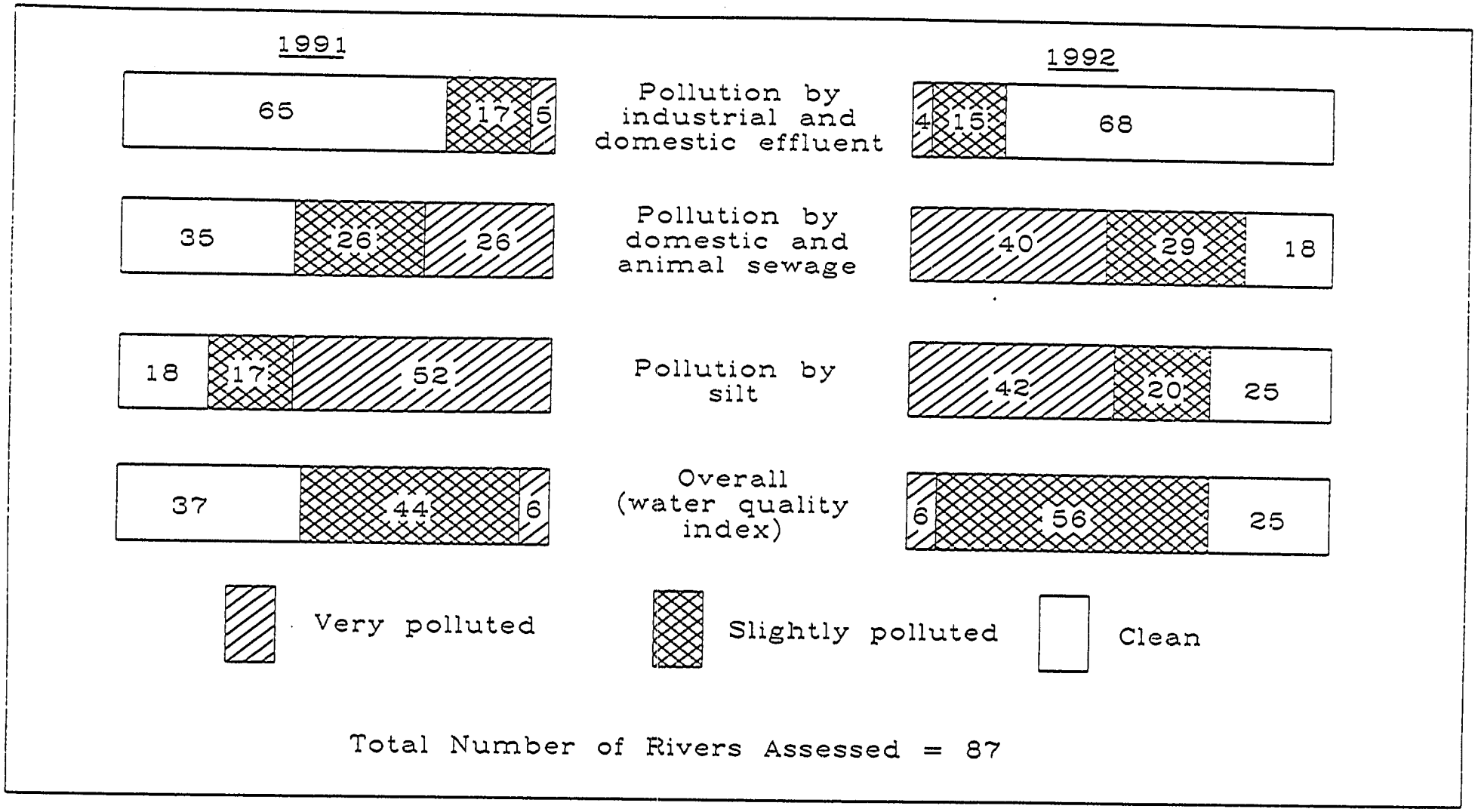


Figure 3 : River Water Quality, Malaysia, 1991－1992

Ⅴ．フィリピン共和国

フィリピン公共事業道路省研究基準局長　Jose H. Espiritu

1．フィリピンの概要

1.1. 国土の概要

フィリピンは約 7,100の島から成り世界でも最大の群島の一つである。北緯4 度23分と北緯21度25分間，東経116 度と127 度間のアジア南方966 キロメートル沖に位置している。

同群島南北の最大距離は約1,851 キロメートル、東西約1,107 キロメートル、西は南シナ海に東は太平洋、南はスル海・セレベス海、北はバシー海峡に接している(図－1 参照) 。最北端の島々は台湾の南約240 キロメートル、最南端の島々はボルネオの北約24キロメートルの所にある。

国土の総面積は約30万平方キロメートル、その92.30 パーセントを最も大きい11島で占めている。フィリピンは主要な3 群島に分けられる。ルソンは面積約14万1,395 平方キロメートル、ビサヤ約5万6,606 平方キロメートル、ミンダナオ約10万1,999 平方キロメートルである。これらの3 群島はさらに地区に分かれ、地区はさらに州に、州は市、町に、また市町はバランガイ（村）に分かれる。首都はマニラである。

フィリピンはそびえ立つ高地と数多くの谷からなる変化に富んだ地形をしている。また、4 つの主要な低地平原がある。ルソンにあるセントラル平原とカガヤン峡谷及びミンダナオのアグサン峡谷、コタバト峡谷である。これらの低地は隣接する高い山脈と著しい対照をなしている。またミンダナオ島にあるブキドナンやラナオ高原の存在は多様な地形に一層彩りを添えている。

フィリピンはまた世界で最長の不連続の海岸線を有している。その広範囲にわたる海岸線には良港、航行可能な河川や湖が点在している。73の州には61ヶ所の自然港と雨期には 3倍にも大きくなる小河川を除いて132 本の河川がある。

1.2. 気候

同国の気候も山脈や高原のために多様である。気候の違いは主に、一般的な気流、群島の位置、最も一般的な嵐の通り道などの結果として起きる局所気流に左右されている。

この国の気候は雨量、乾期の有無、雨期の長きなどに基づき，次の4 つのタイプに分けられる。

第1 タイプ: 11月から4 月の乾期、その他の月間は雨期という際立った2 つの季節を有する。

第2 タイプ: 乾期はなく、最長雨期は11月から1 月までの雨期を有する。

第3 タイプ: 季節の差はたいしてなく、11月から4 月までが比較的乾燥しており、あとの月間は湿度が高い。雨期は明確でないが、１ヶ月から３ヶ月の短い乾期がある。

第4 タイプ: 雨が年間を通じて程度の差はあるが大体むらなく降る。

1.3. 人口

総人口は1980年の4,830 万人から1990年には6,067 万人に増加し、さらに1995年には6,641 万5 千人に増えると見込まれている。

人口は南部タガログとマニラ首都圏に集中しており、それぞれ総人口の12.72 パーセントと12.

32 パーセントを占めている。年間増加率では次の6 つの地区で国の増加率2.71パーセントを上回っている。西部ミンダナオ(4.31 パーセント)、南部ミンダナオ(4.28 パーセント)、北部ミンダナオ(3.58 パーセント)、首都圏マニラ(3.58 パーセント)、南部タガログ(3.25 パーセント及びカガヤン渓谷(2.76 パーセント)である。これらの地区での高い人口増加率の原因は主として移民の増加によるものである。これらの地区と対照的に最も増加率の低い地区の一つが東部ビサヤで最小の1.49パーセントである。

1980年の60都市の人口は国の人口の21.17 パーセント、約1 千19万人で1975年の数字に比較して16.68 パーセント増、145 万人増であった。1980年のフィリピンの国勢調査によると、人口密度は1 平方キロメートル当たり160.3 人で、これは1975年に比べると1 平方キロメートル当たり20.1人増え、率にして14.34 パーセント増となった。マニラ首都圏は最大の人口密度で、1 平方キロメートル当たり9,317 人で、その次に中部ルソンが263.4 人で続いている。

1.4. 経済及び社会

漁業、林業を包め、農業が、国家経済への貢献度の最も大きい産業となっている。過去20年間に農業は国家経済の総付加価値(GVA) で年平均240 億ペソを付加してきている。農業部門は1970年から19年の間に年平均約16億5,000 万ドルにのぼる輸出収入をあげており、これは年平均成長率3.5 パーセントの伸びに当たる。漁業もまた国の経済にとって大きな貢献をしており、1982年に140 億ペソから1989年には460 億ペソ以上を稼ぎ，目ざましい増加を示している。

2．公共事業の現状

2.1. 国土開発に関する基本計画

同国の開発事業について触れるに当たって、公共事業道路省（ＤＰＷＨ）では1993-1998 年の中期社会基盤整備整備計画を通じて国家の開発目標を支援するために必要な基盤整備に努めている。これらの開発目標はフィリピン中期開発計画に沿ったもので、(a) 貧困の緩和、b) 不平等の解消 (c) 生産雇用機会の創出、(d) 広範囲な人的開発及び (e) 維持可能の成長の達成などである。これらの目標は、国際競争力の追求、開発の過程でやがては福祉の向上に資することになる確固たる経済の回復及び成長を達成のためのバネとなる人材の育成を通じて実現される。人材育成の具体的戦略として，産業基盤開発の活動においてその計画策定からモニターまで男女の平等な参加を保証することが盛り込まれている。

2.2. 全体の投資水準

1993-1998 年間の社会基盤整備計画は、表1 のプロジェクト区分別の投資概要に示すように、全体の投資規模が1,672 億4,660 万ペソ、年当たり278 億7,440 万ペソを必要とするものである。

2.3. 公共事業に関する組織・機関

政府の社会基盤整備事業計画は、経済の生産的な分野を創出するために必要な物的設備を提供することから構成されており、次のような分野をカバーしている。つまり、高速道路、鉄道、空港、港、都市交通などを網羅する運輸; 飲料水の供給、下水道、衛生及び洪水制御、排水など水資源; 学校、保健施設、国家建造物、都市のコミュニティなどを包括する社会基盤; エネルギー資源開発、電力及び農村の電化などのエネルギー関連; 通信・電話及び郵便等の情報伝達など、である。

公共事業及びインフラ関連の政府機関には次のようなものがある。

1. 公共事業道路省
2. 都市上下水道システム
3. 地方水道公益行政官庁
4. 国家水資源局
5. 国家潅漑行政官庁
6. 交通・情報伝達省
7. フィリピン港湾当局
8. フィリピン国営鉄道
9. エネルギー省（新設）
10. 内務省及び地方行政府
11. 教育・文化省
12. 国家住宅局

2.4. 主な社会資本整備の歴史・整備状況と課題

1987年から1991年までの間、フィリピンのインフラ部門は生活向上及び経済成長の維持のための基盤・支援設備の増強に重点を置いてきた。地方に基盤をおく小規模のプロジェクトや既存の施設・設備の保守・改修を優先させてきた。政府は、資金の活用やプロジェクトの執行管理を促進するために幾つかの対策を打ち出した。これらのなかには、計画・プロジェクトの実行と監理のそれぞれに地方政府機関(LGUs)や民間組織(NGOs)の参加をさせることも含んでいた。インフラ開発には特にビルド・オペレーター・トランスファー(BOT) や関係計画を通じて活発な民間部門の参加も奨励された。

一般的に、インフラ部門の開発努力は、現在も未解決になっている次のような幾つか主要な問題によって妨げられている。

- インフラ計画、政策、プログラム、プロジェクトの実行に於いて政府機関/ 地方政府機関間での不十分な調整。このために、事業遂行の未達成、プロジェクトや既存の施設・設備のまずい運営・保守(O & M) といった結果につながった。
- 資金投資やO & M 経費財源の提供に於いての財政的制約。
- プロジェクトの準備不足とプロジェクトの実行に影響する環境や地域社会の問題解決のた

めの明確な手続きの欠如。さらに、

・　自然災害によるインフラ設備への広範囲の損害。

2.5.　実施中及び計画中の主要プロジェクト

2.5.1.　進行中のプロジェクト

・　マニラ周辺道路3号線(C-3)プロジェクト。16.8km(3億2250万ﾍﾟｿ)。1987-1994 の間で84.9パーセント完成。

・　西レイテ及び北西レイテ道路改修工事。198.0km(8億7620万ﾍﾟｿ)。1990-1993 の間で24.0パーセント完成。

2.5.2.　提案中(計画中) のプロジェクト

・　マリキナーインファンタ道路。132.9km(6億8280万ﾍﾟｿ)。1994-1998 年予定。

・　スリガオーダバオ沿岸道路。545.0km(37億4250万ﾍﾟｿ)。1994-1998年予定。

3．公共事業道路省研究基準局（ＤＰＷＨ／ＢＲＳ）の概要

3.1　公共事業道路省（ＤＰＷＨ）の公共事業の研究開発所轄部署は研究基準局（ＢＲＳ）である。

3.2　研究基準局（ＢＲＳ）は、行政通達124号のもとに公共事業道路省が再編された1987年に創設された。その任務は国のすべてのインフラストラクチャー施設・設備の安全を確保するとともに、政府の公共事業の効率を良くし高い品質を保つため効率のよい基準や適切なガイドラインを設けることである。この業務を達成するためにインフラストラクチャー開発に係わるすべての主要分野に於いて研究開発に当たることになる。

3.3　研究基準局の組織概要については別添図を参照。

3.4　同局は局長を筆頭として全部で167 名の人員を擁し、土木技師を主体とする6 つの技術部門を抱えている。この他、化学技術者、化学者、統計担当者、地理担当者、実験技師などの職務がある。同局の部門・職務の人員配備の内訳は別添を参照。

3.5　同局の総予算は1993年度で2,336 万2,300 ペソ。この内訳は別添図を参照。

3.6　公共事業道路省の研究開発活動では、まず研究基準局が同省のすべての現場部署、技術支援部署をカバーした必要性調査を行う。この詳細な調査の提言は次のような評価基準に照らして優先順位が決められる。

1.　そのプロジェクトの緊急性・必要性

2. 期待される成果を達成するための成功の見込み(リスク要因)
3. そのプロジェクトによってもたらされる利益
4. 技術革新

優先順位が決められた調査プロジェクトは公共事業道路省事務局に提出され承認が求められる。承認されると、そのプロジェクトの財源が検討され政府や政府以外の財源から割り当てられる。引き続いてパイロット・プロジェクトが実施され、実際の仕上がりがモニターされ評価される。この結果は各種の公共事業道路省関係機関にガイドライン、省通達、その他の通達様式で配付される。

3.7 研究基準局の調査施設はケソン市ディリマンの公共事業道路省並びの新設ビルに配置されている。この施設には土壌、セメント、アスファルト、鉄鋼、コンクリートなどほとんどすべての種類の建設関連の材料のための試験機材が揃っている。また、最近日本の国際協力事業団（ＪＩＣＡ）や英国の運輸道路研究所（ＴＲＬ）などの無償援助により最新機器やコンピュータ、製本機、複写機などのオフィス機材も導入した。

3.8 最近の研究開発成果

インフラ関連のすべての分野の研究開発に携わるという研究基準局の任務に照らして、研究基準局では、次のような成果を挙げてきた。

a. コンクリート舗装工事におけるフライ・アッシュ使用の研究の結果、コンクリート舗装工事でフライ・アッシュを混和材として、ポルトランドセメントの20パーセントを置きかえ使用することを認める省通達を発布した。この研究は広範囲の資料調査、室内実験、長期にわたる試験の結果に基づいている。地方で調達できるフライ・アッシュを最大限使用することができるようになるとともに建設工事におけるポルトランドセメントの節約が実現した。
b. コンクリート工事で、地方で生産できるポルトランド・ポゾラン・セメントIP型の使用。この結果、建設工事のピーク時でポルトランドセメントの不足と高価格の問題が緩和された。公共事業道路省所轄の工事でこのセメントの使用を承認した省通達が出された。
c. 路面のくぼみの補修のためのアスファルト乳剤・骨材舗装配合の常温配合設計方の確立。雨期や湿度の高い季節では路面のくぼみの補修にアスファルトの加熱配合は、通常有効ではないので、アスファルト常温混合を承認する省通達が出された。
d. サブベース骨材やベースの粗骨材の代替として一般土壌用のセメントと石灰で固めた材料の使用。これで、国の一部地域で従来のサブベース骨材、ベース粗骨材が全く手に入らないかあっても非常に不足しているという事態が緩和され、豊富な地方の土壌が最大限に使用されることになった。この材料の使用の省承認通達が出された。
e. 道路基盤材として風化した石灰岩（アナポッグ）の使用。これにより、地方で入手可能な良質のアナポッグが最大限使用されることとなり、一部の地域で従来のベース粗骨材が全く手に入らないとか乏しいことによる工事の遅滞が避けられるようになった。公共事業道路省の道路

工事では、アナポッグ混合材や粒状土の使用を承認した省通達が出された。

f. コンクリート製中空ブロックへの火山灰、火山砂の使用。ピナツボ火山の噴火のために現在大変豊富にあることから、これらの材料が有益な建材として使えるかどうかが確認された。

g. アスファルト配合における有効アスファルト含有量の確立。この調査により、仕様限度内で、安定した、ワーカブルな、しかも耐久性のある配合を得るための骨材の混合、粒度はもとより骨材とアスファルトの経済的な混合比が決定された。

i. 土石流や泥流災害の鎮静化についての研究。この研究は1992年4 月に完了し、公共事業・高速道路省の所轄として、研究基準局が担当して技術ワーキング・チーム（TWG）が発足。土石流・泥流災害を早急かつ短期的にくい止め、災害地の損害を最小に止める対策が講じられた。この調査費用ではわずか100 万ペソしかかからなかったが、その成果は政府の支出が平均300 万ペソも必要な外国のコンサルタントの成果と同等のものであった。

h. 国際協力事業団（ＪＩＣＡ）やＴＲＬなど海外組織との提携。ＪＩＣＡの道路舗装専門家が道路調査・研究の技術援助を行うためにフィリピンに派遣された。ＴＲＬとは現在、劣化したコンクリート舗装の改修のための省コスト手法に関する共同調査が進んでいる。

4．主要な研究開発プロジェクト

4.1 主要な研究開発プロジェクトの名称

4.11 再生アスファルト・コンクリート使用による舗装保守・たわみ性舗装配合設計

4.12 疲労コンクリート舗装改修のための最適手順、材料の決定

4.13 コンクリート構造物への軽量骨材の使用

4.14 土石流・泥流被害の軽減のための研究

4.15 舗装工事における、サブベース材、ベース粗骨材としての多目的ブロックおよびコンクリート配合における細骨材への火山灰、火山砂の利用に関する研究

4.16 舗装工事におけるローラ転圧コンクリートの使用

4.17 アスファルト配合における海砂の使用

4.18 コンクリート混合材としての海砂の使用

4.19 アスファルト舗装におけるアスファルトの一部代替材としてのゴムの使用

4.20 道路基盤材としての砂・アスファルトの使用

4.2 実施中の主要な研究開発プロジェクト

4.21 疲労コンクリート舗装改修のための最適手順、材料の決定

4.211 背景及び行政

1992 年に研究基準局(BRS)は英国の運輸道路研究所(TRL) の海外事務所(OU)と道路舗装について共同研究プロジェクトを推進することになった。研究基準局とTRL は既に協定覚書

(MOA) を結んでいたので、同プロジェクトの成功に向けて全面的な実施協力を確認した。このプロジェクトは、現在パイロット・プロジェクトの実施に当たって、公共事業道路省の当該現場事務所の協力を得て、研究基準局の技術者とTRL から派遣された２人の専門家、ジョン・デビッド・パリイ氏とトム・ジョーンズ氏が進めている最中である。この調査は研究基準局および研究基準局が調達できない必要資材・機器を含めたて無償資金協力事業の形でのTRL の援助により資金提供がなされている。

4.212　期間

第1 段階(フェイズ 1) の完成は1994年4 月末日(テレサ、アンチポロ、リールに於けるパイロット・プロジェクトのモニタリング、評価のための一年を含む) の予定。このパイロット・プロジェクトは1993年4 月に完成し、現在施工によるモニタリング、評価が行われている。

4.213　方法

共同研究では、道路舗装の失敗の原因の追求、アセスメント及びそのような失敗を防止、もしくは最小にくい止める対策・実施計画を立室することが挙げられている。また、パイロット・プロジェクトは疲労コンクリート舗装の改修のための様々な方法が試される。

4.214　見込まれる成果

この調査が、ますます重要となりつつある疲労コンクリートの改修の問題に対処するための最も有効な対策の決定を目指す、将来への先行投資である。それぞれの改修方法の投資効果についても、この研究でしっかりした結論を引き出した上で検討されることになろう。

4.215　実施上の課題

建設資材の搬入の遅れ。地域事務所がピナツボ火山灰の氾濫を防ぐ対策に追われ、パパンガの指定パイロット部門の仕事が一時的に中断を余儀なくされている。

4.3　研究開発の実施上の課題

1. 政府の政策的支持及び信任

開発計画と同様に研究開発計画は、通常、国家の開発目的・政策の内容の枠の中で施行されるべきものである。従って、こうした活動には事業と事業目的の遂行を支援する政府の信任、政治的意志、政策が絶対的に必要である。

2. 財政

この地域で研究開発を維持するためには、実行、操業、保守および投資価値の下落をカバーするのに充分な資金の流れが必要である。乏しい資源、増大する政党の要求という現実から、資源の配分もしばしば政治の都合や経済的原理に左右される。そこで、研究開発事業も運営、保守、設備及び投資価値下落等のための資金の欠如や不足が障害となる場合もしばしばである。

3. 技術的要因

訓練や再訓練の機会や研究・開発施設が政府・民間双方で不足していること。また、この国には学校ですら特定の教育・訓練を受けることができず、訓練設備・機器も乏しいこと、及び

資金的支援が不足していること。これら技術の大部分は先進国からしか入手するしかなく、国自らがそれを得るのには大変費用がかかる。

4. 外部的要因

研究開発の計画や事業はその時点での政治的、経済的、社会文化的環境の枠内で行われ、それらはしばしば研究開発が影響を及ぼし、制御することのできないものである。政治的、経済的不安定によりしばしば研究開発の維持が阻害される。政権交代、実行機関の改編等がしばしば発生すると、インフレを招き天井知らずの予算となり、外為の不安定、主要機械やスペアー部品の購入がむづかしくなる外、国内外の物価の変動などが起こる。

5．国際研究交流プログラム

5.1　現在，公共事業道路省は研究基準局を通じて、日本からは国際協力事業団（ＪＩＣＡ）を通じて、また英国政府からは運輸道路研究所（ＴＲＬ）の海外事務所を通じて、研究開発援助を受けている。

5.11　ＪＩＣＡによる道路舗装ためのミニ・プロジェクト方式技術協力

この技術協力の目的は研究基準局（ＢＲＳ）の舗装道路の設計、建設、保守分野における技術力を研究開発分野とともに強化することである。日本政府より研究基準局へ二人の舗装専門家が派遣された。この技術協力の規模はアスファルト及びコンクリート舗装の技術移転と設計、試験、建設に関するセミナーの開催、またこのプロジェクトに携わる研究基準局スタッフの日本での訓練などからなっている。同局の調査活動を支援するために、幾つかの土壌関連の機械・装置、道具、アスファルト、コンクリートなどがＪＩＣＡから贈与された。

5.12　ＴＲＬとの公共事業道路省研究基準局との共同研究開発

研究基準局は英国の交通調査研究所（ＴＲＬ）と協定覚書（ＭＯＡ）を結び、道路調査の共同プロジェクトの実行の成功に向けて協力を確認した。同覚書に規定されているように、この共同調査は道路舗装の失敗の原因を追求しアセスメントすること、またそのような失敗を防止あるいは最小に止めるための実行可能な対策、実施計画を開発することである。また、疲労コンクリート舗装を改修のための様々な方法でパイロットプロジェクトを実施し、その有効性を評価するためのモニターを行う。コスト比較分析もその経済的実効可能性を評価するために行われ　ることになっている。また、コンピュータを含む幾つかの調査機器も研究基準局に贈与された。

5.13　技術図書の交換プログラム

研究基準局の調査、標準化の活動とともに技術図書の普及・推進の方針に沿って、同局は外国の諸団体と技術図書の交換プログラムを継続的に行ってきている。外国諸団体のなかには、米国道路交通協会（ＡＡＳＨＴＯ）、米国材料試験協会（ＡＳＴＭ）、米国コンクリート研究所（ＡＣＩ）、及び調査、公共事業に携わる他の団体などがある。

5.2　実施上の課題

5.21　現在のコミュニケーションと情報システム/ ネットワークの活用の必要性

益々高度に進歩している研究開発や科学的研究を促進するに当たって、世界のコミュニケーション・ネットワークや情報システムで継続的に改良が進められている点を利用、組み入れて統合する必要がある。協力を可能にさせるためには、開発・通信を最新の状態にしておくことが先決である。

5.22　援助分野の適切なアイデンティフィケーションの必要性

どのように援助の必要性を適切に推し量ればよいかという問題を提起する必要がある。このためには、性質上どちらが政治的で価値ある判断かということを適切に表明すべき開発途上国にとっては、賢明な経済計画と行政が必要とされる。一般的に、開発の性質は、当該国がどの位の援助を受け入れるか、またそのタイミングとも関係してくる。従って、それらの政府機関は、将来的な価値判断や維持可能の開発レベルを考えて、その目的を適正に判断・評価をし、表明することが必要となる。

5.23　有効な援助の必要性

援助国が援助、協力、交換プログラムに対して条件をつけることは常である。これは「しばり」という現象によって特徴づけられ、それで援助国側が一定の条件のもとに援助を行うことになる。これらの例としては、

(i) プロジェクトのしばり：資金または援助は、ある特定の支出、分野、または活動だけに費やされる。また、

(ii)調達のしばり：資金または物品やサービスの援助は一定の国、通常援助国から調達するように限定される、などである。

5.24　財政上の制限

開発途上国は無償援助よりも借款という形で援助を受けることがむしろ多くなっているのも事実である。そのため国の支出バランスの上でこれらの返済負担もまた益々大きくなっている。開発途上国ではこれらの負債の問題が緊急かつ現実の問題となっている。

5.25　技術

開発途上国自体の情報、訓練・再訓練の機会、政府・民間双方の開発施設などが不足しており、国内で専門教育・訓練が得られず、学校ですら試験機材・器具が無く、また資金援助の裏付けも不足しているので充分受けられない状況である。これが技術を吸収し同化するとともに、研究開発の成果をさらに発展させるのに大きな影響を与えている。

5.3 アジア地域での国際研究交流の必要性と実施上の課題

認可とそのシステム及び特許供与についての大きな国際協力及び改革（自由化）の提案が真に維持可能でより有効な開発を提起させるために必要とされている。これらにより全体の調査費用が低減されるとともに負担のかかる調査費用を補うことが可能であると見込まれる。しかし、このような交流は特別な機材や手順の介在なくしては適切に行われないであろう。またそのような

交流を促す前提条件を整えることが必要である。その目的、政策、計画を統一し、有効ならしめるために、アジア間での調査交流を調整する母体を設立し、参加国の様々な調査・開発・広報組織の活動を調整する必要がある。また、この分野で改革と新しい指導力を生み出し、母体の下で遂行された科学的な調査結果を移転することも必要となる。

6．「災害・防災」に関する取り組み状況

6.1　要旨

6.11　道路災害

フィリピンは永らく国全体の社会・経済開発プログラムの視点から基幹道路の開発に力を注いできており、これに基づいてかなりの道路網の拡張が行われている。しかし、これまでの成果にもかかわらず、斜面破壊、崩落、地滑り、土石流などの自然災害や道路交通システムの機能低下を招くような災害のために、最も重要な道路のいくつかが多くの被害を被っている。

6.12　火山噴火

中部ルソンのピナツボ火山が1991年6月12～15日に噴火を起こし、引き続いての台風の来襲と土石流は公共施設と個人の財産に莫大な損害をもたらす結果となった。この自然災害のために低海抜地域はほとんど完全に破壊され、優良な農業生産地帯の広い範囲には流されてきた残土が残り、商業・産業にも相当の損害をもたらした。

米国地質調査所（ＵＳＧＳ）やフィリピン火山・地震学研究所（ＰＨＩＶＯＬＣＳ）の試算によれば、91年6 月の15日の噴火では約70億立方メートルの火山砕屑物が吹き出し、その大部分が火山周辺の高地斜面に堆積した。これまでのところその火成砕屑物の堆積物の20パーセントは火山周辺の8 本のすべての主要河川に流れ込み堆積しており、相当な地域で氾濫を起こしている。火成砕屑物の25パーセントまでは当初の3 年間に浸食され、50パーセントまでが10年以内に浸食されると推定され、適切な措置を講じないと被害を拡大する危険がある。

マヨン火山は1993年2月2日13時11分に突如噴火し、さらに2月3、6、12日と引き続き爆発を続けた。最初の噴火で火山砕屑物が発生し、ボンガ峡谷を6 キロメートル南南東方向に下り、少なくとも70名が死亡、6 万人以上が避難し、1984年の火山砕屑流によってできた扇状地の大部分をおおいつくした。この火山砕屑流の総流量はざっと1～2 ×10E 立方メートルで、それでも1984年時の火成砕セツ物の流量(30 ×10E 立方メートル) よりもかなり少ないのである。1993年2 月の流量の半分は、流れが下る時のガリーから削りとられた1993年以前の岩石と推察される。

被害総額は約3 億5 千万ペソにのぼった。農耕地の被害が甚大であった。また、火山灰が国、地方、市町村の道路を数㎞覆った。幾つかの公共施設と個人の財産も被害を受けた。土砂は雨期が訪れる頃には脅威となる。

6.13　公共事業道路省の防災への取り組み

6.131　道路災害

道路災害防止の重要性に鑑み、フィリピン政府は国際協力事業団（ＪＩＣＡ）を通じて、日本政府の好意あふれる援助を受けて道路防災の長期的計画策定に乗り出した。

1983年(第1 期) と1985年(第2 期) に防災可能性調査プロジェクト計2 件がスタートした。その第1 期には災害指定箇所を認定し、マハーリカ・ハイウエイ(レイテ地区ルソン、サマール) 、ケナン道路、アゴバキオ市道路及びナギリアン道路の4 ヶ所の国道に沿って災害区間の優先順位がつけられた。

優先順位区間の決定に基づいて、第2 期にはダルトンパスの区間及びマハプレグ・ソゴド区間(両方ともマハーリカ・ハイウエイ沿い) とケナン道路の3 区間の可能性調査が実施された。

第2 期の調査「フィリピン道路防災プロジェクト」にはルカナ・カラワグ区間、アレン・カルバヨグ区間、ナギラン道路の3 区間の可能性調査結果がまとめられている。これらのプログラムで採用された典型的な防止策として、路面の排水施設、地下排水施設、のり面保護、アンカー、落石防護網、石積み、擁壁や防護壁などであった。

6.132　火山噴火による災害

6.1321　ピナツボ火山噴火被災地

噴火後、救助、避難、救援等の緊急活動が、個人も含む民間団体の参加も得てあらゆる政府機関を動員して実施された。

この緊急活動に引き続いて広範囲にわたり被害を受けた基盤施設の復旧、改修、再建計画が実施されるとともに、必要な社会的サービス、財産を失った避難民の再居住、仕事の復帰、新たな生計手段の確保などの対策が速やかに講じられた。

6.1322　マヨン火山噴火被災地

ピナツボ火山噴火に比べて社会・地域基盤に対する被害はかなり小さかったので，公共事業道路省では交通網を閉鎖することなく、土砂の除去実施している。これにより人、物、商品、サービスの移動が自由に出来、速やかな復旧と修復に役立っている。さらに、同省では道路上の火山灰を片付け、災害時の救助、避難、救援活動を容易にした。

6.14　洪水、堆砂災害の広範囲な対策

1991年のピナツボ火山の噴火によってもたらされた損害は計りしれない。何百人の人命と何十億ペソに値する財産が失われた。土砂の脅威は終わりを告げるどころか、少なくとも、向こう5 年から10年の間、脅威は残されている。傾斜面に放出された70億立方メートルに及ぶ火山砕屑物のうち、僅か20パーセントしか流れ落ちていない。雨の降るたびに人命と財産が危険にさらされている。

緊急活動と対策の一端として、公共事業道路省は次のような優先順位別に活動を行ってきている。

a.　人、物、サービスの流通・移動をスムーズにして速やかな回復、復興に役立てるため、

特に主要な道路と河川の交差路での交通網の確保と土砂の除去。

b. 教育と必要な行政サービスの復興を計るために、土石流の被害を受けた地域外での学校やその他の公共の建物（より高規格の設計のもの）の再建と復興。

c. 再居住と生計手段に対する支援のための救援、社会サービス、公共施設に対する援助を行うことによって、他の政府機関の復興活動を支援。

d. 人命の保護。地域社会、農業地域、養魚池及び社会基盤施設の防御。さらなる破壊、土石流、洪水のような今後も起こりうる損害の影響の緩和策。

フィリピン火山学・地震学研究所(PHIVOLCS)が土石流による被災の危険度によって地域と社会の区分を試みた研究結果から、それぞれの区分に対応する対策が施されている。

i) 高リスク地域またはグループⅠ地域

公共工事を行ったとしても、直接、土石流の通り道に位置しており、土石流となる可能性のある地形的にも低地であり、土石流となる可能性のある大量の土砂が堆積しているために土砂に埋められてしまう恐れのある地域。

対策:

- 基本的には、特別な対策工は施さず自然のなすままにさせておく。
- 高リスク地域から住民を避難させ新たな居住地域に住まわせる。
- 被災民との相談の上、高リスク地域周囲に近いタウン・センターなど保護すべきものは保護する。ただし、この対策はコンクリートでライニングした堤防や排水システム等の強固な技術的構造物によって可能である。また、この水路はスムーズに水を流すためにも維持・管理されるべきである。

ii) 中リスク地域またはグループⅡ地域

土より影響を受ける可能性はあるものの、ふつうの工事で防御できる地域。

対策:

- 発生源における堆砂を止める。
- 土砂を直接、海に運んでしまう。
- 山から沖積層の扇状地へと移動する。堆砂を制御する。

iii) 低リスク地域またはグループⅢ地域

土石流に冒される危険のほとんどない地域で、最小限の工事だけで済む地域。グループⅡと同様の対策案が考えられるが必要とされる範囲は、狭くて済む。

また、公共事業道路省を長とし研究基準局を総合窓口とするピナツボ火山復興技術科学委員会は、技術ワーキング・グループ（TWG）を通して土石流の緩和および復興対策を研究し、土砂災害の緩和及び土石流災害地に対する短期的対策を行った。

洪水対策工事が洪水に対する最も一般的な対策であり、技術的にも定着したものである。既存の洪水対策には次のようなものがある。

a. 洪水にみまわれる峡谷では、川の土手に沿ってあるいは町などの重要な地域の周りに堤防を建設し、決水が水路内に留まるか、ある一定の地域でのみ氾濫を許すようにして

いる。

b. 水路を深くしたり広くしたり、ライニングを施したり、真っ直ぐにするかあるいは草木や瓦礫を除去し、水の疎通能力を高める等の水路の改良。

c. 他の洪水対策が不可能だったり、充分でない峡谷では、水量が特に増える期間、洪水流の一部を分流しているところもある。

d. 洪水調節用貯水池の設置。

[6.2～6.4 省略]

7. 「環境と社会資本整備の調和」に関する取り組み状況

7.1 要旨

公害、人々の健康、自然環境への関心は、環境保護や管理の重要性に対する意識を高めた。今日の環境問題は貧しい国でも裕福な国でも一様に認識されている。フィリピンを含む第三世界にとっても環境問題を開発計画、意志決定の過程で考慮する必要性からいろいろな計画立案手段を提供した。その一つが環境インパクト・アセスメント（ＥＩＡ） である。

環境インパクト・アセスメントとは、環境全体と人類の福祉に対して立案された計画が与えるインパクトを把握し、予想するとともに、そのようなインパクトに関する情報を計画立案者や意志決定機関に伝える形式的なプロセスである。

環境インパクト・アセスメントの過程には通常次の二つのステップがある。

- ふつう環境インパクト・ステートメントと呼ばれる文書を準備する。この書類は当該プロジェクトの建設現場の環境の現状に関する情報と同プロジェクトが環境に及ぼす影響についての予測と評価が収録されている。また、
- その文書が正確であるかどうか、またその提言をどのように進めていけばよいかを考える意味で、政府や公的機関によるその評価、見直し。この見直しはアセスメント・レポートのような形で意志決定者に報告される。

このようにＥＩＡにより、ダム、発電所、埋め立て、道路、橋など環境的関心を必要とし、実際、環境的に重要な場所に建設される主要なインフラ工事が確認される。

フィリピンでは環境インパクト・ステートメントを遂行することが問題の処理となる。ＥＩＡを推進するために必要なのは行政の要請ではなく、重要な計画・立案の手段である。計画立案者や意志決定者は、一般的にＥＩＡを受け入れなければならないし、この見直しの過程で得られるいろいろな緩和策を受け入れなければならない。

社会基盤プロジェクトを進める際の環境に対する包括的考察には、開発活動における環境の係わりに関する新しい知見に照らして、開発計画の全体的目的を根本的に見直すことも含まれる。国内の建設、復興、再建に於いて環境保護策を採り入れることの重要性が認識されている。この

ことは、国の生物資源とその救助、生体系機能、全体の環境の質を適正に保護しながら経済成長を達成することを目標としている「維持可能な成長のためのフィリピンの政策」の概念的骨子にも生かされる。

公共事業道路省はその核として幾つかの実行方針をもっている。それは国の開発努力のなかから生まれる地形的、経済的、自然的資源の利用をめぐっての多様な、時には相反する問題を調和させ決定することを目指している。

地震再建プロジェクト(ERP) と指定の社会基盤プロジェクトの復興・修復・修理のためのインフラ再建計画(IRP) のための環境評価ガイドラインが準備されている。これらのガイドラインは、すべての復興・修復・修理作業において考慮すべき環境要因を明確にするため準備された。さらに、指定された復興・修復・修理のンフラ工事に環境保護、セイフガード要件を加味するという重要性、妥当性についての広範囲かつ深い理解を得るように、ERP/IRN 双方のプロジェクトに携わる地域の設計技術者、コンサルタントを援助するのが目的となっている。

また、インフラ工事の負のあるいは逆の影響を緩和或いは相殺する適切な緩和策が考えられるようになってきている。これらの奨励される緩和策のなかには、浸食、推泥、沈澱水、騒音、振動、空気汚染、水汚染、人の居住地の排泄、美的・社会的・経済的インパクト等に対する措置がある。

7.2 フィリピンの現状と課題

台風Sisang(1987年)、Unsang (1988年) 、Uring (1991年) 、Trining (1991年) 、1990年7月の地震、1991年6月のピナツボ山の噴火、および1993年2月のマヨン火山の噴火は、ルソン島および東ヴィサヤ諸島に社会基盤の破壊と人命損失という点で甚大な被害をもたらした。前述の災害によって橋梁、高速道路・道路、家屋、病院および医療施設、灌漑システム、洪水調節用排水路、上水道、学校および政府の建造物ならびに第３級の港、埠頭などの基礎構造施設は破壊され、あるいは、損傷を受けた。熟練者および専門家が分析し結論づけたように、社会基盤に甚大な被害をもたらしたのは、主として a)地質および地形が局部的、および地域的に相違しているため地震の増幅された中、b)不十分不適切な設計と建設、および c)これら両者の相互効果による結果であった。とくに明らかにされた被害の主要な原因は、水路の氾濫と洪水、川のせき止め、表面断層、液状化、地滑りと土石流及び地面の揺れである。

7.21 社会基盤整備事業の環境への影響

7.211 高速道路・道路・橋梁に対するもの：

・裸地化による山腹の侵食で沈泥の流出、切取り埋立地域、牧草地および低木林地、地滑り、泥流と土石流、および大規模な切土および盛土による土地の侵食

・浮遊微粒子（風塵、煙霧）、騒音および振動、排気、臭気およびばい煙、エアゾール、有毒ガス（二酸化炭素、炭酸ガス、窒素酸化物）、およびその他の排出物質による大気汚染

・土、グリース、ガスおよび他の危険な物質の偶発的な漏洩

・水界生体系および他の有益な水の使用の悪化、これには水質汚濁（水系および他の水域、および沿岸地域）、水用および水体系の変化などが含まれる
・野生生物、漁場、自然植生、国立公園、公共保留地、猟鳥獣保護地区および価値のある動植物相集団の自然保護区の損傷または妨害
・眺望および美観
・社会経済システム特にビジネス関係および雇用パターン、社会福祉事業、運輸通信
・軟土（たとえば、沈泥およびピート土）の掘削および盛土による地盤沈下
・土地利用および定住の形態
・労働者および一般の人々の受ける大気汚染および潜在的な事故による公衆の健康
・考古学、文化および歴史上の史蹟や名勝

7.212 上水道および灌漑プロジェクトに対するもの：
・地表水および地下水の質と量に関する影響
・潜在的水流の減少、以前地下水で生存していた草木の消滅、浸透、涌水や沼の枯渇および地盤沈下
・貯水池、ため池の流域、帯水層または流水の水文学的な特性へ潜在的効果
・水界水態系（河川、小川、クリーク、小湾、湖、マングローブ、珊瑚礁、河口域）に関する影響
・取水、灌漑および非灌漑地域における環境障害
・過度の水の汲み上げによる地盤沈下
・小処理、浄化技術からの濁水
・定住の種類および公衆の健康
・社会経済システム（ビジネス、所得、生計、社会福祉事業、生活様式、雇用、人口、運輸・通信）
・考古学、文化および歴史上の史蹟や名勝

7.213 洪水調節に対するもの：
・土砂の移動に伴う行為（浚渫、築堤の安定、締固め）による沈砂と堆砂
・水辺の動植物に突発的に影響をあたえる河川水質の悪化
・工事段階での大気汚染（騒音、振動、臭気、煙霧および風塵）
・土地使用および定住の種類
・社会経済システム特にビジネス関係および雇用パターン、社会福祉事業、運輸通信
・風景の眺望および美観
・考古学、文化および歴史上の史蹟や名勝

7.214 港湾および埠頭に対するもの：

・水界生態系（河川、河口域、湾、湖沼、沿岸水域および珊瑚礁）、沈砂および堆砂による水質
・量の潜在的悪化
・大気汚染（騒音、振動、臭気、煙霧および大気浮遊塵埃）
・浚渫の捨土の棄却および土地埋立材料の処理
・土地使用および定住の種類
・油、グリスおよび他の危険な物質および物体の偶発的の漏洩
・社会経済システム（ビジネス、所得、生計、社会福祉、雇用、生活様式、人口、運輸・通信）
・風景の眺望および美観
・考古学、文化および歴史上の史蹟および名勝

7.215 政府および学校建造物にたいするもの
・建設段階での短期の大気汚染、水質汚濁および土地汚染
・潜在的な資源の破壊（たとえば、空気・土地エネルギー、動植物）
・自然植生、考古学、文化および歴史上の史蹟・名勝に関する潜在的効果
・掘削土、岩屑および破砕土の堆積

7.22 フィリピンの持続的開発戦略（PSSD）

世界環境開発委員会（WCED）によって定義された持続的開発とは、“将来の世代の能力がそのニーズや目標を叶えるための可能性を傷つけることなく国民のニーズと願望を叶えるもの”です。持続的開発では、相互に矛盾のない環境の保護と経済成長を考察する必要性が強調されます。これは成長の目的が社会のニーズばかりでなく、自然の発達の歴史と矛盾の無いものであること、および生態系の能力を進めることを意味している。フィリピンの環境および開発問題にたいする応答は、基本的には、1989年11月に正式に政府が承認したフィリピンの持続的開発戦略（PSSD）のなかにまとめられています。フィリピンの持続的開発戦略は、天然資源の蓄積を激減させずに、そして、環境の質を低下させないで、経済成長を達成し、持続し、広めていくことを目的としている。この戦略には、環境の持続的開発のためのプログラム、プロジェクト、および活動を指導する 10 の基本原則と政策の指示がある。

a. 意思決定の際の環境への総合的考察

開発計画の目的は、意思決定において、環境および経済への配慮を考慮することを可能にするために再編成される。経済システムにおける天然資源の生産的役割を強調するための天然資源の評価、主要プロジェクトの環境へ結果を評価する環境影響アセスメントシステム、および環境の質の予想に基づく最適条件の土地使用割当を決定する土地使用計画のような、分析手段および方法論は、環境への配慮が意思決定の際に考慮に入れられた証明をするために使用される。

b. 天然資源の適切な評価

資源管理は、資源の供給を補充し、増加すること、そして適切な代替を用意する費用を基礎とした天然資源の適切な評価をすることによって改善されます。環境への損傷を誰が償うのかという質問は、明確にされます。環境への損傷を誰が償うのかという質問は、“汚染者負担の原則”および貨幣換算できない資源の値の適切な評価に重きをおくことで定義される。究極の目的は、資源の利用者が資源の基本の質を悪化させない方法を選択する自己制御システムをもつことである。

c. 権利の適正な刷新

戦略の核心は自小作農家と一次資源の占有者の所有権を保障することです。これは、天然資源の開発を行う関連する地域社会または個人の自己管理の結果と考えられます。しかし、このような資源の適正な管理は、資源の取得権利を基本として受取者個人あるいは、地域社会が証明しなければなりません。

d. 生物の多様性の保護

野生種および発生の多様性の保存は、急速に変化する地球環境にもかかわらず存続と発展にかかる将来の問題に広範囲な可能性を与えることが強調される。保護区域では、野生生物の生命と貴重な生態系の保護、およびそれらの科学、教育、および歴史的価値の保存が確立されます。したがって、現在の国立公園および保留地が保護され、低下した公園にたいする修復戦略が展開され、そして、新しい保護区域が決定される。

e. 衰退した生態系の復活

大量の破壊がすでに起こっており、自然の再生産能力は十分ではないので、プロジェクトでは衰退した生態系の復元が実施される。天然資源の原材料と製品の両方にたいする需要の増大によって圧力が生じたので、復元行動に対する国の公約と能力を強化しなければなりません。したがって、森林再生、裸地化した流域、マングローブ植林、生物学的に死滅した河、海中植物の輸送の復活を含む公害の浄化と管理などの計画が活発に行われる。これらの再生計画は、生態系衰退の社会経済の原因を決定的に取り扱うための生態系保護計画、政策改善、および制度の強化とリンクされる。

f. 残留物管理の強化

汚染の問題は、原料とエネルギーを節約する資源の復活、リサイクル、および適切な生産設計などの原料政策に対する、より総括的構想に向けられます。“パイプの終わり”管理システムに狙いを合わせるのでなく、この戦略は、無駄の流れを減少させることを目的とする工業プロセス設計に最新の改良を採用することに注意を集中することである。

製品の再製、残留物からの販売可能な副産物の開発、プロセスの再設計と組合わせは、廃棄物を減らし、価格も安くする手段を提供するいくつかの方法です。同様に工場に公害防止装置を設置することを奨励するための経済的な刺激のような政策手段によって適切な汚染管理の実施を強化し、不足を満たす。

g. 汚染増加の制限と人類の資源の開発

急速な人口増加を制限する国の計画は、数の制限だけでなく、健康、教育、地方の開発計画が含まれる。それらは、地方および自治体レベルでの総括的社会経済計画の一部として実行される。この計画は、人口の文化的、宗教的規範として矛盾の無い方法に基づいて実行される。

h. 地方の成長の誘発

経済の復旧と長期安定は、人々の大部分が住んでいる地方における収入と雇用の増大に依存するので、地方の開発には特に注意が払われる。地方の経済、社会、および政治的潜在力は、貧困を緩和し地方の貧しい状態を向上させるために役立つ。この地方の開発戦略は、(a) 政策立案およびプロジェクトの実行に熱心に参加することで、地方の貧困者に可能性を与えること、および(b) 富の分配の公正と生産者への刺激の増大を達成するために土地改良の早急な実行、(c) 地方に反する経済政策と公共投資の傾向の除去、(d)地方の生産性を高め、市場を拡大する社会基盤と支援活動の準備、(e)産業および商業活動の基地としての成長センターの確立と強化、および(f)教育、健康と食物のような社会奉仕の強化が特徴づけられる。

i. 環境教育の促進

環境教育は、市民が経済の発展のもとで適切に管理された環境によって果たされる役割と同様に、複雑な環境の性質を理解し、正当に評価できるよう促す。この具体的な目的は、環境の保護を強力に支援する社会的価値感を発展させ、困難な問題を処理するための公約と政治的意思を創造し、そして、最善の選択をするため基本的能力を人々に授けることによって環境の研究に対する理性のある理論を発展させることである。

j. 市民参加の増加

非政府機関（NGOs）は機動力がある。そして、非政府機関と政府機関間のネットワークは、自治体の組織化、公共情報キャンペーン、調査・状況アセスメント、環境の監督および監視および環境的に健全な技術の促進を援助するため形成される。

7.3 組織の活動

Ⅰ. （開始される）提案されたプロジェクト

次のアプローチと指標は、新しいサブプロジェクトの潜在的な環境への影響・効果に関する初期の準備アセスメントを観察し、勧告する。

1. 高速道路・道路・橋梁に対するもの：

1.1 適切な関連政府機関と十分に相談し、サブプロジェクトが適用できる現行の法律におよび政府の政策（たとえば、国、地方および現地の開発構想計画）に従い、あるいは効力が遡及することを確認する。

1.2 地図、仮スケジュール、図面および図形とともに簡潔な証明書の作成。サブプロジェクトの現場の位置を含める。

1.3 提案されたサブプロジェクトによる重要で包括的な環境への影響・効果についての適切な基盤の開発。この基盤は、工事段階だけでなく工事後の段階も取扱つかわなければならない。

この目的は、最適設計を達成するため環境と工事の要因間のバランスを調整することである。

1.4 (a) サブプロジェクトに関連する環境への主要な潜在的影響および(b) サブプロジェクトの成功に反対または否定的に作用するかもしれない環境への影響（すなわち、国道は洪水、侵食、地滑り、液状化など危険度の高い場所にあるので、プロジェクト寿命を短縮する）； 橋梁は、埋積（岩屑の堆積で＜川床の＞高さを上げる）・侵食または沈泥・堆砂した水系に位置するかもしれない）。

1.5 サブプロジェクトの現場が環境影響声明書（EIS）の範囲内に含まれる環境上危険な地域（1981年12月14日付け大統領布告第2146号によって確認された）の上または付近に位置しているかをチェックする。

1.6 サブプロジェクト関連・関係づけられる主要な潜在的問題を確認・決定したのちに、以下の基準・程度にしたがって効果・影響に関するアセスメントを迅速に行う。

小、中、大

短期	－	長期
変更できない	－	逆にできる
重要	－	重要でない
否定	－	肯定

この迅速なアセスメント・評価は判断のプロセスである。そして、この目的のために集合した複数の訓練グループによって管理することが可能である。そうでないときは、これは記録を残し、そしてある場合には、サブプロジェクトの重要性、厳格さ、規模、および期間・時間構想に関する数字のスコア・値を与える適切な利害関係団体・熟練者と相談することによって行われる。これらの評価によって、コンサルタントは影響の無い、あるいは取るに足らない影響を除去して、より重大な影響に焦点を合わすことができる。

1.7 主要な環境への制限は計画の段階で確認されることのチェック。

1.8 継続してサブプロジェクトの契約の変更および・または設計変更の影響に対する管理・システムの検討の確立。

1.9 特にサブプロジェクトと関係の無い、評価された否・反対の効果を減少・相殺する適切な軽減計画の設定。

1.10 契約者がとりわけ、以下に関する特殊な制限に従うことを保障するため、工事後の維持、不慮の出来事および観測計画の作成と記述。

1.10.1 偶然の漏洩、火事、地震活動、地震などの事故または設計の失敗によるプロジェクトの工事中および工事後に起こり得る重要な環境上の偶然の危険、およびこれらが含まれた理由、およびこのような事故発生の確率の測定方法

1.10.2 （できるならば）このような事故、または自然な出来事の見抜くこと、その応答のなかで使用される手順および装置を始め反応して行われる改善方法の計画

1.10.3 環境の復旧、浄化、およびこのような事故の回復計画

1.10.4 このプロジェクトの工事段階での建設された仮の建造物および施設の撤去、および配置計画

1.11 特にサブプロジェクトに関する環境上の、または工事後の監視計画、および３つの基本となる目的を達成するよう設計された計画の作成。３つの計画は、1)EIA（環境影響解析）に関連する要求事項によって設定されるサブプロジェクトの条件に従い、2)意思決定者、計画者、機関および公共に対し影響の傾向の変化および該当する影響に対応する管理に関する環境データおよび情報の用意、および3)関連するすべての部門への環境の状況説明。

2. 上水道および灌漑計画に対するもの：

上水道サブプロジェクトの全てではないが、そのほとんどが相対的に小さいプロジェクト、および地震復興プロジェクト(ERP)の下で行われた７つの灌漑プロジェクトは、環境に対して非常に短期間であるため影響は最小であると考えられる。しかし、この種類の新プロジェクトの計画または事前の可能性調査段階では、この現場あるいは位置の土質および地震条件についてとりわけ付録 A および B の適切な節ですでに真剣な考慮が述べられていることに注目しなければならない。

これらのサブプロジェクトの初期の環境への影響へのアセスメントのなかで取り上げ・指導することは、高速道路・道路・橋梁に対して列挙した一段階あるいは項目も適用できます。そして、それゆえ、エンジニア・コンサルタントがケースバイケースで考慮するよう勧告される。

3. 洪水の管理と河岸の防護に対するもの：

侵食と沈泥（主として森林、裸出状態にすること、流域の破壊および強い降水）は、水系に最初

に影響する２つの自然のプロセスであるので、人の居住要因にも十分注意する必要がある。

高速道路・道路・橋梁にたいする手引書を、この種類の初期の環境への影響アセスメントで、適切に最小の変更・修正することで使用することができる。（Ｉ－ 項目1 参照）。

4. 港湾および埠頭に対するもの：

社会基盤復旧プログラムに基づく第３の港湾および波止場の大部分は、相対的に小さくそれらの再建築・修復はすでに完了している。将来の財政を含めて後ほど確定される新しいサブプロジェクトについては、サブプロジェクトのこの種類の初期のアセスメント・評価に従う環境上の手続きは、サブプロジェクトの特異な要求事項に従って改修する幹線道路・道路・橋梁に対する勧告と類似している。（Ｉ－ 項目 1 参照）。

5. 政府および学校建造物・病院に対するもの：

地震復興プロジェクトおよび社会基盤復旧プログラムに基づいて、これらの種類・部門での認可された全てのサブプロジェクトは、改造、修繕・修復用のみです。これらのサブプロジェクトは液状化が起こりやすい区域にあるものを除いて、これら多数のサブプロジェクトの設備の環境への影響が重大でないと評価される。認められ、資金調達のメドがついた新しいプロジェクトについては、影響評価に対して勧告される高速道路・道路・橋梁の環境上の手順が、サブプロジェクトに適合するように適切に修正されて使用される。

Ⅱ．進行中のプロジェクト

進行中のプロジェクト（大部分が高速道路・道路および洪水調整、いくつかの主要な橋梁、病院、学校の建物、灌漑、第３位の港および埠頭）に対しては、確認され・測定された環境への影響・効果に対して適切な軽減手段を制定し、厳格、かつ、完全に実行されることを保障するため以下の手引書が勧告される。

1. 高速道路・道路・橋梁に対するもの：

1.1 プロジェクトの環境への潜在的影響・効果にに関するリストを作成。

1.2 新プロジェクトのＩ項目1.6に記載されている基準または等級の方式を用いて潜在的環境への影響・効果についての迅速なアセスメント・評価。

1.3 確認された主要な環境への影響・効果について定期的な監視の実施。
また、プロジェクトの実行プログラムの変更（たとえば、期間延長させるプログラムのズレ）の評価。

1.4 大プロジェクト（国および地方の幹線道路、橋梁、洪水調整、灌漑）に対する社会経済の監視

プログラム、および自治体の連絡グループの確定。

1.5 特にこのプロジェクトに関連して環境への負の影響をを減少・相殺するため適切な軽減計画を設定してすること。雨期の開始を考慮して1990年7月16日地震および1991年のピナツボ噴火に伴う初期の地滑り、および土石流・泥流の堆積地域に合わせて十分綿密な注意をしなければなりません。この地滑りと土石流・泥流の精査区域はDigdigの合流点からサンタフェまで延伸したMaharlika高速道路に沿っています。N-S（北から南に傾いているルソンCordillera連山、およびCaraballo山の間が最も広がっている場所も、地滑りと土石流・泥流の脅威が継続している。

1.6 評価された建築の危険（空気汚染および水質汚濁、騒音および振動、土地の汚染、土地の侵食・沈泥、流出など）は適切に取組むこと、そして軽減および・保護の方法が適切に評価されていることを保証する。軽減・保護の方法は河岸の保護および傾斜の安定を中心にしなければならない。これはエンジニアとコンサルタントの十分に密接な監視・監督を必要とする。

2. 上水道および灌漑のプロジェクトに対するもの：

2.1 Ⅱ項目1.1, 1.2, 1.3, 1.4, 1.5, および1.6の行動を実行すること。進行中の上水道のプロジェクト（約 13 DPWH- 実行され約5LGU- 実行）および灌漑施設備は（約5LGU- 実行）は、地滑りおよび岩屑流出または液化を起こしやすい地域のいずれかにありますので、軽減等は、その注目を沈下の危険、水質汚濁、水と陸の生態系、水使用の紛争、土地の使用など）に集中する必要がある。

3. 洪水調節に対するもの：

3.1 Ⅱ項目1.1, 1.2, 1.3, 1.4, 1.5, および1.6の行動を実行すること。DPWH リストに基づいて、約76の洪水調節施設が進行中です。ほとんどがルソンの中央平地（Pangasinan, Nueva Ecija, Bataan およびTalac）およびCAR地域Ⅱ（Nueva Vizcaya, Quirirno およびisabela）Benquetおよびabra にあります。したがって、それらがさらされている危険、あるいはそれらに影響を与えやすい危険は、侵食、地滑りおよび土石流である。自然の猛威および追加の負荷に耐えられる適切な構造・工学的な設計に焦点をあてる軽減方法が、適切に制定され、処理されることが必要である。これも、十分な監視と監督が要求される。

4. 港および埠頭に対するもの：

4.1 Ⅱ項目1.1, 1.2, 1.3, 1.4, 1.5, および1.6の行動を実行すること。地震復興プロジェクトおよび社会基盤復旧プログラムに基づく大部分が完全に復元されるか、あるいは取替え・再建されますので本質的には小数の港および波止場だけが建設中である。地震復興プロジェクトDPWH で実行される進行中の港湾工事は、La Unionにとそして、社会基盤復旧プログラムに基づく地域I V-Aに２つがあります。小さいけれども、軽減したり、最小限にする必要のある環境への影響と

しては、大気汚染および水質汚濁、浚渫廃物の放出、埋立、自然海岸の縮小および漁場および他の海洋生物に関係がある。

5. 政府・学校建造物および病院に対するもの：

5.1 建設・修繕中のNueva Ecija にある８つの高校の建物、９つのStage大学および総合大学、および２つの病院を除いて、Ⅱ項目1.1, 1.2, 1.3, 1.4, 1.5, および1.6の行動を行うこと。地震復興プロジェクトによる学校および政府の建造物および病院は、完全に建設・修繕が行なわれた。短期の大気、水質および土地の汚染、および見込まれる堀出土の堆積、および破壊・建設岩屑は勧告された防護および矯正する手段を採用することによって環境への影響・効果を容易に軽減・保護できる。

Ⅲ．完了プロジェクト

地震復興プロジェクトおよび社会基盤復旧プログラムに基づいて完全に建設・修復された社会基盤施設の多くは道路、橋梁、洪水調整および灌漑で、サブプロジェクトが実際に与える環境への影響・効果を査定・評価ができるように十分な工事後の批判的な監視が必要である。この定期的な活動および実行によって、どこでいつ軽減や矯正策が必要かということを実行機関に定期的に提案し、勧告できる。

1990年7月16日の地震、および1991年6月のピナツボ山の噴火からの教訓としては、地震および雨で誘発される地滑りを起こしやすいと確認される危険地帯の地図、PHILVOCSを作成する結果になった。土石流・泥流、洪水および大きな侵食の防護のためである。発生に考えられる要因は地震活動度および場所、傾斜（危険度18から35%）、土質（粘土質）、岩石学からの地質上の特徴（最近の砂礫・泥土などの堆積）およびフィリピンの断層組織である。

完了したプロジェクト施設の建設後の適切な監視のためにエンジニアおよびコンサルタントを使用するため、つぎの一般的な２つについて取上げられることを勧告される。それらは：

1. 妥当な危険地域の地図を使用して選択された主要社会基盤のプロジェクトの位置を決定すること。実際の現場の踏査・調査によって選択された社会基盤のプロジェクトの区分された現場の位置を実証し、確認すること。

2. 工事後の環境監視の実施と運用

一般的考察事項

地域Ⅰ、Ⅱ、Ⅲ、Ⅳ－A、Ⅳ－B、ⅤおよびⅧ、CAR およびNORにおける数千のプロジェクトをはじめ、地震復興プロジェクトおよび社会基盤復旧プログラムに基づく社会基盤の再建・復旧・復興。これらのプロジェクトは８つのプロジェクト部門から構成される。すなわち：

1. 国、地方、地方自治体およびbarangay道路および橋梁

2. 洪水調整施設
3. 上水道および灌漑施設
4. 港湾および埠頭および灌漑施設
5. 学校・政府の建造物および病院
6. 住宅

大部分のプロジェクトは、完了しているか進行中です。それらの大多数が小規模で直ちに環境上の影響・効果が無いと確認され、評価されますので、公共的に重要な実質的な環境上の影響の試験および調査は、厳しい選別を基礎にして行われる。主要な社会基盤施設と公共的に相当重要なもののみが環境評価プロセスに含まれる。

このため、主要プロジェクトにたいしては、（潜在的、および実際に継続して環境への影響・効果があるので）評価と監視について付属書3に述べられています。

7.4 地球環境および生活環境を考慮した社会基盤開発計画

社会基盤プロジェクトに対して課せられた負・逆の効果を減少・相殺するための適切な軽減計画が、確認されてきた。勧告された軽減手段としては、侵食・沈泥・淀み水、騒音、振動、大気汚染、水質汚濁、人の定住妨害・移動、美学的な影響および社会経済的影響が含まれる。

侵食・沈泥・淀み水に対するもの：

・斜面および河岸の安定にたいする設備（石工事、石がまち、適切な植物種類などによる　再生長）。
・被害に遭遇した地区にたいする十分に計画された最舗装および補職植
・池および人口湖または集水域の使用
・淀み水を緩和する問題に対する排水口設備

騒音および振動に対するもの

・緩衝地帯・遮音塀および緑地帯の設置
・上水道プロジェクトにおけるポンプステーションの適切な間隔
・建設機械、エンジンおよび装置にたいする適切な消音器および防音装置の使用。機械用緩衝取付装置の使用
・高速道路建設の場合、人口の多い地区および考古学的、文化的および歴史的に保存される地域に対する迂回道路。障害路、洪水発生の起こりやすい地区、壊れやすい地方の　生態系の場所の付近
・草木・緑地帯の設備
・適切な交通信号、案内標識、交通整理職員の配置
・慎重に立案された交通の新計画および管理
・慎重で合理的な工事計画および建設行動のタイミング
・他の公益企業体との適切な調整

大気汚染用（毒性および危険物質、粉塵、臭気、ばい煙）に対するもの：
・建設資材および機器の適切な通風のある場所での保管設備
・工事および運転段階における適切で良好な計画および安全方式の採用
・特別な地域における厳格な公害管理規則の作成および施行
・土地移動活動の結果塵埃の発生、堆積に対する定期的な水撒き
・建設現場からの掘削土および浚渫廃物の迅速な除去

水質汚濁に対するもの：
・プロジェクト工事段階および工事終了後の慎重で合理的な計画
・汚染排出物にたいする適切な排水システムおよび構造上の安全・防護設備
・水路の分水設備
・十分に計画された監視プログラム

居住地の不安および移動に対するもの：
・移動した居住者の受け入れ可能な移転地への再定住
・移転・再定住者の生計および・または雇用機会の設定
・移転した居住者に対する適切で合理的な一括保証の規定
・住民の再定住および移動にたいする輸送および労働の規定

美学的影響に対するもの：
・プロジェクトの周辺および沿線の緑地帯の確立
・適切な空地および慎重に選択されたリクレーション（たとえば、ピクニック場）および駐車場

社会経済への影響に対するもの：
・以下による公共意識の創造および公共の情報の宣伝の推進：
  － プロジェクトに関する影響を受けた地域社会の認知を決定する徹底的に重要な情報提供者のインタビューおよび非公式なグループの討論・対話の指導
  － プロジェクトについての十分な情報を影響を受けた部門に提供する目的ばかりでなく、彼らの示唆を懇願するため提案されたプロジェクトに対する環境上の要約概要説明の実施
  － 環境上の大衆に関する提案されたプロジェクトの影響を軽減・高揚に関する全ての事柄についての民間部門と同様、すべての関係する国および地方政府当局との調整

8．今後議論したい課題

1. アセアン地域土木研究所の設置

これはアセアン諸国間で参加国によって採用され得るインフラに関係する共通の技術に基づいて共同調査を行おうとする提案である。これにより合弁の調査事業も活発となり、調査の重複を避けることも出来る。終局的には近隣のアセアン諸国、またフィリピンの発展にもつながることになろう。また、調査費用の軽減にも影響をもたらし、莫大な調査費用を補塡する力も持つと見込まれる。

この機能を果たす研究所とともにアセアンまたはアジア間の調査の調整機関が設立される必要もある。この調整機関は(a) 目的、政策、プログラムを統合し、もっと有効にする、(b) 参加国のいろいろな研究開発活動や情報を普及・宣伝する組織などの調整に当たる、(c) アセアン地域で改革と新しい指導性を刺激する、(d) この権限のもとに引き受けられた科学的調査の結果を移転する。

同研究所は5 年とか長期的な調査、開発の戦略を立て、技術情報の普及活動をする。特に一連の技術援助、アセアン地域、アジアに於いて経済成長、環境的にも健全な成長を促すそうした活動が期待される。

この研究所は下記に挙げるような問題に対する適切な情報政策を確立するだろう。

a. どのようにしていろいろなアセアン諸国間で、インフラストラクチャーと建設の調査・開発活動を調整するのか。
b. アセアン諸国と他の世界と結び情報を分かち会える情報ネットワークやデータバンクをどのようにして作り上げるか。
c. 独占的な特許、産業、商業上に機密、安全上の制限によって作りだされている障害をいかに軽減するか。
d. 建設、エンジニアリングなどの分野で新しい先端技術をアセアン諸国によっていかに普及されるか。特に同地域の現在の状況や特殊な環境を考慮してどのように普及するか。
e. アセアン地域に於いて、維持可能の開発、環境との調和、科学に裏打ちされたエンジニアリングを促進するのに必要な人材をどう教育・訓練するか。
f. コミュニケーション、情報処理分野の近年の開発を調査活動に採り入れ、完全に自動化することの推定できる見返りは何か。
g. 研究所の活動を国の必要性から、或いは産業への応用といった点からそのようにしてモニターできるか。

また，アセアンの多様な文化、言語を考えると、技術、仕様、試験規格、ガイドライン、情報、報告書などの標準化、翻訳設備を備えることなどの必要性もある。

研究所の長期的な成功のためには調査、開発、設計、適用、促進の場で欧米や日本の経験、成果、方法を学び改革していかなければならない。

2. 公共事業及び建設の情報ネットワークの改良プログラム

公共事業道路省は益々高度化し進んでいる世界のコミュニケーション・ネットワークや情報システムを用いて，調査，情報ネットワークを統合する緊急の必要性がある。二カ国間或いは多国間の協力を可能にするためには、もっと進んだ開発とコミュニケーション及び調整システムを主な特徴としている。

提案しているプロジェクトはこの二つの主要な目的を確立することを目指している。最初に、公共事業道路省はこの努力を調整し、主要な学問的研究機関、調査施設、援助国の機関、エンジニアリング情報機関などともっと最適な連携を保つために、国内海外を問わず、すべての潜在能力、関心をもつユーザーを考慮して中央化したネットワークを、例えば研究基準局を中心として確立する必要がある。次に、上記の研究基準局を中心とした中央化したネットーワークに似た公共事業と建設の情報促進ネットワークを地方レベルで試験的に作り、地域や市町村の支局を通じてデータ・情報を収集する。さらに科学的進歩、持続可能な開発に関する調査の関心を普及する。

このスタディによって、ふつう国内的に広く手続き、方法を確立することで、公共事業と建設に関する技術、情報が安く、より入手可能になり、利用しやすくなるであろう。

外国の情報機関、調査専門組織、国際機関などとの接触、提携も確立し、グレードアップを計り、引き続き更新しなくてはならない。また、地方や外部の情報源から最大の情報を集め、それをユーザーに抜粋、定期刊行物、セミナーなどの形での普及を目指す。

このプロジェクトは提案している「アセアン地域土木研究所」のフィリピンでの活動に対して補完的な役割を果たすことができるものと考えられる。

以　上

Ⅵ．シンガポール共和国

シンガポール国家開発省公共事業局土木技術担当課長　Khor Poh Hwa

１．シンガポールの概要

1.1　国土の概要

シンガポール国は東南アジアに位置し（第１図参照）、領海内のシンガポール島と約５８の島しょから成る。本島は長さ約４２㎞、幅２３㎞である。沖合の島しょを含め、シンガポール国の総面積はおよそ６３３平方キロメートルである。

シンガポール本島はおおまかに下記の３つの地域に分けることが出来る。火成岩組成の中央部丘陵地帯、堆積岩から成る西部地域－これらの堆積岩は北西方向に一連の丘陵と谷を形成する－と、砂利が堆積した比較的平坦な東部地域である。シンガポール本島のほぼ中央に位置する１７６メートルのブキット・ティマ・ヒルが最高峰である。

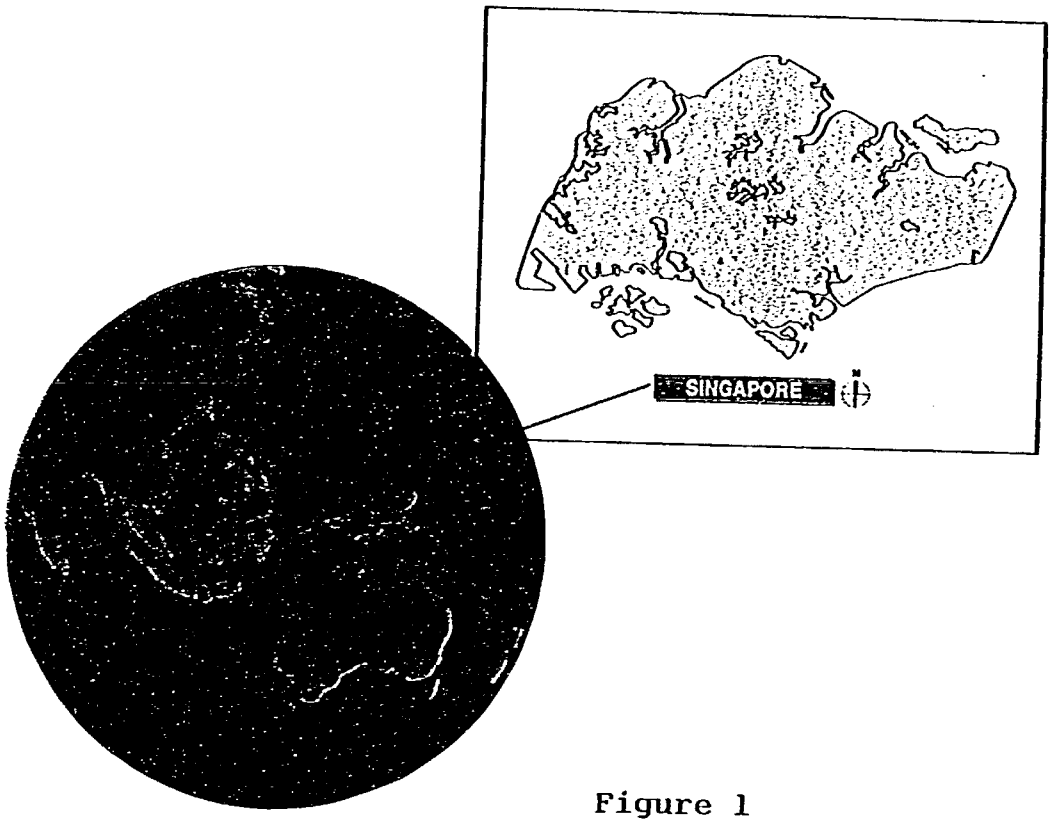


Figure 1

国土の利用状況は下表のとおりである。

表－1

国土総面積（本島及び島しょ）	６３３．０
建物集中地域（新工業用地を含む）	３１１．６
農業地域（ゴム及びココナツ・プランテーションを除くライセンス・ファーム）	１０．８
森林	２８．６
湖沼と潮湿地	１５．７
その他（内陸水域、オープン・スペース、公園、共同墓地、軍施設がある建物非集中地域、採石場ゴム及びココナツ・プランテーション、未利用地）	２６６．４

1.2　気候

シンガポールの気候は、比較的一定した気温、高い湿度、海に面し赤道に近いことによる豊かな降雨を主な特徴とする。

第２表に気候統計を示す。

表－２　気候統計

１日の平均気温	２６．７° Ｃ
１日の平均最高気温	３０．８° Ｃ
１日の平均最低気温	２３．８° Ｃ
最高気温	３５．８° Ｃ
最低気温	１９．４° Ｃ
１日の平均相対湿度	８４．５％
１日の平均最高相対湿度	９６．３％
１日の平均最低相対湿度	６４．２％
平均年間降雨量	２，３６２．８㎜
最高年間降雨量	３，４５２．４㎜
最低年間降雨量	１，４８３．９㎜
２４時間の最高降雨量	５１２．４㎜

1.3　人口

国勢調査が行われた1990年６月現在、シンガポールの人口は3,002,800 人であった。この総人口の内シンガポール島の人口（市民及び永住者）は89.6%を占め、2,690,100 人であった。人口は1980年から1990年にかけて平均年率1.7 %で増加した。外国人人口は312,700 人で、これにはシンガポールで働いたり勉強したり住んだりしていた外国人は含まれるが、ホテルに滞在する旅行者と船の乗組員及び乗客は含まれていない。

人口の内訳は、中国系2,089,400 人、マライ系388,600 人、インド系191,000 人、その他の民族が29,200人である。中国系は人口の77.7%を占め、マライ系が14.1%、インド系が7.1 %、その他の民族が1.1 %を占める。

1.4　経済と社会

シンガポールの経済は、貿易に依存する貨物集散地から、幅広い基礎を持つ経済へと転換し、製造業、金融及び経営関連のサービス業、商業、運輸・通信が主要な部門となっている。

今日、シンガポールの経済開発戦略は広げられ、成長の一対のエンジンとして製造業とサービス業の振興に重点が置かれている。それに加えて地方企業は、地域の成長部門へ経営を多角化し、技能を高め、輸出中心の企業として発展することを奨励されている。

1990年代、アジア太平洋地域は世界の企業にとっての戦略的重要性が増すであろう。シンガポールはその可能性を基に、親・企業的かつ競争的環境を提供し続けることを目指す。国際的・地域的戦略の開発と実践のための国際的企業とのパートナーシップを重視する。

1960年代に工業化プログラムがスタートして以来、シンガポールは高度経済成長を経験してきた。国内総生産（ＧＤＰ）は1969年から1984年まで年率9.45%で成長した。しかし1985年、シンガポール経済が密接に結びついている世界経済がリセッションに陥ったことが主な原因となって、経済はマイナス成長に転じた。

その後、政府が導入した各種のコスト削減策が効を奏したこともあり、世界経済の回復もあって、シンガポールの経済は急速に回復した。現在、ＧＤＰは年率およそ６%で成長している。1990年代の今後のＧＤＰ成長率は４%から６%と予測されている。

2．シンガポールの公共事業の現状

2.1　国土開発に関する基本計画

1960年代、シンガポールが直面していた課題は直ちに都市を再建することであった。スラムを一掃し、都市の中心部を再活性化して、経済成長を支え奨励することを可能にすることであった。当時、生活環境を改善し戦後の人口爆発による住宅需要を満たすことが緊要であった。物理的成長を計画するために作成されたマスター・プランは、英国の伝統的企画の概念をモデルとしていた。それは、シンガポールが達成した急速な開発と発展に適したものではなかった。

1971年、新しい柔軟なプランが策定され、コンセプト・プランが策定されることとなった。これはシンガポールの新しい開発の指針とするために考案された、長期間にわたる土地利用と輸送の計画であった。中央集水地の回りに、高密度の住居地域、産業、都市中心部を高能力の効率的な輸送ネットワークで輪状に結合することであった。

都市化された地域の「廊下」が、本島の中心地域（中央ビジネス区域が含まれる）を中心として南部地域に沿って延びた。開発が進むにつれ、タンピネスとホウガングへ通じる２つの「廊下」が追加された。

現存するニュータウン、空港、高速道路、主要道路、ＭＲＴは、1971年のコンセプト・プランにより実現したものである。しかしコンセプト・プラン策定以来多くの社会的・経済的変化があった。1967年から1988年までに人口は1/3 増加した。2030年までには人口は370 万人に達すると予想されている。シンガポール経済は着実に成長してきた。2000年まで年率４％から６％で成長すると予測されている。この成長のための必要を満たし、高度技術や情報の分野の新しい産業の必要を満たすため、十分な土地と資源が配分されなければならない。経済成長に伴いシンガポール国民一人当たりの所得も過去25年間に1,600 シンガポール・ドルから19,500シンガポール・ドルへと著しく増えた。

人口の増加、増大する豊かさ、継続する経済成長と共に、変化するニーズに対応しシンガポール国民の生活の質を向上させるため、コンセプト・プランの見直しが必要となった。最近、シンガポールの土地の供給、我々の最大保有能力、地域社会の様々な部門のニーズを勘案してコンセプト・プランが修正された。修正コンセプト・プランは、シンガポールを優れた熱帯都市、異国情緒のある島、そして国際的中心の１つへと物理的に発展させるための企画を行うという幅広い目標を持つ。この目標は下記のことにより達成される。

i）将来のあらゆるニーズを満たす開発のために土地を守り供給すること。
ii）持続的経済成長を奨励し、調和の取れたインフラストラクチャー開発を行うこと。
iii）生活環境と労働環境の質を向上させること。
iv）生活の質を高めること。
v）アジアの都市と熱帯の島のイメージを明確に示すこと。

これらの目標を実現するためにコンセプト・プランは、シンガポールの人口が最終的に４百万台に

達するX年に向かって段階的に実施される。開発を計画的に実施することにより、シンガポールは変化する周辺環境に対応することが可能となる。企画とは動的なプロセスであり常に変化の影響を受けるものだからである。2000年、2010年、X年のコンセプト・プランをそれぞれ図－２、３、４に示す。

2.2　PWDの建設投資予算

公共事業局（PWD）の職務は、道路、学校、空港、病院、総合診療所、公立図書館、政府庁舎、美術センター等の公共事業インフラストラクチャーの開発と管理である。年間予算は下記の２グループに大別される。道路プログラム用と建築プログラム用である。過去の記録によれば、PWDが扱った道路プログラムと建築プログラムの平均年間開発支出はそれぞれおよそ２億シンガポール・ドルと３億シンガポール・ドルである。道路インフラストラクチャー及び公共建築プロジェクトが幾つか計画中であるので、今後数年間これら２つのプログラムにおけるプロジェクト支出は増大すると予想される。予測される支出を第５図に示す。

2.3　公共事業関連組織

シンガポールには、インフラストラクチャー・プロジェクトの実施に関わる公共機関が多数存在する。それらの名称とその職務を下記に挙げる。

機関	所属する省	職務
公園・レクリエーション局	国家開発省	公立公園とオープン・スペースの開発・管理
排水処理局	環境省	公共排水施設の開発と管理、民間排水施設の監督
下水処理局	環境省	公共下水処理プロジェクトの開発と管理
シンガポール港湾局	通信省	海上航行管制を含む、港湾の開発と管理
高速大量輸送事業団	通信省	高速大量輸送システムの開発と管理
シンガポール電気通信局	通信省	電気通信システムの開発と管理
公共公益設備委員会	通商産業省	電力、水、ガス等の公共公益設備の開発と管理
ジュロン・タウン事業団	通商産業省	工業団地の開発・管理と関連産業設備及びインフラストラクチャーの供給
セントサ開発事業団	通商産業省	休暇のリゾートとしてセントサの開発・売り出し・管理、他の１１の島しょの管理

2.4　主要な社会資本整備の歴史・整備状況、課題

道路開発プログラムについて下記に述べる。

道路のためのインフラストラクチャーの開発はPWDが実施した主要な事業である。シンガポールが英国の支配下にあった植民地時代から、道路の企画と建設はPWDが行ってきた。植民地時代に建

設された多くの道路や橋が、補修されたり修復されたりして今日も使われている。

独立後、人口の増加に伴い廉価な公営住宅を供給するために開発した新しい住宅用地に対応するために、そして共和国の工業化の先鋒となるために開発された工業団地に対応するために、主要な道路建設プログラムはＰＷＤが行った。これには新しい道路の建設と既存道路の改修が含まれていた。多くの都市道路が改良され、交通の流れを良くするために一方通行道路に変えられた。市から放射状に延びる道路は各方向最低３車線に拡幅され、既存道路の一部が、市街地の内と外を迂回する環状道路に改良された。また、重要な合流点での交通渋滞を緩和するために、跨道橋や立体交差点が建設された。

1960年代末以降実施された最も重要な道路プロジェクトは高速道路ネットワークであった。並木のある多くの幹線道路が建設され、印象的な跨道橋やインターチェンジがシンガポールの景観を劇的に変え、自動車交通の概念を完全に変えている。延長１４１㎞の高速道路ネットワーク（第６図）は、1990年代中に完成し、市とその衛星都市及び工業団地を互いに連結し、支線道路を通って車はこのネットワークへ出入りする。最初の高速道路であるパン・アイランド・エクスプレスウェイ（ＰＩＥ）は１３年かけて完成したが（1969年から1981年）、利用者が非常に多く、特にラッシュアワーには急速に飽和状態に近づいている。ＰＩＥの能力を拡大し交通渋滞を緩和するために拡幅が現在行われている。この他、交通の流れを改善するため、これらの高速道路とのインターチェンジの一部の改良が行われている。

道路及び高速道路建設における主な問題は、土地の不足、影響を受ける住民の移住、そして地盤の状態が良くないことである。狭く、土地が少なく、人口が密集しており高度に都市化されているため、シンガポールの主要な道路開発・改良プログラムは、道路開発のための土地の確保等で多くの人々に影響を及ぼさざるを得ない。用地整備や地盤改良のための時間を殆ど取れないのが現実である。シンガポールの地表のおよそ３０％が非常に圧縮し易い軟弱地盤に被われていることが事態を更に悪くしている。その結果、埋め立て地や軟弱心土の上に建設された道路はしばしば建設中や完成後に沈下するという問題が起こった。基礎のない平面の道路が杭に支持された橋や跨道橋と接続する部分で沈下の問題は最も深刻であった。ＰＷＤは建設中に時間が許す限り道路の重要な区間で地盤改良を実施してきた。残念ながら建設段階で沈下を完全になくすことは出来なかった。沈下は続き、道路の走行性に影響を与え、供用中の修理や再舗装を余儀なくされた。

土地不足は、道路が住宅地域の中や側を通る場合、新しい道路の建設や既存の道路の拡幅が交通騒音問題を起こす場合が多いことを意味する。現行の企画指針は、住宅地域と高速道路の間に３０ｍの緩衝地帯を設けることを要求している。しかし既存の住宅地域にこの指針を適用することは容易ではなかった。ＰＷＤは交通騒音の問題を研究するために騒音調査を実施してきた。幾つかの解決方法が可能である。しかしそれらの解決方法がシンガポールの場合実行可能であり効果的であるかどうか不明である。

現在シンガポールの土地の約１０％を道路が占めている。道路ネットワークを更に拡大するために利用出来る土地の量は限られている。道路建設用地の不足を解消する方法として地下道路の建設が考慮されている。

2.5　進行中の主要プロジェクト

シンガポールの公共事業当局であるＰＷＤは主要な公共インフラストラクチャー・プロジェクトの企画と実施を職務とする。1990年代中にＰＷＤは道路開発プロジェクトに５０億シンガポール・ドルを、そして建築開発プロジェクトに７５億シンガポール・ドルを支出すると予測されている。その上、道路と建物の保守のための年間支出は現在の約６５００万シンガポール・ドルから今後５年以内に１億シンガポール・ドル以上に増えると推定されている。

実施中及び準備中の主要な建築プログラムは下記のとおりである。

プロジェクト	概算コスト（１００万Ｓ$）
中学校建築プログラム	８７３
３４の中学校建設と既存１７中学校の改築を含む	
ＫＫ病院再開発	２７７
中央合同庁舎	１３８
新出入国ビルディング	１２１
保健国民歯科センター・ビル	１６８
新議会複合ビル	１００
チャンギ空港ターミナル^　改装	１７０
チャンギ空港ターミナル_　拡張	３００
チャンギ空港第`期	１０００
シンガポール美術センター	７８０
新国立図書館	８０
新文部省本部	１８０
チャンギ刑務所再開発	６４５
タン・トク・セン病院再開発	３２３
東部総合病院	２４８
テマセク総合技術専門学校	３４０
新森林チェックポイント	１５５
ヒル・ストリート警察署	６３

道路建設プログラムと建築プログラムは同時に進行するであろう。シンガポールの高速道路ネットワークの建設は1960年代末に開始された。現在、高速道路ネットワークのおよそ８３%が完成しており、その中には中央高速道路の一部である地下道 2.4㎞が含まれる。今世紀末までには高速道路ネットワーク全体が完成する予定である。

ＰＷＤは高速道路建設プログラムの他に、地下道約９０車線・キロメートルの建設を含むもう１つの大規模な道路開発プログラムを計画している。シンガポールの内側環状道路に続くものとして、そして水域をマリーナ南からマリーナ東へ横切るものとして、シンガポール地下道システム（ＳＵＲＳ）が環状道路システムとして計画されている（平面線形案については第７図参照）。これにより中央商業地区（ＣＢＤ）とその周辺地域の全道路容量は既存の幹線道路の容量よりおよそ４０％増大するであろう。そして主な「廊下」と交差点の交通渋滞を緩和する助けになるであろう。ＳＵＲＳは2030年までＣＢＤ内の交通需要に対応することとなる。ＳＵＲＳの概算コストは４０億ドルである。これは段階的に実施され、１０年から１５年以内に完成する予定である。フィージビリティー・スタディーは完了、エンジニアリング・デザインは始まっている。建設は1994年に着手される予定である。

地下道システムに加えて、島全体の２１世紀の交通需要に対応するため、現在の幹線道路を改良し新しい道路を建設してセミ・エクスプレスウェイ・システムを作る計画がある。

新しい道路開発プログラムがシンガポールの道路容量を更に大きくする一方、ＰＷＤは現在の交通管理システムの効率向上により道路容量を最大にする方法と手段を積極的に調査している。エリア・ライセンス方式（ＡＬＳ）はＣＢＤ内の交通渋滞を防止するためにＰＷＤが1975年に導入した最もユニークでよく知られた措置の１つである。この方式に基づき、午前と午後のラッシュアワーに規制区域（ＲＺ）－ＣＢＤ内の７２５ヘクタールが規制区域である－に進入するドライバーは料金を支払わなければならないこととなる。つまりＡＬＳは道路有料化の１形態であり、手動で操作される。今後数年のうちに電子道路有料化（ＥＲＰ）システムがＡＬＳ方式に代わるであろう。ＥＲＰは、ＰＷＤがＡＬＳ及び週末自動車登録方式に代えて導入する新テクノロジーである。今後数年のうちに実施されれば、シンガポールは世界で最も洗練された電子交通管理システムを持つことになる。いずれＥＲＰは市の中心を離れた地域と将来の地方中心地へ延長される。ＰＷＤはＡＬＳの他にグリーン・リンク・ディターミニング・システム（ＧＬＩＤＥ）と呼ばれる交通対策を導入した。ＧＬＩＤＥはコンピュータによる交通信号制御システムであり、信号のタイミングを中央で監視することが出来、変化する交通状況に適合するように絶えず調節することが出来る。このシステムは既存道路の容量を最大限に利用することを可能にし、交通の流れをスムーズにする。ＧＬＩＤＥは1988年にＣＢＤに導入され、島の他の地域への延長が行われているところである。

3．公共事業局（ＰＷＤ）における研究開発

3.1　シンガポール公共事業局の歴史

公共事業局（ＰＷＤ）の歴史は、島で初めて公共事業監督者が任命された1833年に遡る。この時期海峡植民地（シンガポールはその一部である）は英国が統治するインドの植民地政権に支配されていた。

地元の商業界の進歩と圧力を受けて英国は1867年、海峡植民地の統治をロンドンの植民省の直接統治へ移行するため、直轄植民地を設けることを決定した。更なる発展に伴い、最初の海峡植民地公共事業省が1872年に設置された。1930年代末にはＰＷＤは公共事業長官を長として４５人のスタッフを擁する規模に成長していた。本部はシンガポールに置かれた。

第二次大戦後シンガポールは英国から自治を獲得しシンガポール公共事業省が生まれた。1950年代、ＰＷＤの課題は増加する人口と繁栄する市のために生活の基本的便益を確立することであった。

1954年、新しいアッセンブリー・ハウス（現パーラメント・ハウス）－議事堂－が修復された。翌年パヤ・レバール空港が完成し、1956年にはタン・トク・セン病院に新しい病棟が１棟完成した。この年メルデカ橋（マライ語で「自由と独立」の意）も完成した。1959年５月、独立が達成され、人民行動党が圧勝し、ＰＷＤにとって新しい時代が始まった。完全な国内自治に基づき、新しい指導者達は自治市のような地方当局を廃止し、同年１１月最初の地方公共事業長官が任命された。

国家建設の作業が本格的に始まり、ＰＷＤは重要な役割を演じた。1960年代には、多くの「初めての」があった。初めての図書館である国立図書館は1960年に完成した。1964年には初めての高層駐車場が出来、初めての歩行者跨道橋、初めての地下歩道が出来た。1966年、初めての常設テレビ・スタジオが完成した。1968年には初めての短期大学が設立された。

1970年代へ移行する頃にはシンガポールの政治情勢は安定していた。ベビー・ブーム世代の子供たちは学齢に達しており、1973年に最初の学校建設プログラムが開始された。この年、東南アジア半島競技大会開催のためのナショナル・スタジアムが完成した。

1970年代はＰＷＤ内部も変化した。1972年、建設管理の職務がＰＷＤへ移管された。排水・下水の職務は環境省へ移管され、公園・レクリエーションの職務を司る独立の部が設置された。この時期までに、シンガポールを公園都市にする重要な基礎は既に敷かれていた。

1980年代へ移行するとＰＷＤは、豊かな車好きの市民に遅れないように高速ギアに切り換え追い越し車線へ入って行った。多くの道路が建設され既存道路が拡幅されたが、1980年代はまさに高速道路の１０年であり、1981年にはパン・アイランド・エクスプレスウェイ、イースト・コースト・パークウェイ、ベンジャミン・シアーズ橋が開通した。1985年、ブキット・ティマ・エクスプレスウェイが道路ネットワークに加わり、続いて1988年にはアイア・ラジャ・エクスプレスウェイが加わった。セントラル・エクスプレスウェイ（ＣＴＥ）トンネル・システムが1991年９月に開通し、シンガポール市民は新しい道路交通時代に入った。

1980年代にはチャンギ空港第Ｉ期工事が完了し、1981年に開港した。第二滑走路は1984年に完成し、1991年にはターミナルＩの営業開始後僅か１０年でターミナル２の営業が開始された。

今後もＰＷＤはより意欲的な事業に着手し、シンガポールを優れた熱帯都市へと発展させていくであろう。

3.2　組織図

ＰＷＤは公共事業局長を長とし、次長が補佐する。局は５つの部から成り、各部に部長が置かれている。５つの部とそれぞれの職務は下記のとおりである。

i）法人事業部

財政・人事・管理・広報・コンピュータ化の業務を局に提供する。

ii）建設管理部

建築の安全確保のため民間の建設工事の規制を行い、民間建築物がその所有者により十分維持管理されることを確実にし、民間の住宅購入者の利益を守る。

iii）専門事業部

学校、短期大学、消防署、刑務所、庁舎等の政府建物建設の企画、設計、監督を行う。

iv）開発管理事業部

コンサルタント業務の開発。これにはプロジェクト開発事業、プロジェクト管理事業、財産管理事業が含まれる。

v）道路・運輸部

公道、高架横断道路、橋、歩道の企画、設計、建設、保守。道路ネットワーク利用の最大化と道路安全策の実施、駐車政策の実施。

ＰＷＤの組織図を第８図に示す。ＰＷＤは約１５００人の職員を擁し、この中２０％は専門家スタッフである。

3.3　予算

政府の１局であるＰＷＤの運営予算は全額政府から支給される。年間予算は２つの要素、即ち経常支出と開発支出に大別される。経常支出は主として人件費とその他の運営費－ユーティリティ、文房具、旅費、事務機器の購入と保守、政府建物・道路等の保守など－から成る。開発支出は道路建設と建物建設のための年次開発予算から成る。

1993会計年度（1993年４月１日から1994年３月31日まで）のＰＷＤ年間予算における支出項目は下記のとおりである。

項目	年間支出（百万シンガポール・ドル）
人件費	７０
その他の運営費（政府建物と道路の保守を含む）	１１７
道路開発	３８４

3.4　主な研究設備

人員不足のため、ＰＷＤ内には研究を実施するための常設研究施設が無い。ＰＷＤでは伝統的にＰＷＤ工学研究所が主導的役割を演じてＰＷＤ内の研究開発を行ってきた。ＰＷＤ工学研究所は、土壌、コンクリート、鉄鋼、道路舗装材料等の建設材料の日常の試験も行っている。この研究所はシンガポール最古のものであり、有数の土木材料試験所の１つでもある。近年では、ＰＷＤ専門事業部の各専門部局が担当する応用Ｒ＆Ｄプロジェクトが次第に増え、専門家がそれぞれの専門分野で技能や知識を磨いている。

シンガポールでは多くの組織がＲ＆Ｄ活動に参加している。シンガポールの２大学－即ち国立シンガポール大学（ＮＵＳ）とナンヤン工科大学（ＮＴＵ）－には優れた研究設備があり、優秀なスタッフが建築・土木工学関連のＲ＆Ｄを行っている。ＰＷＤはＮＵＳともＮＴＵとも共同でＲ＆Ｄプロジェクトを実施してきた。こうした共同研究開発業務は、大学の優れた研究設備を使う機会をＰＷＤに提供するばかりでなく、ＰＷＤの技術者が自分の実際的経験と問題を大学人と分かち合うことを可能にもする。これら第三の機関を通してＰＷＤは、最近その共同研究を東京工業大学等の外国の機関に拡大した。

４．ＰＷＤの主要な研究開発プロジェクト

4.1　研究開発プロジェクト名

最近完了した研究開発プロジェクトは下記のとおりである。

i）ブキット・ティマ花崗岩盤に地下洞穴を掘って多様な用途に供することに関するフィージビリティー・スタディ

これはＰＷＤとナンヤン工科大学（ＮＴＵ）との共同研究であり、ブキット・ティマ花崗岩盤に地下空間を設けて様々な用途に用いることの実行可能性調査を目的とする。シンガポールでは土地が不足しているため、地下を利用することが必要である。このプロジェクトはシンガポール中央部及び北部のブキット・ティマ花崗岩盤をこの目的のために開発するために委託されたものである。

このプロジェクトには政府が資金を供給し、予算は１５０万シンガポール・ドルである。1989年１月に開始され、1993年に完了した。

ii）企画・設計指針作成に関し、シンガポールの地域社会の騒音研究

これはＰＷＤと国立シンガポール大学（ＮＵＳ）との共同プロジェクトであった。シンガポール市民の音響環境に対する反応を評価するために様々なタイプの建物の騒音問題を調査し、各建物のタイプに対して騒音基準を決定することを目的とした。調査は学校や病院、オフィス・ビル、ホテル、図書館、公共リゾートなどの建物について行われた。

このプロジェクトは1989年10月に開始され、1993年に完了した。費用は３１万シンガポール・ドルであった。

iii) 建物の欠陥についての科学的研究

このプロジェクトもＰＷＤとＮＵＳの共同研究であった。これは、シンガポールにおける建物の欠陥及び鉄筋コンクリートの亀裂と劣化の原因となる要因を研究するための基礎知識の総合的調査と開発を目的とした。

このプロジェクトは1992年６月に開始され1993年に完了した。費用は４１万シンガポール・ドルであった。

iv) シンガポールにおける交通負荷調査

このプロジェクトはＰＷＤとＮＵＳ交通研究センターの共同研究として行われたもので、シンガポールの道路の交通負荷の特徴の研究を目的とした。これまでシンガポールの道路は特に英国等外国の設計基準に基づいて建設されていた。このプロジェクトは、道路の企画・設計に有益な交通負荷レベルに関する情報を提供した。

このプロジェクトは1991年12月に開始され1993年に完了した。総費用は９１万５０００シンガポール・ドルであった。

4.2　進行中の研究開発

ＰＷＤは現在多くの研究開発プロジェクトを実施中である。それらは要約下記のとおりである。

i) シンガポールの特に高層建築物に与えるスマトラ地震の影響

このプロジェクトはＮＴＵとの共同研究である。

シンガポールに最も近い既知の活断層は、およそ４００㎞離れた所にあるスマトラ断層である。メキシコ地震（マグニチュード 8.1、1985年９月19日）による災害においては、震央から約４００㎞離れたメキシコシティの湖床の粘土質堆積物の構造的損傷が最も大きかった。これは、離れた場所の地震ネットワークが起こす地動が局所的に増幅されて損傷をもたらすことを示している。

シンガポールでは陸地のおよそ３０％が軟弱土壌で被われており、こうした厚い軟弱土壌層が遠くの地震で発生した岩盤動を増幅し市内の建物を損傷する可能性がある。

この共同研究は設計スマトラ地震が発する地震波がシンガポールの建築物－特に高層建物－に与える影響を評価するである。プロジェクトには、分析用の地震データの入手と、２棟の商業ビルと２棟の居住用ビルの構造評価のための設計地震の確立が含まれている。

この研究プロジェクトは３年の期間と概算８２万シンガポール・ドルの費用をかけて実施される。

ii) 掘削と付近の建物の支持システムの相互作用

このプロジェクトはＮＵＳとの共同研究であり、1993年１月に開始され1995年１月に完了する予定である。費用は概算２０万シンガポール・ドルである。

ＰＷＤは近年、多くの深基礎プロジェクトの設計と建設を行ってきた。更に多くのプロジェクトが

準備中である。基礎工事における主要な注意点の１つは掘削に対する支持システムであり、これは周辺の建物や敷地に掘削の影響を及ぼさないものでなければならない。土木工事のこの面に関しては目下設計指針は皆無である。従ってこのプロジェクトの目的は、現地の土壌に基づく適切な構造モデルを使って、正確に較正された数値コードと設計指針を開発することである。このコードにより技術者たちは深掘削工事周辺の地盤の変位と変形を正確に把握することが可能となり、最も経済的な設計を行うことが可能になるであろう。方法としては、遠心分離試験と有限要素模擬実験技術が含まれる。最近東京工業大学がこの共同研究分野のパートナーとなった。

iii）出入り用通路のルーバーとエキスパンション・チェンバーを通る爆風圧力の研究と、シェルターの衝撃分析と設計要件

このプロジェクトは1991年７月に開始され1994年６月に完了の予定である。タイトルが示すとおりこのプロジェクトは民間防御シェルターの設計に関するものであり、技術的課題を解決し下記の目的を達成することを目指す。

i）通路及び防風扉設計のため、出入り用通路での爆風圧力の伝播を予測する方法の確立。

ii）防風ルーバーとエキスパンション・チェンバーの色々な配置の効果の確認。

iii）民間防御シェルター内の人命と生命維持に必要な機器を保護するための設計要件の確立。

プロジェクトの重点は各分野の分析と設計の改善につながるソフトウェアの開発に置かれており、研究費は４６万１０００シンガポール・ドルである。

4.3　研究開発推進上の課題

シンガポールは建築土木分野のＲ＆Ｄ活動において下記の問題に直面した。

i）人的資源の不足

建築・土木分野のＲ＆Ｄ作業実施の研修を受けた人材が全般的に不足している。建設ブームのためシンガポールでは現在労働市場の供給が少ないので特にそうである。シンガポールの建築・土木専門家の殆どは新プロジェクトの企画、設計、建設や既存の建築インフラストラクチャーの保守管理に従事している。建築・土木のＲ＆Ｄ実施に優れた人材を引きつけるには困難がある。これは、ＰＷＤと地方大学が共同で実施している幾つかの研究プロジェクトの研究スタッフの異動率が高い理由となっている。

ii）研究設備の不足

シンガポールは小さい国であり、地方の建設市場は大きくない。この制約が地方の建設会社の規模を限られたものにしている。殆どの地方建設会社は、数社の比較的大規模なものを除き、Ｒ＆Ｄ作業を実施する技術的能力と財政的能力がない。建設産業の特徴である好況と不況の循環も、地方建設会社の長期的企画と研究開発実施の意欲を削いでいる。その結果、建築・土木のＲ＆Ｄ作業は主に大規模な国営機関と大学機関で行われている。

iii）現在Ｒ＆Ｄ活動の殆どは政府に援助されており、科学技術委員会（ＮＳＴＢ）を通している。科学技術委員会はシンガポールのＲ＆Ｄ活動を推進するために政府が設置した法定組織である。現在まで、ＮＳＴＢは高度技術、製造業、サービス産業の競争力を高めるようなＲ＆Ｄ活動の推進を重点的に行ってきた。建設産業は輸出の可能性が限られており経済への貢献が小さいため、低い優先順位しか与えられていない。従って建築・土木関連のＲ＆Ｄ活動に対する政府の財政援助を確保することは、他の産業よりも困難である。

５．国際研究交流プログラム

5.1　現況

過去数年間ＰＷＤは幾つかの国際的研究交流プログラムに係わってきた。それらは下記のとおりである。

i）材料科学技術に関する日本－アセアン協力プログラム

このプログラムに基づくシンガポールのプロジェクトは構造物の腐食防止についてであった。このシンガポール・プロジェクトに直接参加した機関はＪＩＣＡ、日本の建設省、運輸省、シンガポールの科学審議会、住宅開発委員会、シンガポール港湾局、国立シンガポール大学、シンガポール規格及び産業研究所であった。ＰＷＤはこのプロジェクトに直接参加はしなかったが、このプロジェクトのために開催された審議やセミナーに参加している。

このシンガポール・プロジェクトは1987年８月に開始された。飲料水貯蔵タンクの腐食防止と港湾のコンクリート建造物の腐食防止について研究が行われた。プロジェクトは1990年に完了し、1990年９月にシンガポールでセミナーが開催され、各日本－アセアンＲ＆Ｄプロジェクトの成果が発表された。シンガポールの港湾建造物の腐食防止に関する研究プロジェクトに関し、技術協力を（1990年９月から）更に２年間延長して研究活動を継続し腐食防止マニュアルを完成させることが決定された。

ii）沖合保護調整委員会（ＣＣＯＰ）プログラム

シンガポールはＣＣＯＰのメンバーである。以前はＰＷＤが代表を務めていたが、行政的理由から経済開発委員会（ＥＤＢ）が代表を務めることとなった。ＣＣＯＰにおけるシンガポールの代表はＥＤＢではあるが、ＰＷＤはＥＤＢへの助言やＣＣＯＰが実施する研修プログラムや活動に参加するなど、ＣＣＯＰにおいて活発な役割を果たし続けている。1990年７月23日から８月４日まで、ＣＣＯＰは「陸海工学と地球物理学的環境技術に関する予備研修」についてのワークショップをシンガポールで開催し、ワークショップはＰＷＤが主催した。ＰＷＤ職員は1991年にハワイと中国で開催されたＣＣＯＰワークショップにも参加した。ＰＷＤは現在、ＣＣＯＰ専門家による岩石学的・古生物学的分析に供するため、シンガポール西部の試錐孔の１つから回収された幾つかの石灰石コア（＝円筒形標

本）を提供している。

iii）国際原子力機関（ＩＡＥＡ）

ＰＷＤはＩＡＥＡ開催の審議や研修プログラムにも参加した。ＩＡＥＡの活動では、シンガポールの代表はシンガポール科学審議会（現科学技術委員会）が務めた。これまでＰＷＤは放射能を土木工学に応用するプロジェクトに直接参加することはなかったが、シンガポール科学審議会と共に、土木工事に放射能技術を応用する可能性についてＩＡＥＡの日本人専門家と話し合った。ＰＷＤ職員はＵＮＤＰ、ＩＡＥＡ、ＲＣＡが日本で開催した「非金属材料」に関するワークショップにも参加した。

5.2　実施上の課題

人的資源の不足はＰＷＤ内でのＲ＆Ｄ推進を制約しているばかりでなく、国際研究開発交流プログラムの推進における制約でもある。現在の交流プログラムは研修と開発に重点が置かれている。例えば、ＰＷＤはＪＩＣＡグループ研修制度、コロンボ計画奨学制度、英連邦奨学制度等のプログラムに従ってＰＷＤの専門家を大学の講習や実習、研究のため定期的に海外へ派遣している。ＰＷＤはその返礼にコロンボ計画研修制度に従いアセアンのカウンターパートからの申込に応じて研修制度を設けている。

シンガポールでは建築・土木工学関連のＲ＆Ｄ活動を行っている機関は多い。Ｒ＆Ｄ分野でシンガポールとの協力を考えている外国の機関にとって的確な機関を選ぶのは多少困難かも知れない。

６．「災害および防災」に関する取り組み

［6.1～6.3　省略］

７．「環境と社会資本整備の調和」に関する取り組み

7.1　要旨

シンガポールは1992年、開発と環境の調和の原則に対応するための戦略的方向を定めるグリーン・プランを策定した。グリーン・プラン運動は、環境に強い関心を持つ国民を育成し、環境保全と低公害技術を推進し、地域及び地球環境保護の努力を強化することを目的とする。これらの戦略的方向に基づいてアクション・プランが策定され、現在実施されている。

これらのアクション・プランには、固体廃棄物管理、廃水管理、排水システムと水域、環境管理と保護、自然保護、危険物管理、環境教育、環境技術その他が含まれる。

グリーン・プランの長期目標は、持続可能な社会・経済開発の文脈の中でシンガポールを緑の都市のモデルとして発展させることである。

7.2 シンガポールの現状と課題

シンガポールはこの30年間にわたり、環境の管理と保護のために社会資本を総合的、かつ、効果的に開発してきた。環境保全の必要性は重視されており、他の分野から切迫した財政上の要求が出された場合でも、おろそかにしてきたことはありませんでした。しかし、取り組まなければならない以下の問題がある。

a) 固形廃棄物の処理

現在、国内のゴミの収集水準は1年間に約 2.2百万トンである。このゴミは一人一日当たり、約 1.1 kg となる。

毎日のゴミの収集業務は、確実に実施されていますが、依然として人力による収集態勢が主力となっており、技術水準はかなり低く、労働集約型となっている。

シンガポールは、限られた実状と、他の目的に使用するための土地の需要が増大し、激しい取得競争が行われているので、地下埋込み式のゴミ処理施設用の土地や不燃ゴミおよび消却灰を廃棄できる土地が限られている。現在の地下埋込み式の処理場は、1997 までに満杯になる。

b) 排水管理

すべての排水は海や河口に排出される前に処理される。排水の量は1985 年の 2 億5 千万立方メートルから、1992 には、約 3 億 5 千万立方メートルトンに増加し、2000 年には、4 億 7 千 5 百万立方メートルに達すると想定される。

現在、シンガポールでは、約 2250 キロメートルの下水道と 6 箇所の汚水処理場で構成される 5,520 億Ｓ$の下水処理の網目状組織が配置されている。6 つの排水処理施設は、開放設計で、処理装置が国内の多数の場所に配置されている。臭気が強烈なところでは、臭気の放出がいまも問題となっている。

C) 産業界からの大気汚染

産業施設および発電施設からの排気は大気汚染の主要な源です。これらの施設では、放出基準に準拠した流出ガス浄化装置を設置しています。今日、われわれの周囲にあるすべての大気の汚染度は、世界保健機関（WHO）および米国環境保護局（US EPA ）の基準値以内ですが、産業および経済部門の発展が継続されるのにともない、燃料の使用量は対応して増加する。二酸化硫黄、窒素酸化物、二酸化炭素、および、ばいじん（微粒子）の放出量も、増加する。

d) 埋立の環境への影響

シンガポールは、過去に、海岸地域から約 6,500 ヘクタールの土地を埋立ててきた。 2000 年までには約 2,100 ヘクタールの土地が埋立てられます。その後、他に5,300 ヘクタールが埋立ら

れる予定である。以前に行われた埋立プロジェクトでは、環境への影響に関するアセスメントは1つ、ないし2つの方法で実施されてきましたが、主として流動モデルの調査と水質の変化に対するアセスメントに限られていた。 今後は珊瑚礁、マングローブ自生地、および海洋生物にたいする影響に　　ついて精力的なアセスメントを行うことが必要となる。

7.3　環境改善に関する活動

環境改善活動の要約は以下の通りです。

i) 不燃ゴミおよび消却灰の処分用の沖合の地下埋込み処理施設の研究

ii) すべての排水処理施設を 1993 年から40 年以上の期間で段階的にコンパクト化し、遮蔽された設計にし、その中に臭気ガスを閉じこめるようにして施設の性能を高める。

iii) ゴミの少い社会を目指し、再生、再使用およびリサイクルを通してゴミを最小限にすることを奨励し、現在、一人一日当たり 1.1 kg 発生している固形ゴミの重量 を 2010 年までに 0.9kg までに減少させる。

iv) 開口溝および運河は改修し、流れの一部を利用してリクリエーション活動ができる審美的で、人々を楽しませる水路へと改良する。

v) 1995年までに公害の監視を自動化し、高性能にする。大気監視用の相対成長アロメトリ機構を適所に設置する。

vi) 2010年までには、二次処理流出水を海岸地区に排出しない。

7.4 地球環境と生活環境を考慮した社会資本整備に関する活動

i) 無鉛ガソリンは、1991 年 1 月に導入された。1991 年の 2 月に奨励金制度が導入され、無鉛ガソリンは標準ガソリンより安くなった。ドライバーの半数は、1991 年 3 月までに自動車 を無鉛ガソリンに切り換えて無鉛ガソリンを使用することが可能である。このパーセンテージは増え続けており、1991 年の 7 月からは、すべての輸入新車は、無鉛ガソリンで走行しなければならなくなる。

ii) 消火器、消火装置および冷蔵庫に使用されるCFC制御支援ハロンは、1998 年までに徐々に廃止される。フロンガスの使用量を削減するため、非薬剤のエアゾールおよびポリスチレンシート・フロンガスを含有する製品の輸入と製造が 1991 年に禁止された。

iii) 現在、約 2,000 ヘクタール、つまり、約 3 パーセントの土地が自然保護のために確保されている。長期的には、国土の 5 パーセントが完全に埋め立てられた後、自然保護のために確保され、自然が認識されて、国の天然資源に一層の関心を高めるようにしている。

８．今後論議したい課題

ＰＷＤは、高度に開発された都市地域に大規模な地下道路システムの建設に着手することとなるので、道路用トンネル建設が隣接する施設に与える影響に特に関心を持っている。影響には、建設中に発生する騒音と振動、掘削による地動、トンネル営業による入口の騒音と大気汚染が含まれる。

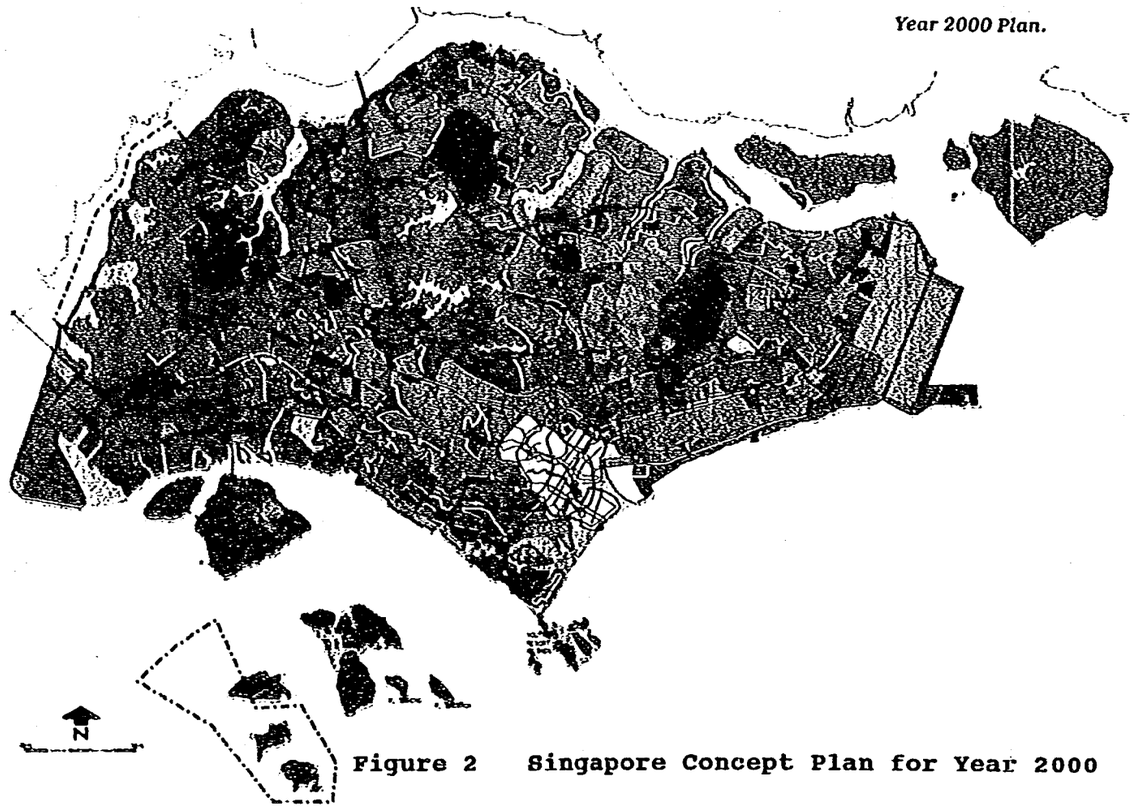
海を埋め立てて約 7,600ヘクタールの土地を得る。不燃廃棄物と焼却灰を処分するための埋め立て所を沖合に設けることも我々は提案する。こうした埋め立てプロジェクトと沖合廃棄物処分場開発において我々は環境に与える影響に関心を持っており、生態系と環境に十分配慮しその保全のためにあらゆる必要な措置を取る。

シンガポールは土地が不足しているため、地下空間のより有効な利用の可能性を調査することが必要になるであろう。全般的に土壌が軟弱である都市地域の地下空間の利用に加えて、堅固な花崗岩盤を持つブキット・ティマ地域も、地下空間を設けて色々な用途に使える可能性が非常に高い。

上記に基づき、日本の関連専門家たちと更に話し合うために下記の事柄を提案する。

i) 開削式工法及び掘削式工法による道路トンネルの建設。
ii) 軟弱土壌での道路トンネル建設が、ＭＲＴトンネルや建物基礎、公共施設等の隣接構造物に与える影響とその予測。
iii) 軟弱土壌における深掘削の影響を受ける構造物の補強。
iv) 特に海洋生物と植物に対する、海岸地域の埋め立ての環境影響評価。
v) 地下空間開発の技術と政策。

Year 2000 Plan.



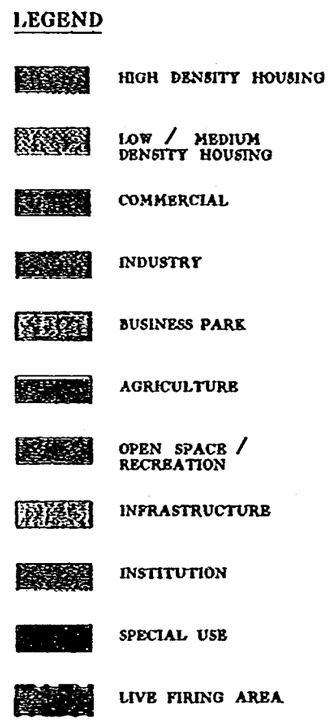
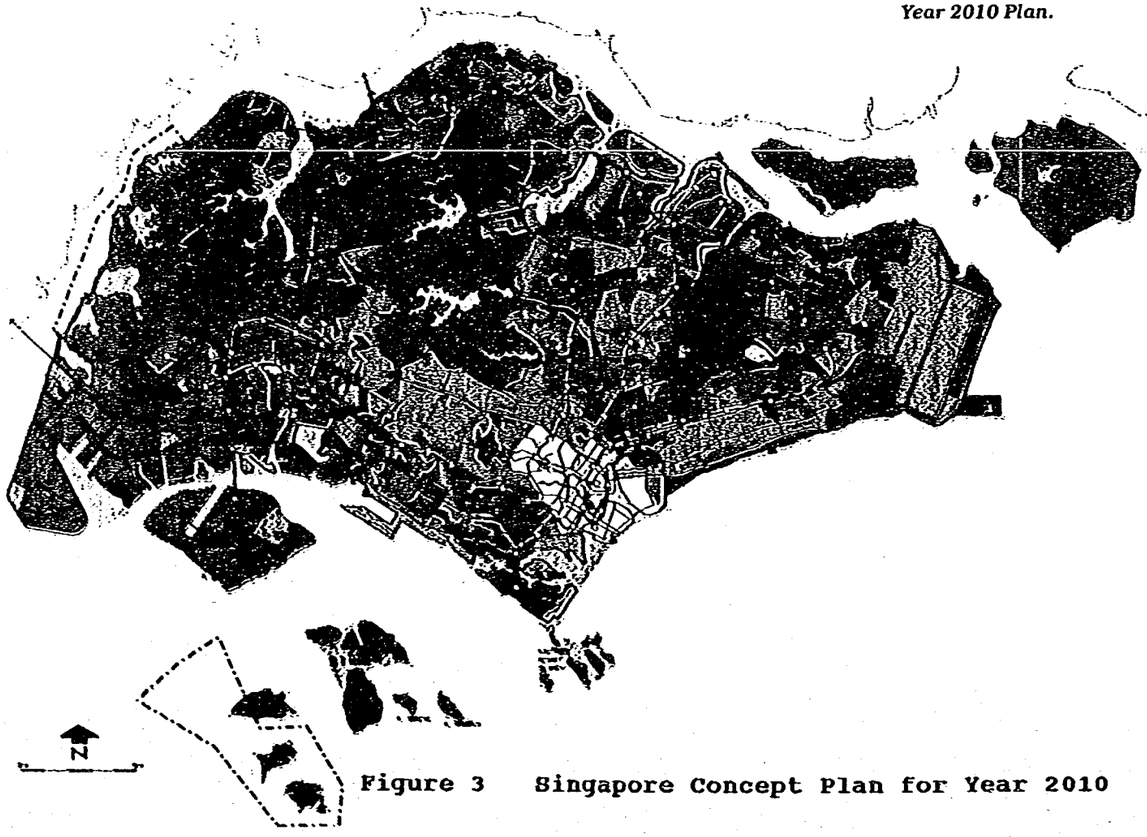
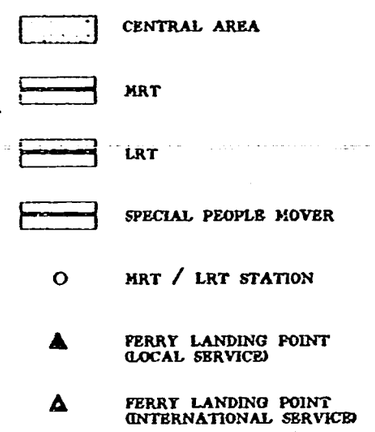


Figure 2 Singapore Concept Plan for Year 2000

Year 2010 Plan.





These plans are part of the vision of Singapore's future. But the timing of developments depends on demand.

Figure 3 Singapore Concept Plan for Year 2010

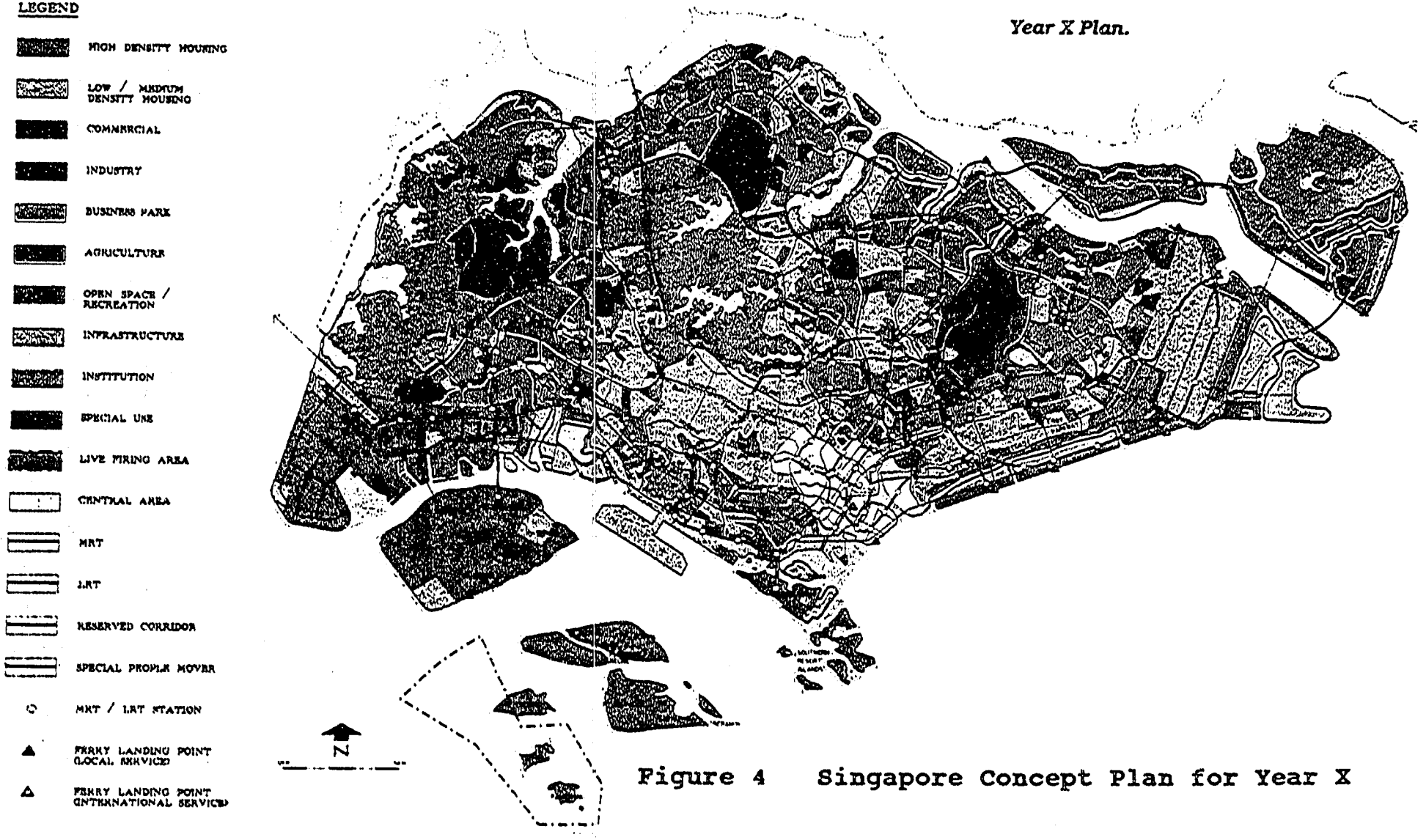
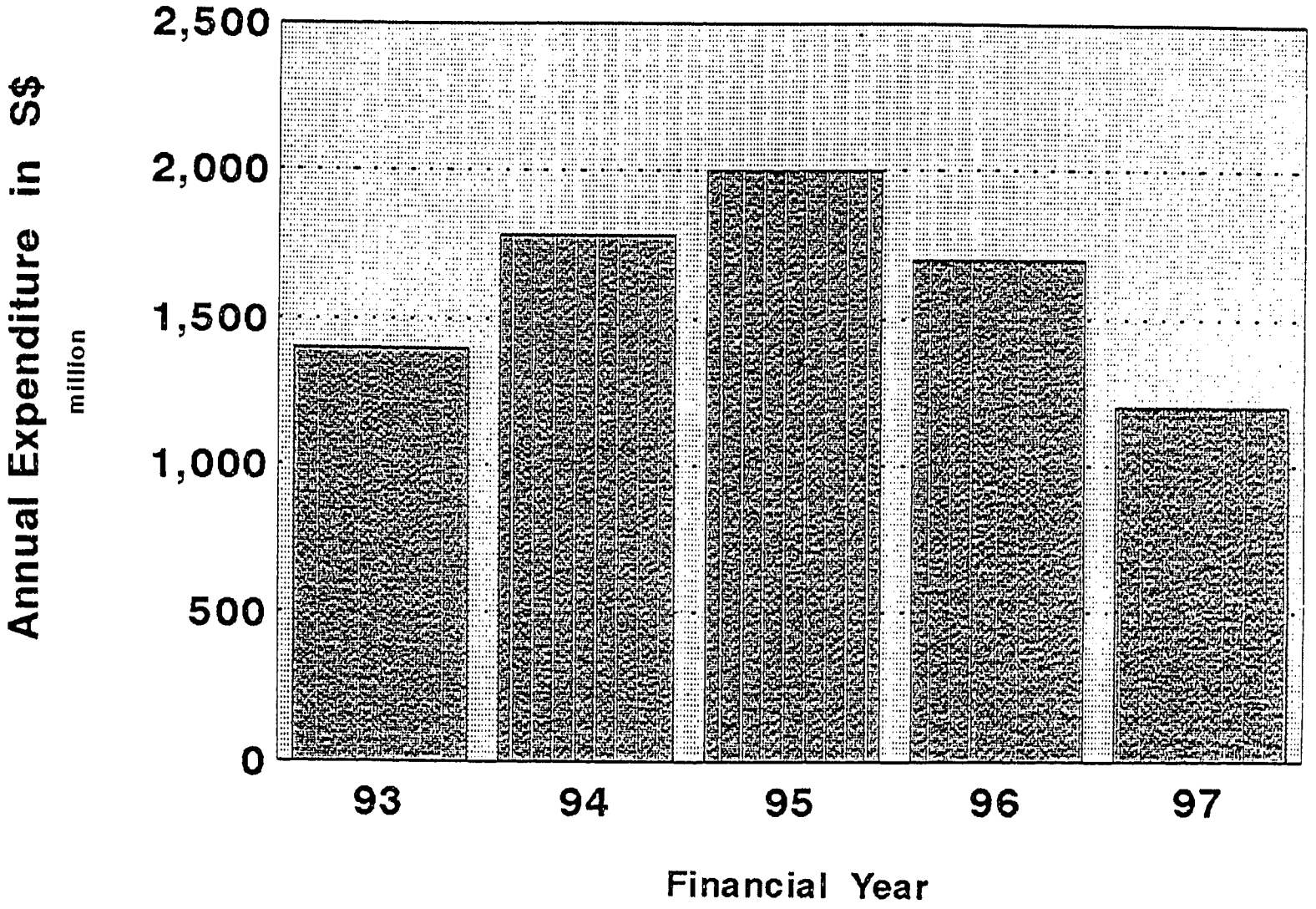


Figure 4 Singapore Concept Plan for Year X

Figure 5 Projected Total Budget



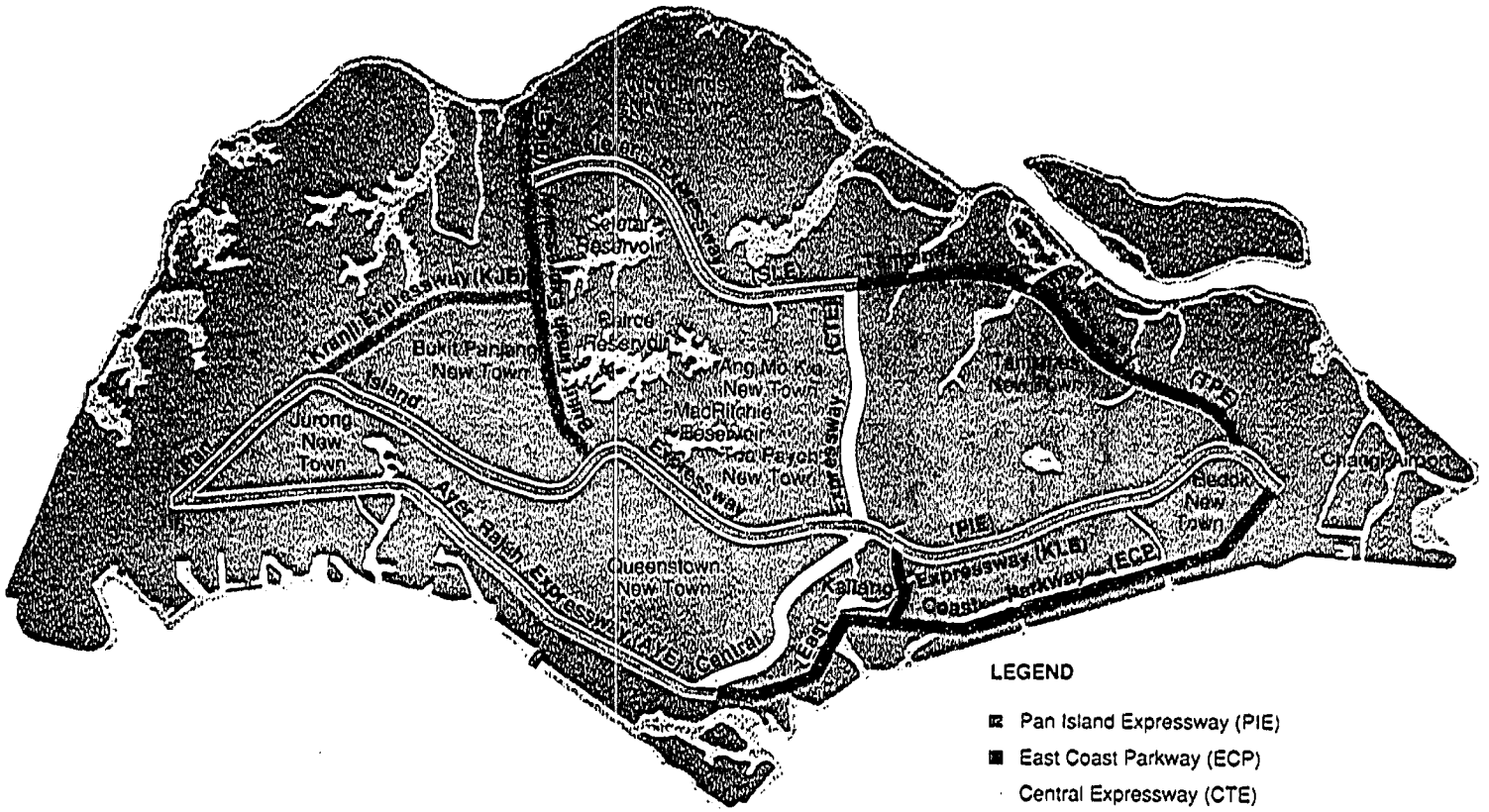


Figure 6 Singapore Expressway Network

By the end of the 1990s nine expressways will cross the island

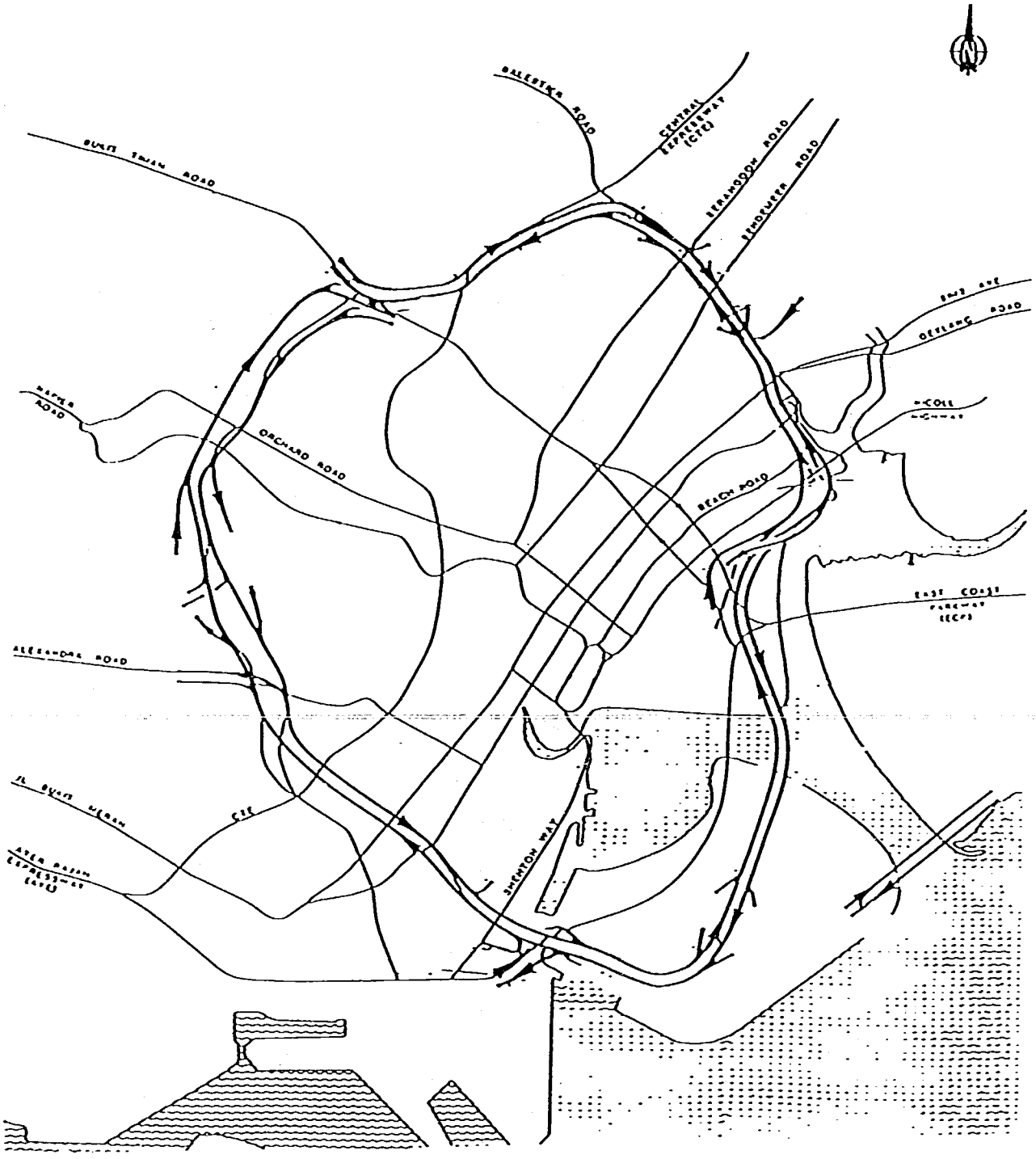


Figure 7 Proposed Singapore Underground Road System (SURS)

ORGANISATION STRUCTURE OF THE PUBLIC WORKS DEPARTMENT

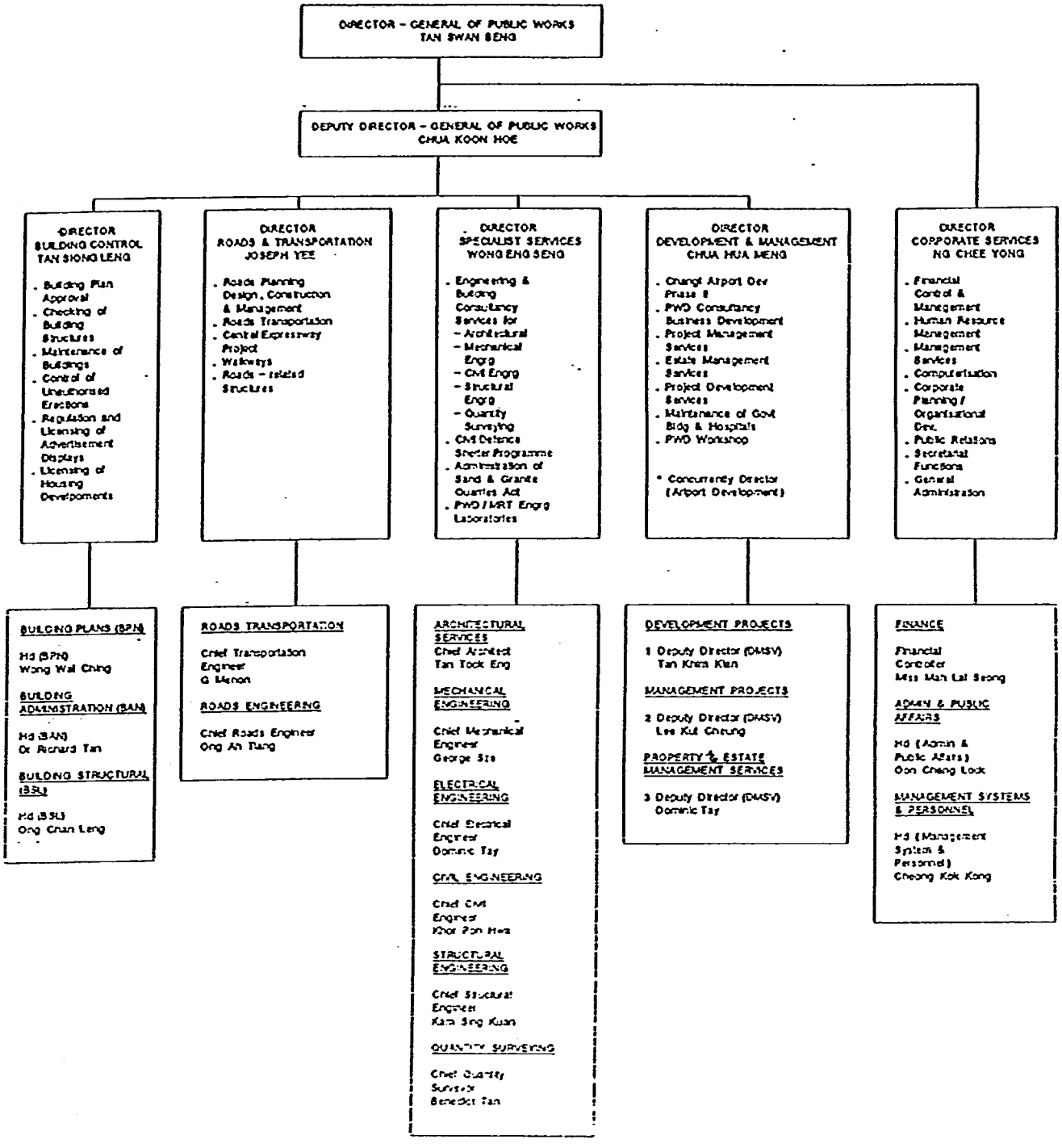


Figure 8 Organisation Chart of Public Works Department, Singapore

Ⅶ. タ イ 王 国

タイ内務省公共事業局材料研究部長　Anusornant Mahavinichaimontri

１．タイ国の概要

１．１　国土

タイ国は東南アジア陸地部の中心に位置し（図１．１、１．２）、北緯５度３０分から２１度、東経９１度３０分から１０５度３０分に広がる国土面積５１３，１１５平方キロメートルを有する国である。北側はラオス民主人民共和国およびビルマ連合社会主義共和国と、東は民主カンボジアおよびタイ湾と、西はビルマ連合社会主義共和国およびインド洋と、南はマレーシアと、それぞれ国境を接している。タイ国は南北に約２，５００㎞、東西に１，２５０㎞あり、海岸線延長はタイ湾でおよそ１，８４０㎞、インド洋で８６５㎞である。

自然条件的にはタイ国は、1)北部地方、2)中央平原、すなわちチャオプラヤ川流域、3)東北部地方、すなわちコラット高原、4)南部地方、すなわち南部半島部の４地域に分けられる。

北部地方は自然林、山地、深く肥沃な沖積峡谷部などから成る山岳地帯である。

中央地方は緑豊かで肥沃な峡谷部である。ここはタイ国でももっとも豊かで、広大な米作地帯である。

東北部地方は起伏に富んだ地域やなだらかな丘陵部で代表される乾燥地帯である。

南部地方はうっそうと繁る原生林や埋蔵量豊かな鉱物鉱石を誇る、丘陵地帯や山岳地帯である。この南部地方はゴム生産やその他の熱帯作物栽培の中心地である。

１．２　気候

タイ国は温暖でやや湿潤な熱帯の国である。気候的にはモンスーン気候であり、大体５月から９月までつづく典型的な雨期と、その前後の比較的乾燥した乾期を特徴としている。気温は３月から４月にかけて最高となり、１２月から１月にかけて最低となる。平均気温は２３．７℃から３２．５℃である。

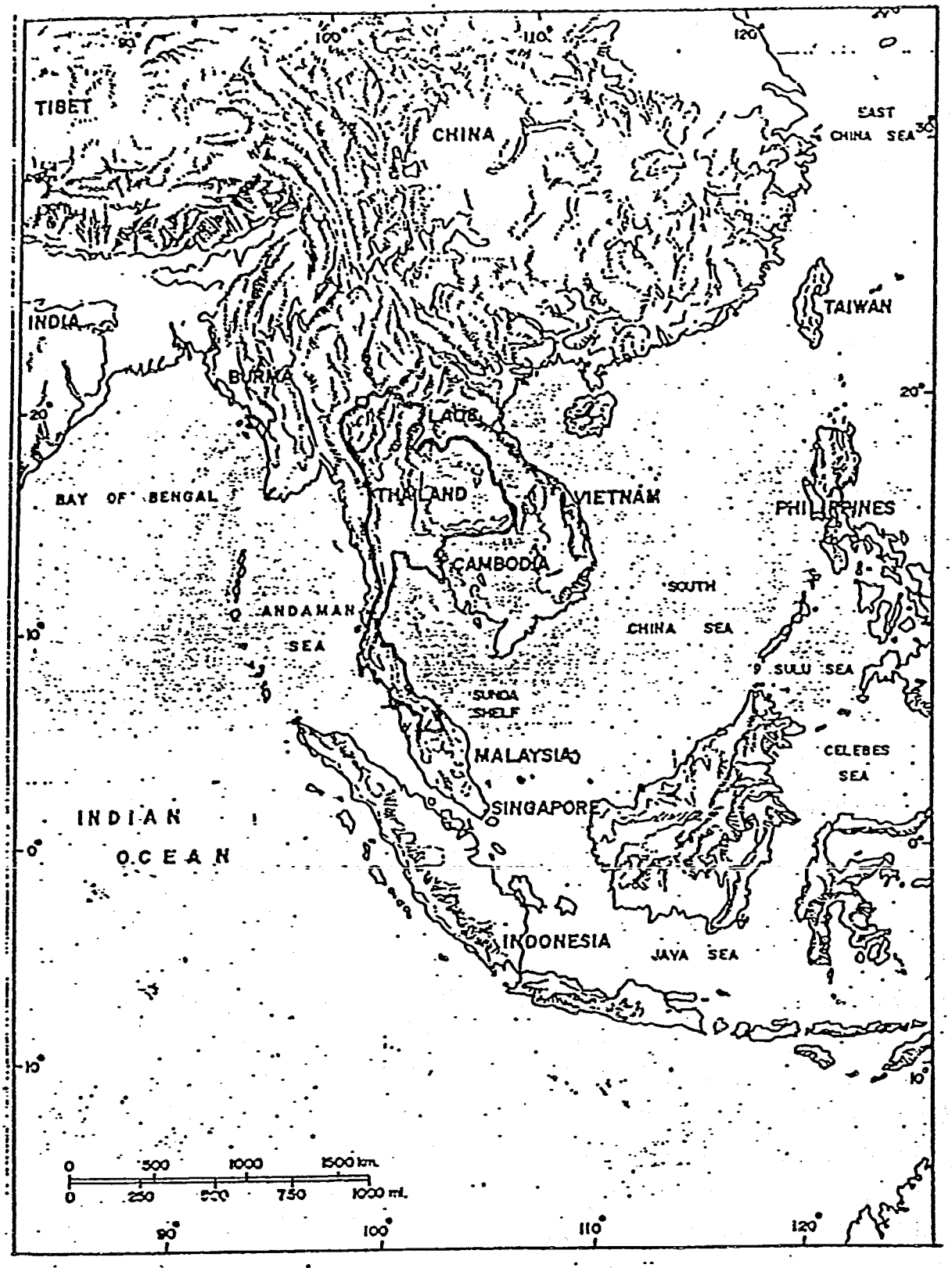
１．３　人口

タイ人の起源については諸説がある。３０年ほど前までは、タイ人はおよそ４５００年前に中国四川省北西部にその起源を発し、その後現在地に移動してきたという説がかなりの確度で語られていた。ところが、タイ国東北部地方、ウドンタニ州ノンハン地区バンチャン村において明白な先史時代の石器類などが発見されたことにより、この説は覆され、今日では、タイ人は現在地に出現し、その後中国の一部を含むアジア地方に分散したのだろうと考えられている。

タイ国の人口は57,788,965人で、年間増加率はおよそ１．３％である。少数民族としてもっとも重要なものは中国人であり、この外マレー人、カンボジア人、非タイ系山岳種族、ベトナム人などが存在する。また、都市部の人口は 5,562,141人である。

１．４　経済および社会

ＧＮＰ（１９９３年）はおよそ２，０７２ドルであり、１９９２年の輸出総額はおよそ２４０億ドル、これに対し輸入はおよそ３００億ドルであった。



Physiographic map of East Asia, Southeast Asia showing position of Thailand in relation to the surrounding areas.

FIGURE 1.1

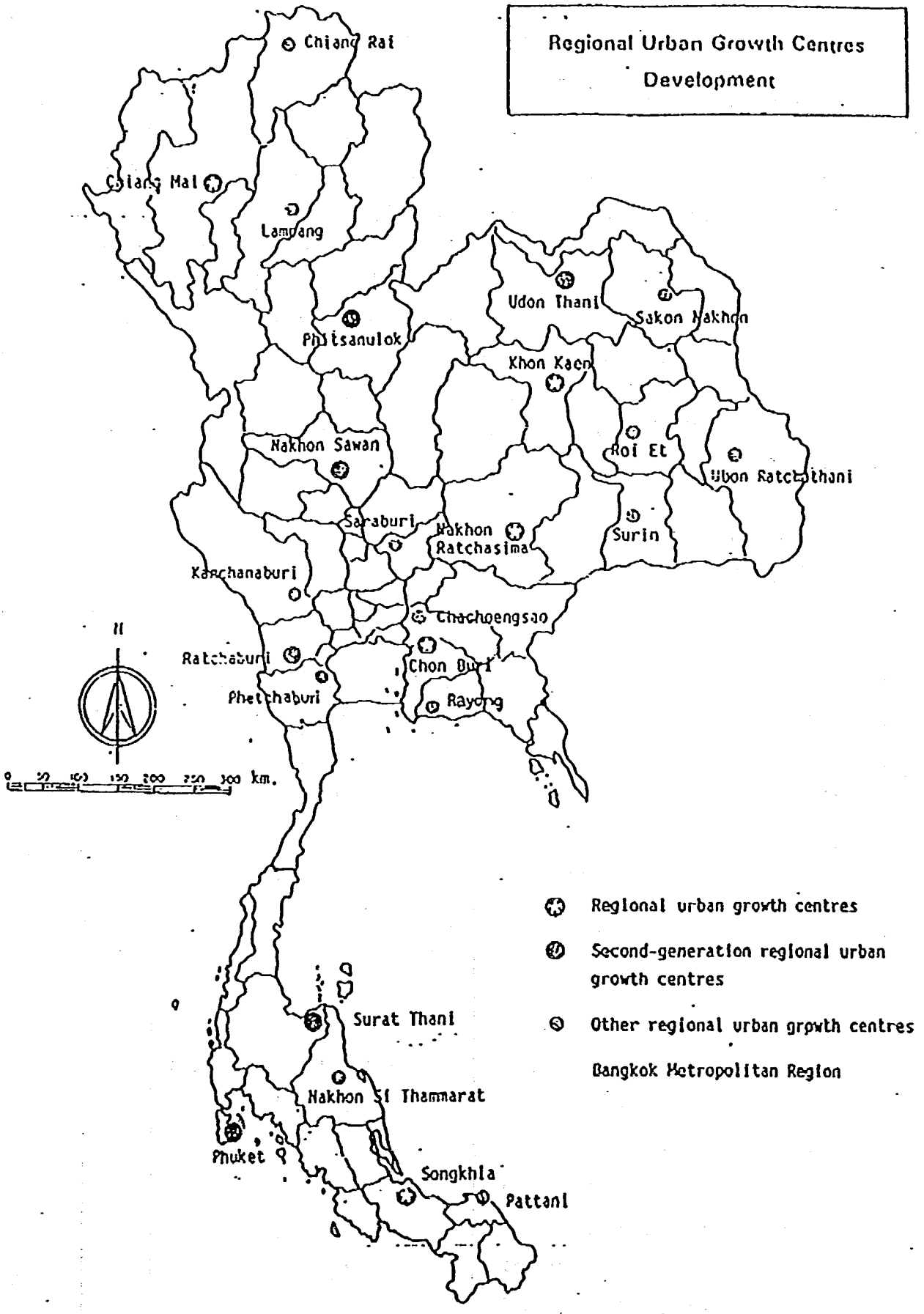


FIGURE 1.2

Office of the National Economic and Social Development Board

２．公共事業の現状

２．１　国土開発に関する基本計画

南部沿岸地方が国土開発プロジェクト対象地域のひとつである。このプロジェクトは１９９２年１月に着手されたが、これは２１年計画であり、最初の１０年が行動計画となっている（図２．１）。この行動計画期間中の活動にはこの計画で提言している諸施設の拡充が含まれており、プロジェクト展開の全体像を表している。このスケジュールにはユーティリティーは含まれていないが、上記諸施設の完成時点までには各種ユーティリティーは利用できる状態になっているはずである。

南部沿岸地方は南部半島部の一部をなしており（図２．２）、５州から成り、面積は３２，２５４平方キロメートル、人口２８０万人である。このプロジェクトの基本的な考え方は地球規模の輸送貿易網の国際的心臓部となる可能性について調査することである。このプロジェクトの主要目的は経済地域の新設、１０年間で２３万人分の雇用の創設、観光の振興などである。この１０年間の行動計画の基盤整備総額は７２１億７千万バーツである（図２．３）。

２．２　建設投資の予算

建設投資予算は次の２大部門に大別できる。

２．２．１　プログラム部門

(in million baht)

Fiscal year / Sector	1993		1994	
	Amount	%	Amount	%
Transportation and Communication	46,933.2	8.4	53,450.9	8.6

２．２．２　機能経済部門

(in million baht)

Fiscal year / Function	1993		1994	
	Amount	%	Amount	%
- Community and Social Service				
1. Housing and comunity Amenity Affairs and Services	22,301.5	4.0	30,135.4	4.8
- Economic Services				
1. Mining and Mineral Resource Affairs and Services, Munufacturing Affairs and Services; and Construction Affairs and Services	3,408.4	0.6	3,106.1	0.5
2. Transportation and Commurication Affairs and Services	61,482.4	11.0	69,557.3	11.2

２．３　公共事業に関する組織・機関

２．３．１　公共事業局

全国のユーティリティー、施設、建設業務、社会基盤全体を担当。ただし、法律により他の機関が担当すると定められているものを除く。

２．３．２　地方政府

地方自治、衛生行政地区における建設業務、社会基盤を担当。

２．３．３　農村開発振興事務所

上記公共事業、地方政府両部門が担当しない分野のすべての社会基盤を担当。

２．３．４　国営企業

運輸、電力、水道を担当。

２．４　主な社会資本の整備の歴史・整備状況、課題

道路の改良

ラーマ７世橋は主要道路改良事業のひとつである。これはトンブリ側のチャランサニトウォン道路とバンコク側のウォンサワン、ピブルソンクラム両道を結ぶ、チャオプラヤ川にかかる３スパンのプレストレスト・コンクリート製二重橋である。このプロジェクトの目的は川の両側で行き止まりとなっていた地点を結ぶことによって生じていた交通混雑の流れを変え、道路通行量を最大限にまで拡大することであった。全長は両側のアプローチ部を含め９３４メートル、河川高水位面からの高さ５．５メートルであり、長さ７０メートルの鉄道用鉄橋も併設されている。３２カ月の月日をかけ、１９９２年９月２３日に開通式を執り行うに至った。この建設プロジェクトは総額１０億８百万バーツであった。建設期間中の唯一の技術的問題点は鉄道用鉄橋の７０メートルという長大スパンの問題であったが、水平スライド方式の導入を図り、これを解決した。

２．５　実施中の主要プロジェクト

ワトナコルンイン橋梁道路建設プロジェクトはトンブリ側のワトナコルンインにてチャオプラヤ川を横断し、全長３０．５５キロメートルの主要道路につなぐ６車線の舗装橋梁であるが、この主要道路はさらにチバノン、ペチカセン、ラタナチベットの各道路を結ぶ道路でもある。推定建設費用は１２３億７千万バーツであり、総工期は９年間、着工は１９９６年の予定である。

SUMMARY SCHEDULE

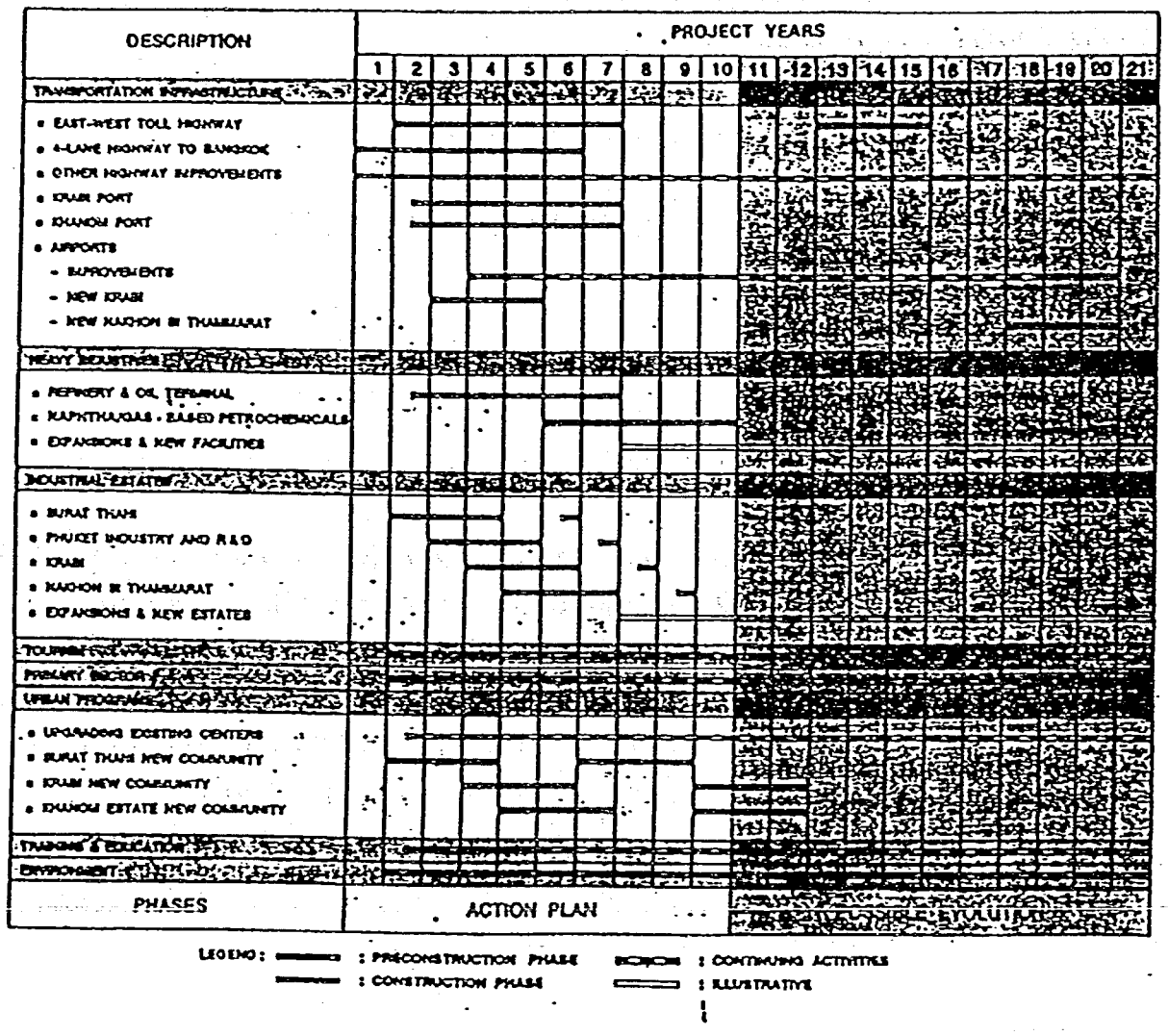


FIGURE 2.1

PROJECT AREA AND EXISTING INFRASTRUCTURE

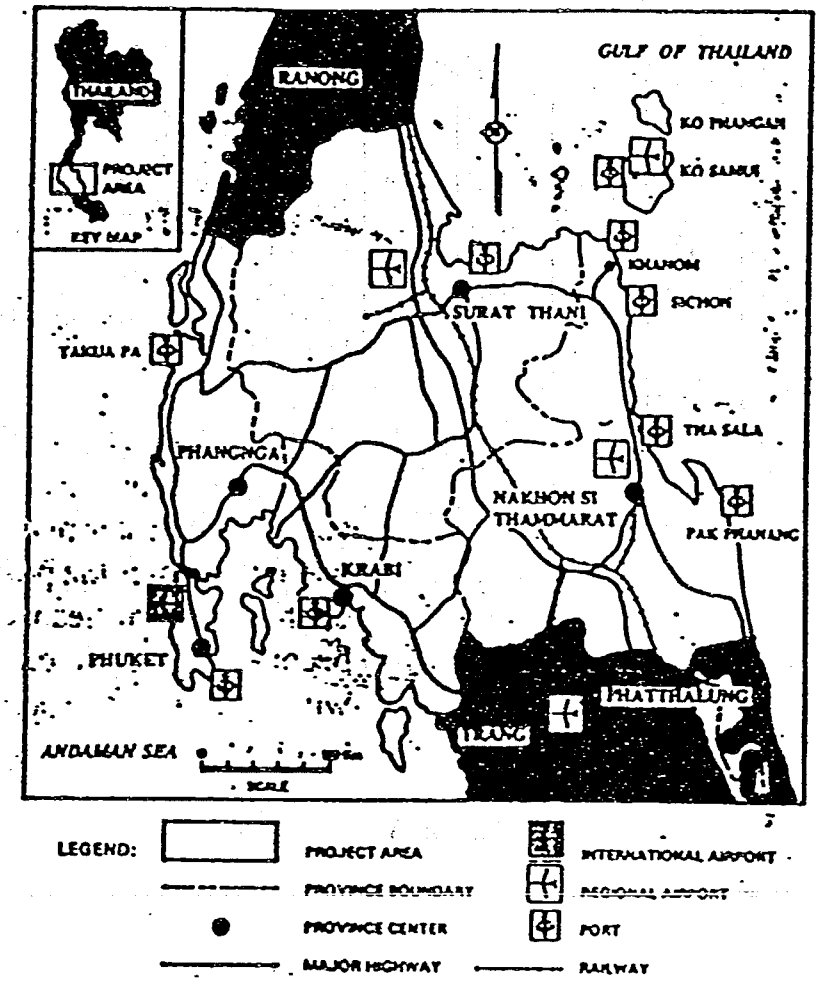


FIGURE 2.2

COST ESTIMATE AND PUBLIC/PRIVATE SPLIT

Unit: Million 1991 Baht

PROJECT COMPONENTS	TOTAL COST	LOW PUBLIC SHARE		HIGH PUBLIC SHARE		REMARKS AND PUBLIC COST RECOVERY MEASURES
		PUBLIC	PRIVATE	PUBLIC	PRIVATE	
Krabi and Khanom General Cargo Ports	4,420	3,680	740	3,930	490	Public share could be reduced by participation of the hydrocarbon industry in its share of the cost of the Khanom port. Partial cost recovery through fees and charges.
New East-West Highway	4,160	170	3,990	1,250	2,910	First stage only. Partial recovery through tolls. Second stage is estimated at 2,830 million baht
Highway Improvements	14,700	14,700	-	14,700	-	No recovery as tolls are not practical on local roads
Airport Upgrading and Construction	1,660	1,660	-	1,660	-	Cost could be recovered through airport tax, landing fees, rents, leases and/or concessions
Hydrocarbon Complex and New Community-Dedicated Infrastructure and Utilities	7,150	5,360	1,790	7,150	-	Site preparation excluded. Private sector share to be determined by negotiations (assumed to be 25% in Low Public case). Partial cost recovery possible through charges, user's fees, leases and/or land sales
Other Industrial Estates and New Communities	4,100	1,560	2,540	2,150	1,950	Infrastructure only. Public share could be recovered through user's fees, leases, rents, and/or land sales
Urban Upgrading (Excluding Utilities)	7,520	4,710	2,810	4,710	2,810	Public share could be recovered in part through municipal and property taxes, special assessments, leases, etc.
Tourism Infrastructure	9,250	9,250	-	9,250	-	Cost could be fully recovered through leases, rents, and/or special tourist tax
Primary Sector Programs	690	690	-	690	-	Cost could be recovered through special assessment on agricultural land and/or special tax on products
Utilities	17,380	3,530	13,850	6,780	10,600	Public share could be recovered through fees and/or charges
Training Programs	970	-	970	485	485	Public share could be recovered through a training tax
Environmental Studies and Monitoring	170	170	-	170	-	Cost could be recovered through an environmental protection tax
TOTALS	72,170	45,680	26,690	52,925	19,245	

FIGURE 2.3

３．公共事業局の研究開発

公共事業局は１８９８年に設置され、現在は内務省に所属している。公共事業局はタイ国全土の農村部、都市部、特定地域における公共事業と開発工事を担当している。

公共事業局では建築安全基準に従って建設工事の監督と実行の両面を担当している。公共事業局では開発計画に従って建設プロジェクトを実施するよう命令を受けているが、これはたいへん重要な仕事であり、国民の生命、財産、福祉に直接関係するものである。公共事業局はまたバンコク地区におけるチャオプラヤ川架橋などの、交通問題解決工事を通じて、バンコクやその郊外の一部とも関わっている機関でもある。さらに、タイ国全土の農村地帯にとって基本的ニーズである運輸システムの改善拡充においても技術的アドバイスを与えている。その他の活動としては、農村部に影響を及ぼすおそれのある河川堤防の侵食防止、人口密集地域における排水浄化システムの設置を含む、一部の大都市における公共用水や家庭用水の不足問題の解決などが挙げられる。

技術サービスに関しては、公共事業局は建設規格・基準と判例集の作成、適正テクノロジーに関連する調査の実施に関与しており、最近の業績としては農村部において採用する低コスト建設資材、すなわち軽量乾草セメントパネル材やラテライトセメントレンガなどの適用が挙げられる。

サポート分野では、地震に関するタイ国建築基準の制定において、公共事業局はチュラロンコン大学と協力して所要パラメータを求めるべく「構造物の現地振動・動的応答研究」を実施している。

公共事業局の常勤職員総数はおよそ４０００人、管理開発予算は１９９３年は１２，２２３百万バーツであり、１９９４年には１３２億１９００万バーツを予定している。

The Organization chart of Public Works Department

is as follow:-

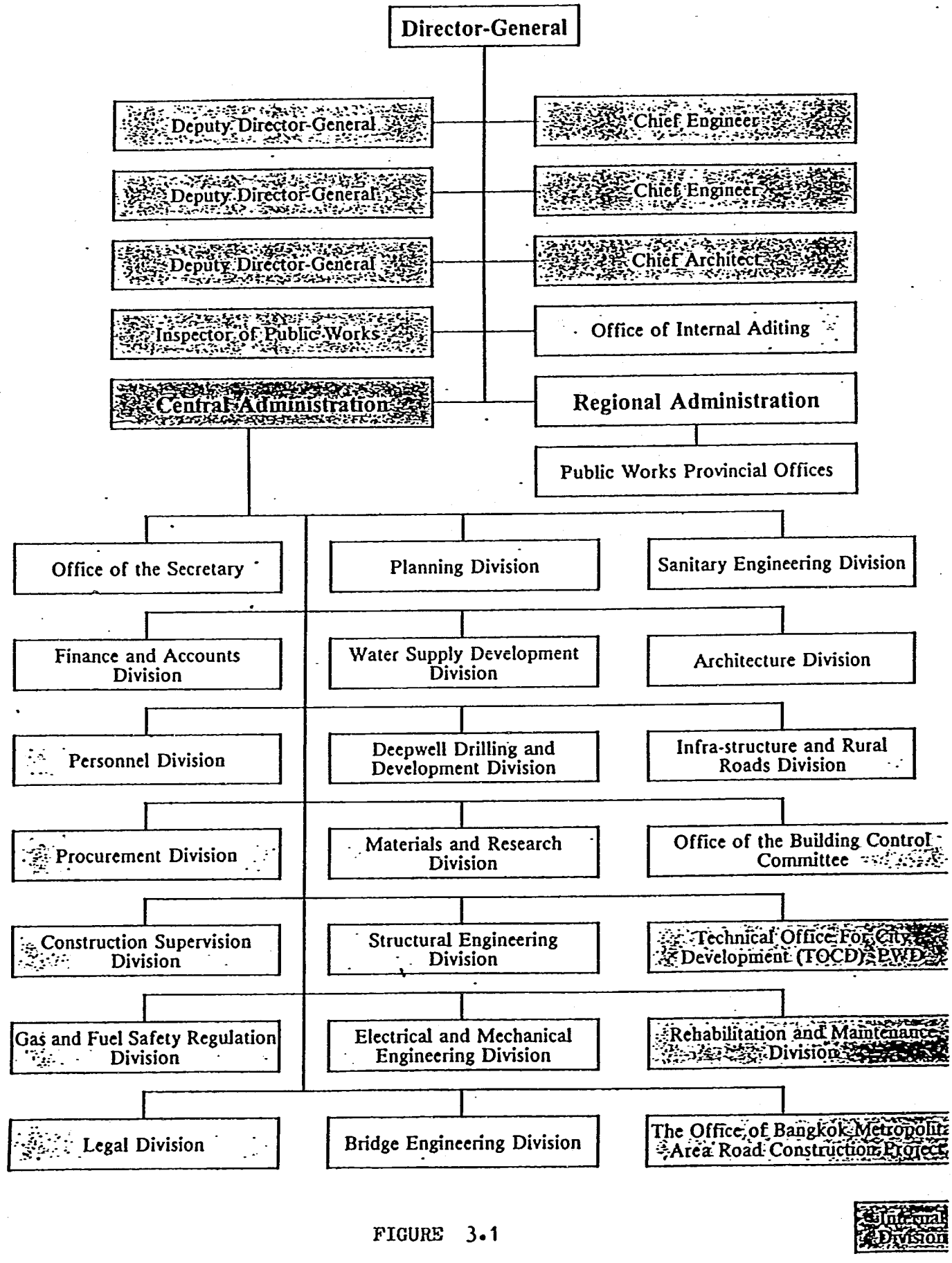


FIGURE 3.1

Organization Chart of Materials and Research Division

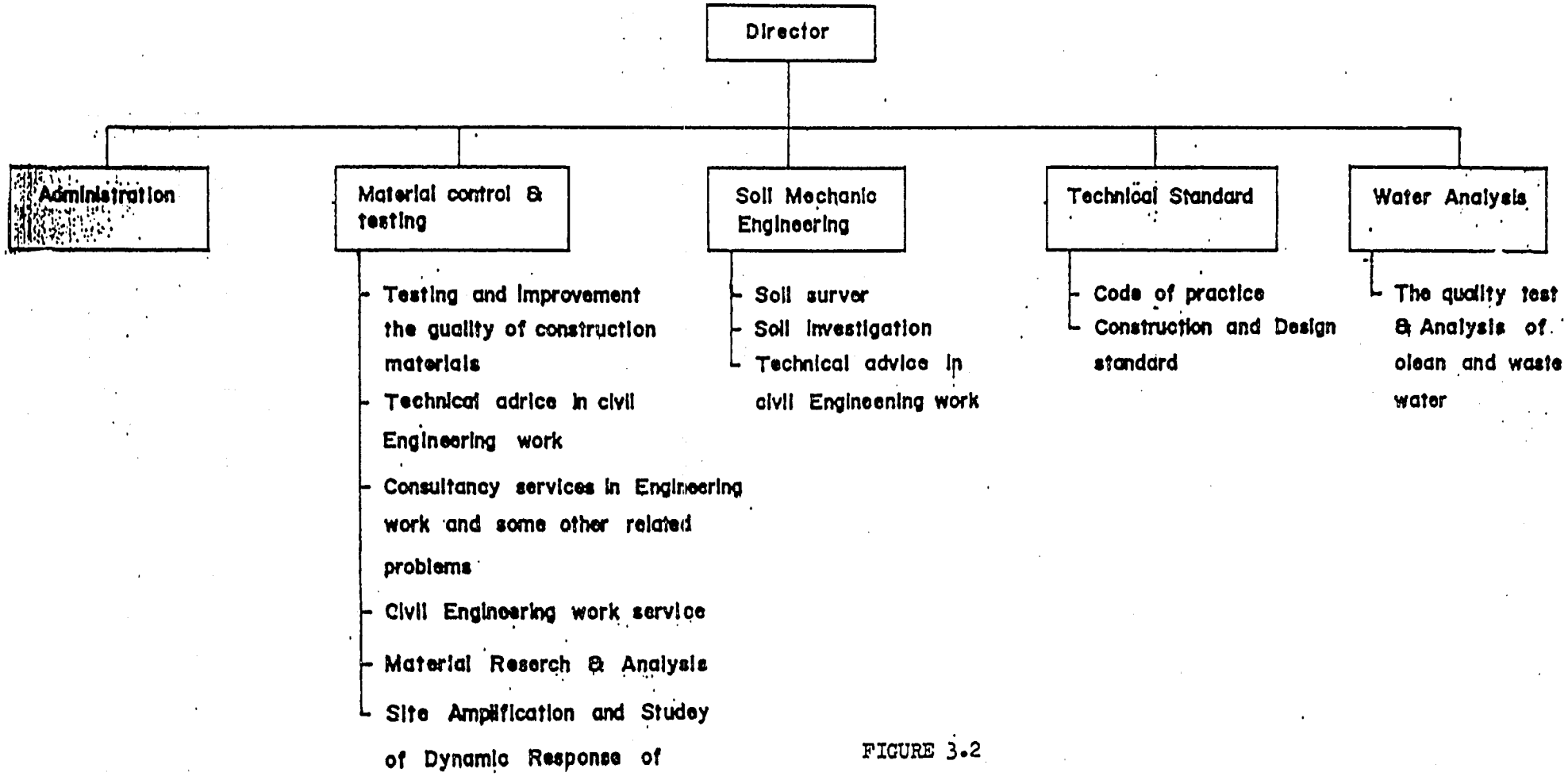


FIGURE 3.2

４．公共事業局の主要研究開発プロジェクト

かつて公共事業局は労働集約地域住民が住宅建築用低コスト建築資材を自分たちで生産できるよう目指した研究開発プロジェクトを実施したことがある。

この研究活動の対象はラテライトセメントレンガ、乾草セメントパネル材などであったが、この成果は原料が入手しやすい農村部で大いに普及し、採用された。

ユーティリティや住民の安全に関連した広範囲の活動分野では、公共事業局は次のような主要研究活動を行っている。

タイ国における排水処理システムの評価

構造物の現地振動・動的応答研究

軽量ポータブル家屋の研究。

１９９４年には、公共事業局はコンサルタント会社と協力して「メコン川堤防侵食防止」の研究事業を実施する予定であり、この研究では変調測定技術やコンピュータプログラム解析などを採用する予定である。

また、将来公共事業局としては可能であれば、現在でも部分的には研究活動に適用しているが、大規模試験や適切なコンピュータプログラム解析が必要となろう。

ただし、このような要求が達成されるか否かはこれを支援する政府の政策や予算、さらには、たとえば、ＪＩＣＡのような外国機関からの協力ないし援助の如何にかかっている。

構造物の現地振動・動的応答研究

1）背景

１９８３年４月２２日にタイで起きた地震はマグニチュード５．９を記録した。この地震はバンコクの中層高層ビルの住民をパニック状態に陥れた。

現在までタイ国には地震に関する建築基準は存在しない。地震災害を防止する地域的な規則を制定するには、建築様式や地震力に関連する充分なる情報を提供する必要がある。この研究はそのために実施するものである。

2）　プロジェクトの目的

２．１　現地振動及び応答スペクトルの研究。

２．２　構造物にかかる全地震力の解析。タイ国における省令と耐震設計あるいは建築基準の改善。

3）　担当組織

３．１　公共事業局材料研究部

３．２　チュラロンコン大学、バンコク

4）　予算（フェーズＩ）

Years	1991	1992	1993	1994
Million Baths	5.941	0.320	1.320	0.302

5）　観測・データ収集場所　　バンコクの４３階建てビル。
6）　データ処理　　コンピュータプログラムを使用。
7）　成果

１９９２年の地震測定装置設置後、地震は２回しか発生しておらず、情報は充分ではない。そのため、プロジェクト期間を延長することになろう。満足すべき結果が得られるかについては地震による充分なデータが得られるか否かにかかっている。なお、地震監視システムも取り付けている。

EARTHQUAKE MONITORING SYSTEM

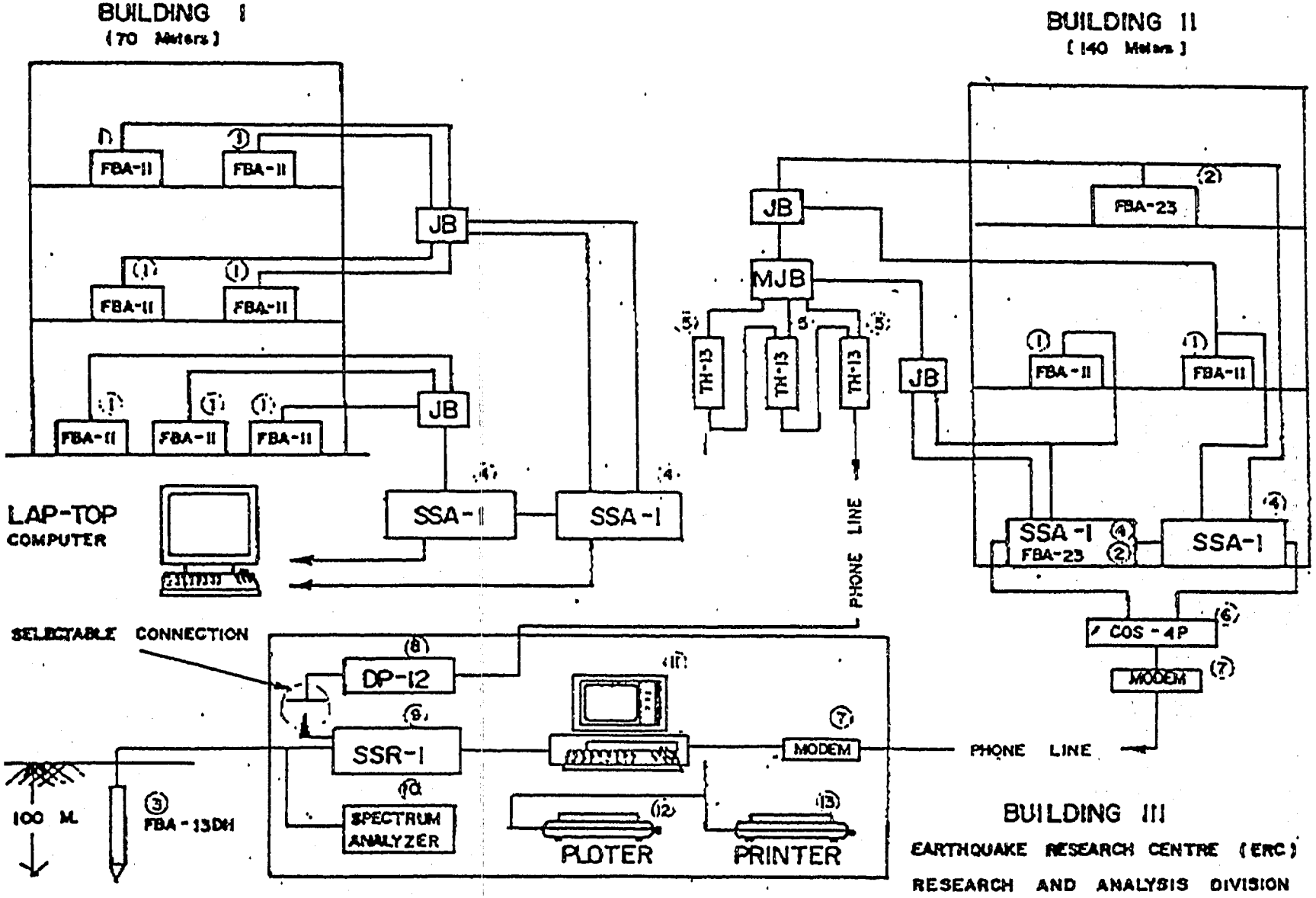


FIGURE 4.1

5．公共事業局の国際研究交流プログラム

公共事業局の研究は実際のところ大規模なものでも顕著なものでもないので、研究の国際交流は今までに見られなかった。また、関連活動もない。ただし、研究活動のグレードアップのためには国際交流プログラムが緊要になろう。

以前の政府の研究活動予算はたいへん低額であった。幸い現在では、タイ政府は新興工業国を目指しているので、そのためには当然最新技術の移転が行われるべきである。そのひとつとして、工業化のためのテクノロジー改善と建設方法の向上に向けた研究活動を計画すべきであろう。このような観点から政府は研究活動に対する予算を増額している。

タイ国では、外国との交流プログラムを実施する以前に、たとえば日本などの援助国から、最新研究活動を含む、技術移転という援助を必要としている。

6．「災害・防災」に関する取り組み状況

6．1　要旨

洪水は経済、人命両面において被害をもたらす自然災害のひとつである。サムートプラカン州は湿地と河川の多い地形にあり、洪水は避けられない運命にある。その被害を緩和する総合対策が治水である。サムートプラカン州東部は比較的平坦地であり、標高も平均海面水位に近い。同州のチャオプラヤ川東岸がこの地区にあたる。地区住民５１２，０００人の大半が「国王の治水堤防」西岸約２２０平方キロメートルの地域に居住している（図6．1）。サムートプラカンは特に工業と貿易で経済上重要な役割を演じている。１９８６年の税収は４４億バーツと、バンコクに次いでタイ国第２位であった。

過去４、５年タイ湾に面するこの地区は洪水の被害が増加している。これには北部に隣接するバンコクと同様の大雨による洪水と、乾期にも発生する高潮による洪水とがある。高潮による洪水は予想可能のものが多く、１０月から１月にかけて発生する。発生頻度は月に７日程度、１日４時間程度継続する。この地域にとって損害と不便を強いるこの頻繁な洪水はたしかに今すぐ注目するに値するものである。１９８３年の洪水がバンコクとその周辺で記録された後、損害の大きい洪水問題の緩和のために調査や対策に大いに努力を払ってきており、バンコク東郊では干拓地型のシステムを利用したマスタープランが採用された。このプランによれば、チャオプラヤ川の排水を行う前に、サムートプラカン東部を貫通する洪水「緩衝地帯」約２４０平方キロメートルの排水を行う必要がある。従って、サムートプラカン東部における排水治水システムを成功させるためには東岸の排水も必要である。
そのため、公共事業局では１９８６年９月２５日着工以来サムートプラカン東部治水排水プロジェクトに取り組んで来ている。

[6.2～6.4　省略]

７．「環境と社会資本整備の調和」に関する取り組み状況

７．１　要旨

タイでは水質汚染問題は１９６０年代に発生したといわれている。メコン川が工業によってひどく汚染されていると報告されたのが約１５年前のことである。損害額はその当時で１億４千万バーツ（５４０万ドル）と推定された。ただし、このケース以外には被害が認められた例はない。これはタイでは水質汚染が危機的状況にないことを意味するものではない。水質汚染による損害に関する総合調査が実施されていないだけのことである。他の河川、特にチャオプラヤ川とタチン川（図７．１１）ではかなりの数の深刻な水質汚染問題が生じている。これは主として工場排水の排出によるものである。このため、工場排水の規制を主眼とした政策、規則、基準などが作成発表されている。規制の努力により、ある程度の産業汚染の削減には成功してはいるが、一層の削減の余地が残っている。そのため河川の水質は悪化の一途をたどっている。これは主としてバンコク首都圏や地方の都市部における生活排水の直接排出によるものである。現在タイ政府は現状と問題解決の緊急性を認識しており、その主な技術的目標は次の通りである。

1)１０年から１５年の適正期間以内における所要水質基準達成のためのチャオプラヤ川とタチン川の汚濁負荷の削減。

2)長期水利用のニーズに応えるべく、両河川各部における水質基準の達成に向けた水質規制。

3)チャオプラヤ川とタチン川両河川に排出しているバンコク首都圏内主要水路への汚濁負荷の削減。

4)河川や水路における漁業、水運などの長期多目的利用の確保。

5)保健、公衆衛生、環境、景観などを強調した、生活の質的向上。

工業が発展すればするほど環境が悪化することは明らかである。それ故、加速する経済成長と調和する形で生態系を改善する何らかの対策を講じなければならない。

７．２　タイ国の現状と課題

水質のコントロールは解決すべき主要課題である。下記に述べるのはチャオプラヤ川とタチン川における現状と課題を示す水質報告書である。

i)チャオプラヤ川

１９８５年以来、国家環境評議会(ＮＥＢ)はチャオプラヤ川全域にわたって河口(ｋｍ：０)から最も上流地点の(ｋｍ：３７９)までの３２ヶ所の調査所で水質監視を継続してきた。チャオプラヤ川には３つのレベルの水質基準が設定されている：

基準レベル４：チャオプラヤ川の下流部分(ｋｍ７から６２まで)

基準レベル３：チャオプラヤ川の中流部分(ｋｍ６２から１４２まで)

基準レベル２：チャオプラヤ川の上流部分(ｋｍ１４２から３７９まで)

１９８５～１９９０年にＮＥＢが行なった水質監視結果によればチャオプラヤ川では年々溶存酸素量(Ｄ．Ｏ．)が減り続けている。チャオプラヤ川の下流域のＤ．Ｏ．は今ではレベル４の基準限界(＝２㎎/１)以下になっている。乾季を除くほとんどの期間でチャオプラヤ川下流域のＤ．Ｏ．は１㎎/１以

下に減少している。
１９７５～１９８０年のＮＥＢの水質監視データによるとチャオプラヤ川の上流と中流域の数ヶ所でＢＯＤ濃度がレベル２と４（１．５と４㎎/ｌ）を超えている。大腸菌数も年々増加傾向にある。

ii)タチン川

タチン川の水質汚染の状態を評価するにあたってＮＥＢ基準による３段階の水質目標レベルを設定した。

基準レベル４：タチン川の下流部分（ｋｍ０から８２まで）
基準レベル３：タチン川の中流部分（ｋｍ８２から２０２まで）
基準レベル２：タチン川の上流部分（ｋｍ２０２から３２５まで）

１９７９～１９８０年のＮＦＢ監視プログラムの対象は主としてタチン川の河口から２０．５～１１２ｋｍの区間であった。１９７９年から１９８０年の調査ではD．O．はｋｍ０から８５の間では、さほど大きく変化しなかった。D．O．が最高値を示したのは上流域で、それから河口に向かって徐々に低下した。一部の調査所(例えば、Krathum Ban 地区や Wat Donkhai 地区、Sampran 地区の調査所)ではD．O．は水質基準レベル４の限界値（２㎎/ｌ）以下であった。１９８９年に行なわれた水質監視により集められたD．O．値の多くは基準値より低いことが分かった。こういった事実はタチン川における水質が悪化しつつあることを示しており、特に中流域から下流域においてその傾向が著しい。

１９８７年の観測値に比べてタチン川の中流から下流域のＢＯＤ濃度は増加傾向にある。この増加傾向は家庭排水量の増加と沿川の農業活動からの高汚濁負荷に起因している。

タチン川全域における大腸菌数はレベル２と３の基準限界（５，０００ＭＰＮ/１００㎖と２０，０００ＭＰＮ/１００㎖）を超えた。この結果は河川水が家庭排水でひどく汚染されていることを示し、この傾向は今後も続くものと考えられる。

７．３　組織活動

ＰＷＤはタイ王国政府（ＲＴＧ）の技術機関として１８８９年に設立された。ＰＷＤは要請に応じて自治体と衛生地区に技術的支援を提供する責任を負っている。ＰＷＤの業務は拡張されて排水を含むようになった。これら各種業務はＰＷＤの衛生技術部（ＳＥＤ）が行なっている。

ＳＥＤはプロジェクト評価からオペレーターの訓練、さらにＰＷＤが下水道を直轄する地方への技術支援を担当している。

全国で合計３４の下水道があり、そのうち１３システムは建設済みまたは建設中で、７つの処理場は操業中である。地方に置かれた中小規模の処理場の能力は２，２００～３２，０００m^3/日である。主な処理方法は回転生物接触法（ＲＢＣ）、オキシデーションディッチ（ＯＤ）、安定化池（ＳＰ）である。Ayutthaya、Pathum Thani と Nonthaburi地域及び Rangsit 地区ではＤＩＷのもとで Rangsit 地区の工場排水処理場の詳細設計作業が最近完了した。そのほかのプロジェクトは実行可能性調査の段階にとどまっている。

7.4　地球環境と生活環境を考慮した社会基盤整備

チャオプラヤ川とタチン川の水質に関して筆者が述べたように、何らかの水質評価方法を考案する必要がある。種々の段階において、計画の有無別の両河川の将来的な水質動向の分析・評価のために、数学モデルを用いた水質シミュレーション手法を開発する必要があった。シミュレーションの結果は意思決定者が水質問題を解決するにあたって緊急修復活動と症状軽減プランの必要度合いを見きわめるのに重要な手段である。

河川の水質を左右する汚染物質濃度と水の流量はともに水質モデルの重要要因である。乾季には水量が減少して汚染を希釈する水量が不足するので、水質悪化が進むのは明らかである。したがって本報告研究においては、何年にもわたる種々の時間インターバルでの河川流量のシミュレーション手法の開発が非常に重要であり、それらは水質評価にも応用できるものである。

7.4.1　流れのシミュレーション

Chainat 県のチャオプラヤダムから放流される水流はチャオプラヤ川下流に流入し、Phophraya 堰から放流される水流とタチン川のメコン流域から流路を変える水流は農業と家庭用水に利用されるだけでなく、河口近くで塩分の侵入を減らす役目も果たしている。塩分が侵入すると川の堤防に沿った農地と水栽培地区に悪影響を与える。

王立灌漑局(ＲＩＤ)、タイ発電局、及び首都圏水道局(MWA)などの関連政府機関は協力して水利用を調整している。たとえばMWAはバンコク首都圏局(ＢMA)、Nonthabri 県及び Samut Prakan 県の飲用水需要を満たすのに十分な水を供給しており、一方、ＲＩＤは灌漑用水を適切な量に調整すると同時に海水の侵入をできるだけ少なくなるようにしている。

最近、ＲＩＤの定常業務に各所の堰の流量の記録とチャオプラヤ川とタチン川の下流に沿った複数箇所での塩分濃度の決定が、含まれていた。こうして集められたデータをもとにＲＩＤはダムと堰の適切な流量を調整し、塩分濃度を望ましいレベルに維持している。

本研究で数学モデルを適用するにあたって、水道消費と灌漑に利用される量を差し引いた後のダムと堰の正味流量を用いて水質の状況を評価した。

本研究で採用した数学モデルはカナダのエーカー・インターナショナル・カンパニーが開発したモデルであり、これを汚染と塩分侵入の点で最悪の条件を呈する乾季におけるチャオプラヤ下流域での灌漑用水の利用状態を研究するのに適用した。チャオプラヤ川から分かれ、同川の下流西堤防の主たる水路の役目を果たしているタチン川については、調査の対象となった河川区域は Phophraya 堰から河口までである。流量シミュレーション・モデルの結果は次の通りである：

7.4.1.1　チャオプラヤ川

モデルによる調査から次のことが明らかになった：３月から４月期間について過去３年間にわたってダム放流量が１００m^3/秒(図7.2)、MWAの平均飲用水製造量が２８m^3/秒であるとするとメモリアル・ブリッジでの塩分濃度は０.１～０.３ｐｐｔ(mg/l)で、残りの５０～７０m^3/秒が海水侵入に対する保護の役目をする。

ダム放流量が７０m^3/秒まで減ると塩分侵入を水量が３０m^3/秒以下となり、その結果、海水侵入の可能性が高くなる。このような現象は過去に発生しており、メモリアルブッリジでは最高

１１．７５ｐｐｔの塩分濃度が観測されている(１９８８年４月)。

海水の侵入防止に関しては次のように結論できる：川からの取水量が３０m³/秒を上回らないとき河川流量は６０m3/秒以下であってはならない。したがってダムからの総放流量は９０m³/秒以下であってはならない。将来はダム放流量はMWAからの飲用水の給水需要の増大に直接に比例させて増やさなければならない。しかしチャオプラヤ川の水質の状況を評価するにあたっては６０m³/秒という流量を用いた。

7.4.1.2　タチン川

モデルを用いたデータと、Phophraya 堰で記録されたデータ、メコン流域からklong Jorakhe Samphan と klong Song Phi Nong 及び klong Tha San Bangpha (図7.3)にコース変更した流れでの記録にもとづき、灌漑に利用したあとの河口における流量はおよそ２７～４３m³/秒であることが明らかになった。こういった状況のもとで Kra Thum Baem調水器で測定した塩分濃度は０.４～１.４ｐｐｔであり、農業用水としては許容できる範囲にあると見なされた。Tha Chin 川下流への要求される最低流量は３５m³/秒と結論された。この値を Tha Chin 川の水質状況を評価するのに使った。

7.4.2　水質のシミュレーション

この研究では次の３つのシナリオのもとでチョプラヤ川とタチン川の水質状況を推定する１つの数学モデルを開発した。：

(1)排水処理施設に投資を行なわない。

(2)経済条件に応じて排水処理施設に適切な投資を行なう。

(3)排水処理施設に利用可能な最良の技術を採用する。

それぞれのケースについて予測される水質汚染を評価するため、今後１０年ないし２０年間の水質をシミュレートした。溶存酸素量(ＤＯ)と５日間生物学的酸素要求量(ＢＯＤ５)を水質汚染の最も適切な指標として選んだ。

7.4.2.1　チャオプラヤ川の水質シミュレーションの結果

計画を目的としたチャオプラヤ川の水質シミュレートを行うため、最悪の状況を想定した。乾期にチャオプラヤ川下流で海水の侵入を抑制するためには最低６０m³/秒の真水が必要と想定した。

1) 現状 － いろいろな用水路と排水管を通じてチャオプラヤ川に排出されている排水に関するデータから、排出量シミュレート値がモデルを代表するデータと一致することが分かった。

2) 現状以上の排水処理を行なわない場合の今後１０年ないし２０年の予測 － 次の仮定にもとづいて将来予測を行なった：チャオプラヤ川に排出される水量とＢＯＤ５は年々２%ずつ増え、一方、水量は６０m³/秒で一定。モデルの係数の多くは不変。シミュレーションの結果によればBODs は河口から５０ｋｍの地点で最高値に達し、１９９０年の１１㎎/１を出発点として２０００年と２０１０年にそれぞれ１３、１６㎎/１に増える。シミュレーションの結果、ＤＯ

(溶存酸素量)低下曲線が2㎎/１以下となる距離は海から上流５０ｋｍ地点で、２０００年には上流に向かって約５ｋｍ長くなり(５５ｋｍに)、２０１０年には約１０ｋｍ長くなる(６０ｋｍに)。こういう予測結果が出たということはチャオプラヤ川への排水の排出を規制する方法を導入することが必要であることを示している。

3) 排水処理に適切な投資を行なった場合の、今後１０年と２０年における予測 － 水量とBOD$_5$ はともに年々２%ずつ増え、排水収集システムがBMA地区内部に設置されると仮定した。この集積システムはBMA地区に排出される排水の７０%を捕捉するものと仮定した。また処理によって生ずるBOD５ の量は２０㎎/１、収集されない排水は水路系及びチャオプラヤ川に未処理で排出されると仮定した。このシミュレーション結果は２０００年と２０１０年におけるDO低下曲線が下流にそれぞれ８ｋｍ、４ｋｍ(河口から測って)延びることを示している。さらにチャオプラヤ川の汚染は河口から上流６５ｋｍ地点に向かって延びている。２０００年と２０１０年に排水収集及び処理システムに適切な投資を行なえば汚染区間はそれぞれｋｍ１５～ｋｍ５５と、ｋｍ１５～ｋｍ６０となる。チャオプラヤ川最低DOレベルは0から２０００年の1.５㎎/１、２０１０年の1.０㎎/１に増える。２０００年と２０１０年の海から５０ｋｍ地点における最高BOS$_5$ レベルについては現在の値１０.５㎎/１はそれぞれ5.０と6.２㎎／１に減る。

4) 実現可能な最良の排水収集/処理装置を利用した場合の今後１０年と２０年における予測 － この場合も排水流量とBOD^5 は毎年２%ずつ増えると仮定した。ただし、排水の９０%が集められ、BOD$_5$ 基準値２０㎎/１まで処理されるものと仮定した。シミュレーション結果によれば、２０００年と２０１０年におけるDO低下曲線の形にはほとんど差異がない。この程度の収集、処理を行なえばDO２㎎/１以下の区間をおよそ３５ｋｍにまで短縮できることになる。すなわち汚染の著しい区間は２０００年にはｋｍ２０～５３、２０１０年にはｋｍ２０～５５となる。海から５０ｋｍ地点での現在の最高BOD$_5$ 値＝１０.５㎎/１は２０００年と２０１０年いずれにおいても5.０㎎/１に減少する。

7.4.2.2　タチン川の水質シミュレーション結果

流量の少ない乾季の最悪の状況を想定し、さらにタチン川への真水の連続流入量を３５m$_3$/秒と想定してシミュレーションを行なった。

1) 現在の状況 － シミュレーションの結果、モデル・シミュレーション曲線はタチン川で採取したDOとBOD$_5$ データとよく一致した。それでこのモデルを高い信頼性を以て将来予測に利用することができる

2) 現状以上に排水処理を行なわないと仮定したときの、今後１０年と２０年に対する予測 － このシミュレーションの結果、DOが2㎎/１以下である河川区間の長さは現在の４５ｋｍから２０００年には６０ｋｍに、２０１０年には６５ｋｍになる。DO低下曲線は現状よりも２０００年には５ｋｍ、２０１０年には１０ｋｍ上流に延びる。最低DO量は河口から４０ｋｍ～９０ｋｍの区間で約1.８㎎/１以下に低下する。そして２０００年と２０１０年にそれぞれ１１.０㎎/１、１４.０㎎/１に増大する。

3) 排水処理に適切な投資を想定した場合の今後１０年と２０年の予測 － 排水の７０%を収集

し、処理すると仮定したときのシミュレーションの結果によると川の最低DOは２０００年には２．５㎎/１に改善される。しかしBOD$_5$ 負荷が増えるので２０１０年には２．０ｍｇ/１に下がる。２０００年と２０１０年におけるDO低下曲線は現状よりもそれぞれ５ｋｍ、２ｋｍ下流に延びる。２０００年と２０１０年に河口からｋｍ４５地点までの区間では２㎎/１DO以下にはならず、これは水生生物と河川の美観に顕著な改善をもたらす。　河口から４０～９０ｋｍの区間における現在の最高BOD$_5$ ８．０㎎/１は２０００年と２０１０年にそれぞれ７．５㎎/１、９．５㎎/１に変化する。

4）技術的に実現可能な最良の排水収集処理装置を利用した場合の１０年後と２０年後における将来予測 － 排水流量とBOD$_5$ が毎年２%ずつ増える中で排水を９０%収集して処理すると仮定した、モデルシミュレーションによれば川の最低DOは２０００年に２．５㎎/１、２０１０年に２．２㎎/１となる。DO低減曲線は２０００年と２０１０年に現状から下流にそれぞれ１２ｋｍ、１０ｋｍ延びる。

河口から４０～９０ｋｍ区間における現在の最高BOD$_5$ 値８．０㎎/１は２０００年と２０１０年にそれぞれ７．０㎎/１、９．０㎎/１に変化する。

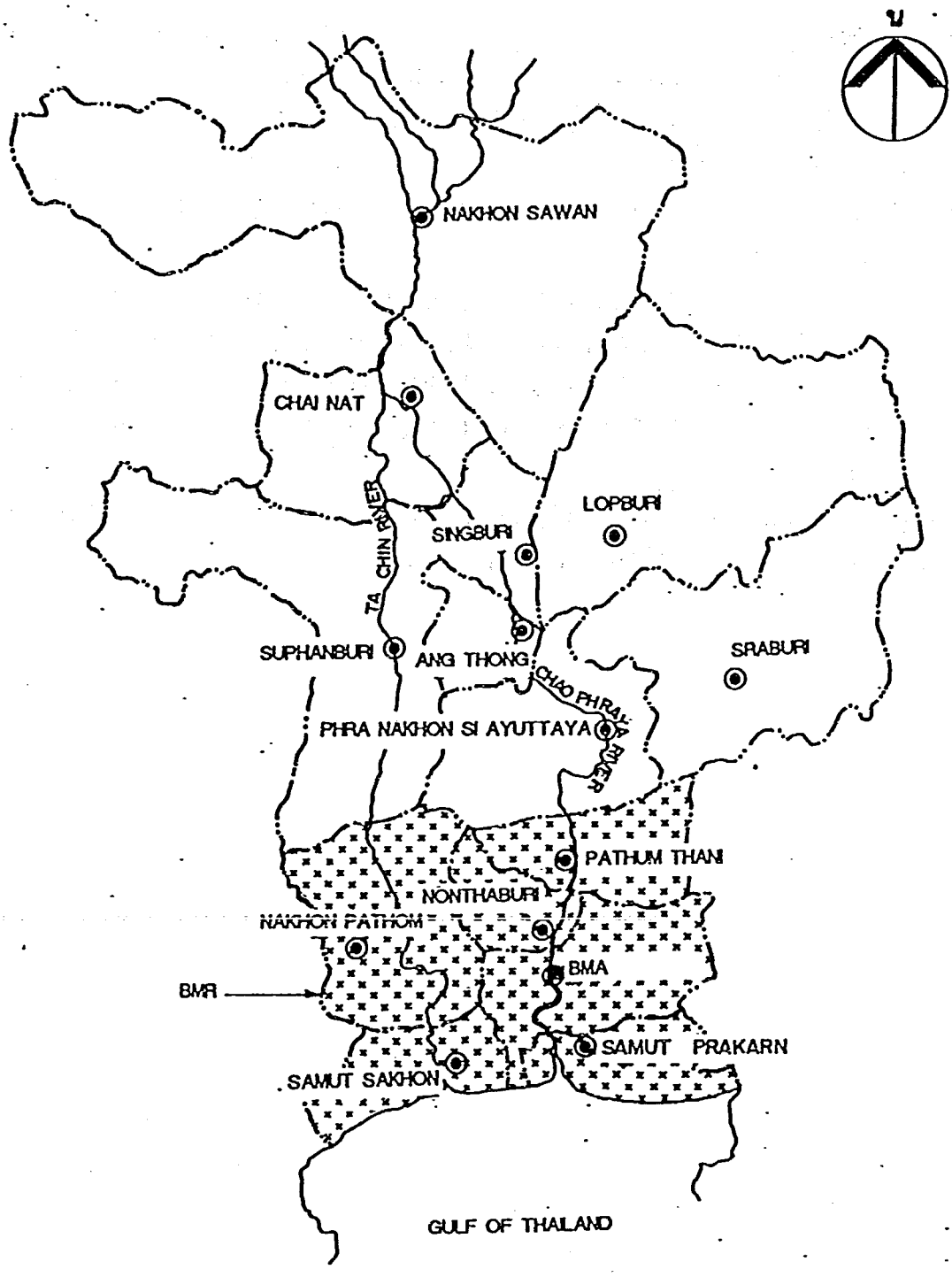

N
NAKHON SAWAN
CHAI NAT
TA CHIN RIVER
LOPBURI
SINGBURI
SUPHANBURI
ANG THONG
CHAO PHRAYA RIVER
SRABURI
PHRA NAKHON SI AYUTTAYA
PATHUM THANI
NONTHABURI
NAKHON PATHOM
BMA
BMR
SAMUT PRAKARN
SAMUT SAKHON
GULF OF THAILAND
0
50
100 KM.

FIGURE 7.1

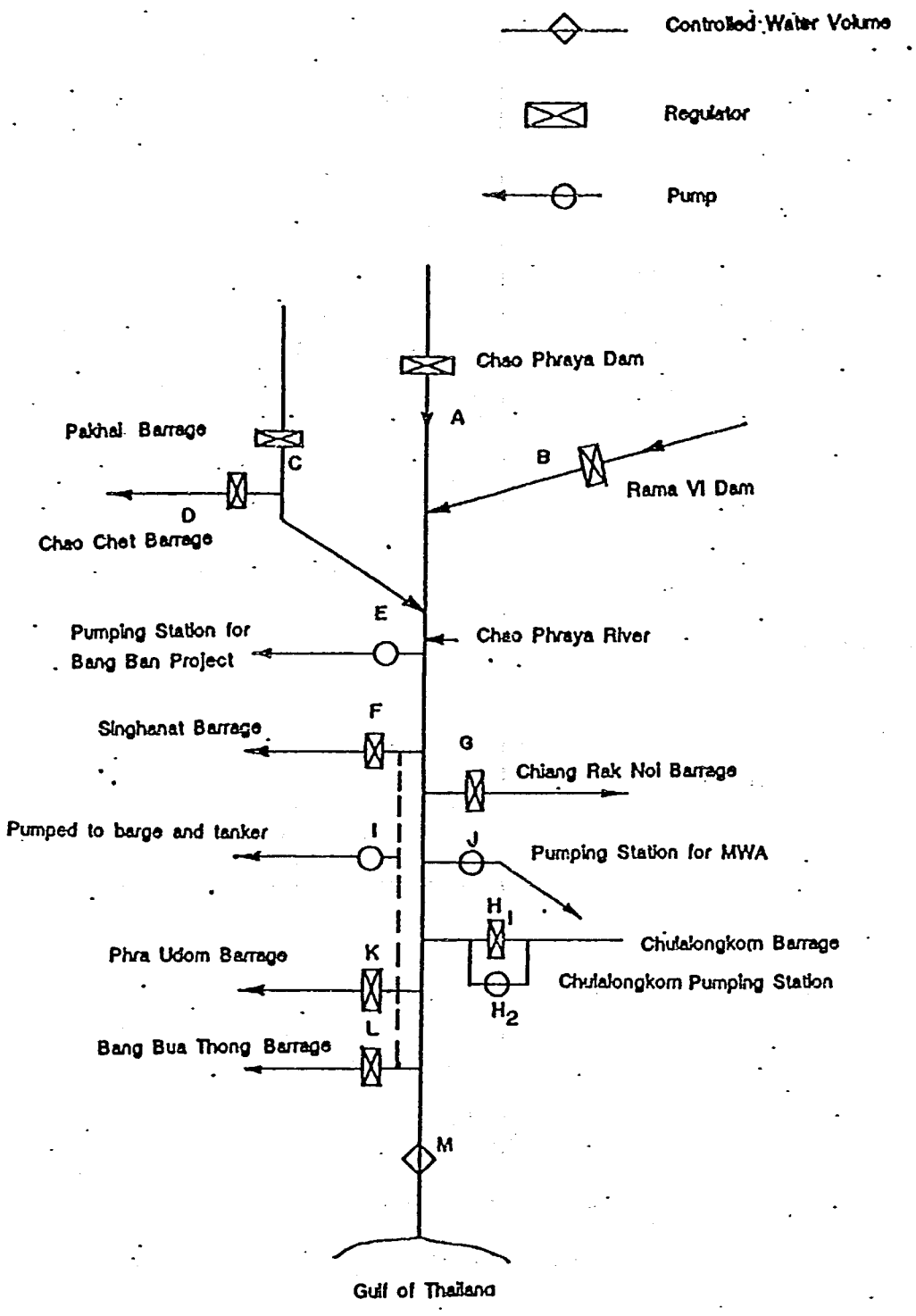

Controlled Water Volume
Regulator
Pump
Chao Phraya Dam
A
Pakhai Barrage
C
B
Rama VI Dam
D
Chao Chet Barrage
E
Pumping Station for
Bang Ban Project
Chao Phraya River
Singhanat Barrage
F
G
Chiang Rak Noi Barrage
Pumped to barge and tanker
I
J
Pumping Station for MWA
H1
Chulalongkorn Barrage
Phra Udom Barrage
K
Chulalongkorn Pumping Station
H2
Bang Bua Thong Barrage
L
M
Gulf of Thailand

FIGURE 7.2

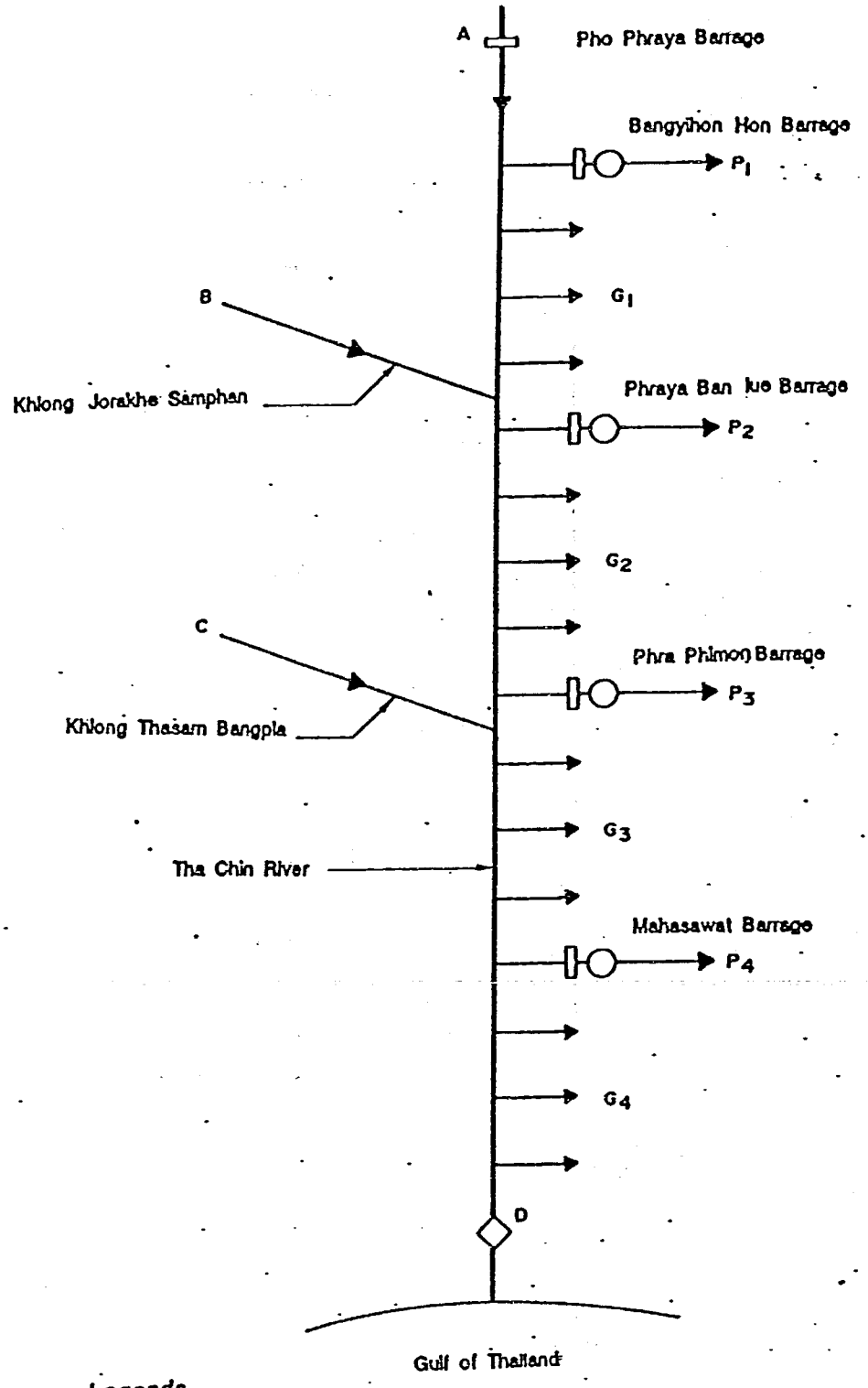

A
Pho Phraya Barrage
Bangyihon Hon Barrage
P1
G1
B
Khlong Jorakhe Samphan
Phraya Ban Iue Barrage
P2
G2
C
Phra Phimon Barrage
P3
Khlong Thasam Bangpla
G3
Tha Chin River
Mahasawat Barrage
P4
G4
D
Gulf of Thailand
Legends
Controlled Water Volume for Dispersing Sea Water
Regulator
Regulator and 2-Way Pump

FIGURE 7.3

8．今後議論したい課題

自国の発展をいかに図るかという点においてアジア諸国に共通する関心事は技術移転による向上が緊要であるということである。実際、技術は各種の研究活動により発展させることができる。緊急の必要性ははるか技術革新まで通ずるものである。

今後の討議の要件は下記項目に基づくべきであろう。

1)（ビル、橋梁、トンネルなどの）新建設方式。

2)最新建設機器機械、および最新研究機器、試験機器。

3)研究成果としての新建造物。

ただし、たとえば、インドシナのある国々のように、新しい技術計画やその応用の局面などをあまり強調しない国も多い。さらに、アジアには後発発展途上国もあり、技術の移転、発展、利用がほとんど行われていない例もある。

従って、新しい技術の管理運用面の展開戦略は国々によって、その社会経済的発展レベル、特定のニーズや優先順位、資源、伝統などに応じて、まちまちのものである。

この目的達成のためには、技術移転は漸進的に実施すべきものである。特に、建設に関しては、公共事業研究が重要な役割を演ずるべきである。その活動は包括的で広範囲のものとなろう。

このような機能は、たとえば日本やＪＩＣＡのような、援助国や援助機関によって追加予算的なプログラム資金が利用できるようにならない限り、その実行は不可能である。また、研究資金、研究交流プログラム、地域研究セミナーなども提供すべきである。

Ⅷ. 日　　本

建設省土木研究所研究調整官　飯　島　　尚

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8．今後議論したい課題 ----------

１．日本の概要

日本は、アジア大陸の東側に延長3,000km（1,860マイル）にわたって、弧状に位置している島国であり、本州、四国、九州、北海道の四つの主な島のほか、散在する4,000あまりの島からなっている。首都東京は東経140度、北緯36度にある。日本列島は環太平洋地震帯上にあり、火山活動も活発であることから、これまでに大きな自然災害による被害を受けてきている。国土の67%は山地で、多くは森林におおわれ、農用地は15%、宅地は3%で、工業用地は僅か0.4%にすぎない。

日本は、経度差約31度、緯度差約25度の広い範囲に位置することから、南北の気候差が大きい。日本全体の年間降水量は約1,800mmであるが、その地域差は大きく、瀬戸内（高松）と北海道（旭川）では、1,000mm程度であるのに対し、日本南西部の太平洋側の一部の地域では4,000mm近くに達する。我が国の降水特性は雪、梅雨、台風の三つに特徴づけられ、特に台風は毎年３～４個が上陸し、多量の降雨をもたらしている。日本全体でみても年間降水量の1/4～1/3が台風によるもので、しばしば各地に大きな洪水、土砂災害等を引き起こしている。

日本の人口は、現在約1億2,000万人を数える。また、人口密度は約320人／km²である。人口の分布は、地域的に大きな偏りが見られ、東京、名古屋、大阪などの大都市とその周辺の都市への人口集中が目立っている。一方、南九州や四国の太平洋側、本州内陸部の山地や日本海側および北海道では人口密度が低く、過疎の地域が広がっている。

日本経済は、1945年の第二次世界大戦の極度の混乱期より戦後復興が進み、その後、1955年頃から石油危機の発生した1973年までの約19年間にＧＮＰの実質経済成長率は年率で約10%を記録した。日本経済は、この高度成長期に４回の不況を経験しているが、なかでも過剰設備により生じた1965年不況は最も深刻で、政府は赤字国債を発行して景気の回復をはかった。これらの不況もあったが、長期的な経済成長の末、ＧＮＰについては現在世界第２位、また１人当たりの国民所得は世界第１位になっている。

我が国の貿易が、資源を輸入して製品を輸出する典型的な加工貿易の姿をみせていたのは、1970年代までであり、1990年には輸入に占める工業製品の比率は50%を上回っている。ＮＩＥＳやＡＳＥＡＮ製品の台頭や、資源輸出国の工業化が進んでいるためであり、輸出の99%を占める我が国の工業製品はより付加価値の高いものに移行している。

２．我が国の公共事業の現状

我が国の国土開発関係の法令は、国土総合開発法、土地基本法、国土利用計画法などの基幹法と、地域ごとの開発を進めるための法令、特別地域の開発を進めるための法令、およびそれらの関連法令とから構成されている。

国土開発関係の計画の大本になるのは全国総合開発計画で、現在「第四次全国総合開発計画」が動いている。また、事業毎にそれぞれの五箇年計画においてより具体的な整備目標を定めている。また、今後10年間の公共事業の基本方向を示す「公共投資基本計画」（1990年公表）では、概ね430兆円の公共投資がはかられる計画となっている。

日本における公共土木事業の執行に関する国の機関、組織（主たる省庁）は、以下のとおりである。

- 建設省
  - 河川、ダム、海岸の整備
  - 砂防
  - 道路の整備
  - 宅地の整備
  - 下水道の整備
  - 公園、緑地の整備
- 北海道開発庁 — 北海道の公共事業整備
- 沖縄開発庁 — 沖縄の公共事業整備
- 国土庁 — 国土計画
- 農林水産省 — 農林水産業基盤の整備（農道、漁港など）
- 運輸省
  - 鉄道の整備
  - 港湾の整備
  - 空港の整備
- 通産省
  - 工業用水の整備
  - 電力施設の整備
- 厚生省 — 水道の整備

建設省が行っている主な社会資本の整備の歴史、整備状況と課題は次の通りである。

1）河川事業

我が国は台風が常襲する国であり、特に1945、1947、1948年と度重なる大規模な台風、豪雨により、1960年に「治水治山緊急措置法」ならびに「治山特別会計法」が整備され、現在の治山事業の制度の基盤が整った。その後、多目的ダム、過度の人口集中に対する総合的な治水対策、地すべり災害、海岸保全等に対し、法制面の整備を始めとして国土保全を積極的に進めてきているが、なお、毎年各地で災害が発生しており、今後とも対策を進めていく必要がある。

2）道路事業

1954年度発足の第１次道路整備５ヶ年計画の策定以来今日の第１１次５ヶ年計画に至るまでに、鋭意、道路整備が始められた。その間、1957年には高速道路の整備に着手した。1955年以降の我が国の高度成長、1965年以降の自動車の大衆化により、交通事故の激増を生むに至った。このため、交通安全対策の充実が図られてきている。この40年間に、日本の道路網は着実に整備され、自動車輸送は国内輸送の中で大きなシェアを占めるに至ったが、未だに急増する交通需要並びに多様化、高度化するモビリティに十分対応しているとは言い難い状況であり、次世代に向けての整備が必要とされている。

3）住宅

我が国の住宅事情は絶対的な供給不足で、緊急な応急対策として、罹災都市応急簡易住宅43,000戸を整備し、その後も量の確保に努めた。その結果、1973年には、住宅数が世帯数を上回るに至り、住宅の絶対的不足の解消が図られた。しかし、住宅難の一応の解消は図られたものの、狭小で質の低い我が国の住宅に対し、その質的向上を図るための政策展開がなされている。

4）下水道

我が国の下水道整備の歴史は浅く、1955年以降までは国の重点事業としての整備はされていなかった。しかし、1955年以降の急速な経済成長は、都市環境の悪化や水質汚濁の進行を引き起こし、下水道整備に対するニーズと重要性が高まった。このため、1963年以降下水道整備五箇年計画を策定し、下水道整備のための努力が払われており、下水道普及率は47%にまでなっている。

5）公園

高度成長期における急激な都市化により、生活環境、都市環境の悪化が表面化したため、1972年に第一次都市公園等整備五箇年計画が策定され、都市公園の急速な整備が進められるようになったが、現在でも欧米諸外国と比較して１人当たり都市公園面積でみると低い水準にあり、整備が必要である。

今日に至るまで官、民、合わせて建設事業の努力がなされてきており、平成４年度は官民総等投資額は85.8兆円になっている。さらに、東京湾環状道路、業務核都市、関西文化学術研究都市、関西国際空港、本州四国連絡橋、第二東名・名神高速道路を中心とする高規格幹線道路の建設事業等壮大なプロジェクトが進められている。

３．建設省土木研究所の概要

建設省土木研究所は、大正11年（1992年）に内務省土木試験所として発足した。昭和23年（1948年）に建設省の設置に伴い建設省土木研究所と改称し、またその後組織の改編・拡充を経て、昭和54年（1979年）に各地に分散していた支所・試験所を筑波研究学園都市に移転統合し、ほぼ現在の組織になった。国土の均衡ある発展と快適な生活環境づくりの基礎となるインフラストラクチャーの整備のための研究開発を担っている。

現在の組織は総務部、企画部の研究支援部門と、環境、河川、下水道、ダム、砂防、道路、材料施工、構造橋梁、地震防災の９研究部３５研究室、積算技術研究センター及び新潟試験所からなり、広範な土木技術の基礎的研究から応用研究・技術開発を実施している。

これら研究開発を推進するにあたり、土木研究所では、建設省が策定している長期展望等との整合を取りつつ、昭和58年度（1983年度）から長期的な観点からの研究の方向付けと研究の効率的・組織的な推進を図るための土木研究所長期研究計画、さらにそれどれの時代の要請に対処した的確な研究開発を行うための研究５ヶ年計画を策定している。現在は平成４年度（1992年度）を初年度とする第３次研究５ヶ年計画に基づき、多様な国民のニーズや行政ニーズに柔軟に対応した研究開発を推進している。

平成５年度（1993年度）の予算総額は約１１２億円、そのうち人件費・事務費約４０億円、調査研究費約５８億円、施設費約１４億円である。職員は研究職３１０名、管理・研究支援部門１６１名の総勢４７１名である。

平成５年度（1993年度）は約４５０の研究課題を実施している。したがって、１課題あたり約１３百万円の研究費となっている。また、１研究室は１０人弱の研究者の体制で、平均１２課題の研究を担当している。これらの研究課題は、土木研究所の研究５ヶ年計画等に基づいて設定されている。さらに土木研究所長をヘッドとする所内ヒアリング及び行政あるいは学識経験者等のヒアリングを通し、指導・助言・研究調整を受け、実施に移される。

特に、行政ニーズが高く、多分野にまたがるテーマ、緊急的かつ重要なテーマについては、複数の研究室が参加するプロジェクト方式で実施される。また、応用的な技術開発にあたっては、民間活力に負うところが大きく、公団、民間等との共同研究制度で実施することも有効な手段となっている。

また、一般の研究課題についても、特に緊急に技術開発を行う必要があるもの、多額の実験費用を伴うものについては、重点的に予算を配分している。これらの研究推進に当たっては、近年の社会状況の変化を考慮に入れ、かつ土木研究所の将来を見通した上での研究マネージメントが重要となる。

最近では、民・学との人的交流を積極的に進めるとともに、我が国の土木技術のセンターオブエクセレンス（ＣＯＥ）として、独自の研究を推進すると同時に、基礎的研究を担当する大学と開発研究を担当する民間企業の仲立ちとして、我が国の土木研究開発の向かうべき方向性を示したり、官、学、民の役割分担を調整することも土木研究所の重要な任務となっている。

4．土木研究所の主要な研究開発の状況

4．1　主要な研究開発の分野

我が国の今後の動向に対応し、土木研究所では (1)社会資本整備に対する多様なニーズに応える研究開発、(2)利用者の立場に立った研究開発、(3)環境に配慮した研究開発、(4)国際的に普遍性をもった研究開発、(5)我が国独自の技術の研究開発、(6)景観、機能、耐久性に優れた社会資本整備を行うための研究開発、以上６点を研究開発の共通理念と考えている。この共通理念のもと、今後取り組むべき主要分野は次の通りである。

1）国土の高度利用の推進
2）安全に暮らせる基盤づくり
3）環境と共生する社会の建設
4）合理化、安全性の向上を図る施工技術の開発
5）あらゆる分野の成果を活用した土木用新材料の開発
6）メンテナンスフリーをめざした維持管理手法の向上
7）宇宙、海洋等ニューフロンティアへの進出
8）総合的、合理的建設マネージメント技術の確立

4．2　現在取り組んでいる研究・技術開発の例

「社会資本の維持更新・機能向上技術の開発」（平成３～７年度）（1991～1995年度）

我が国の公共施設はこれまで着実に整備され、現在では膨大なストックを抱えるに至っている。これらの施設等を良好な状態で維持するための総合技術開発プロジェクトの研究課題として標記の課題を取り上げ、学識経験者からなる委員会の指導・助言を受けつつ、民間企業との共同研究等により、研究開発を推進している。

本課題では、各種構造物の計測診断技術の開発や評価手法の開発、さらに更新・機能向上のための材料・工法の開発を行う。また、維持更新を効果的、経済的に実施するため、評価、対策工法等の要素技術を総合化したマネージメントシステムを開発するとともに、維持管理・更新費用を低減させるための技術を開発する。

4．3　研究開発を進めていく上での課題

建設事業の大型化、多様化が進むにつれて、研究に必要な実験装置の大型化、研究期間の長期化が進行している。しかし、一方では事業の進行に合わせて早急に解決すべき課題も増加していることから、研究を合理的かつ効率的に進めるために、綿密なかつ柔軟な研究計画を立てる必要がある。

研究の効率的な実施のためには十分な予算の確保が必要である。一般に、経済が厳しい状況にあっては研究開発費は削減の対象となりやすいが、研究開発の重要性を関係者に認識させ予算の確保に努めるとともに、予算の合理的な運用、外部機関との連携等効率的な執行が必要である。

さらに組織の改編や研究者の増員、余裕のある研究期間の確保等、研究がしやすい体制づくりも重要である。

５．土木研究所のアジア地域諸国との国際研究交流

５．１　研究課題

土木研究所では、社会基盤整備技術に係わる総合的な研究機関として国際研究協力に積極的に取り組んでいる。平成５年度（1993年度）現在、科学技術協力協定等の枠組みの下に土木研究所がアジア地域の国々と実施している研究協力は下記のとおりである。

１）土砂災害の防止、軽減に関する研究（中国：山地災害及び環境研究所、鉄道科学研究院）
２）滑性斜面、泥石流の防止及び軽減等地質災害研究（中国：鉄道科学研究院）
３）都市緑化技術に関する情報交換（中国：建設部）
４）日中河川及びダム会議（中国：水利部、水利水電科学研究院）
５）道路橋の耐震性向上技術に関する研究（中国：国家地震局、工程力学研究所）
６）ライフライン施設の耐震性向上技術に関する研究（中国：国家地震局、工程力学研究所）
７）扇状地における土砂災害防止技術に関する研究（ｲﾝﾄﾞﾈｼｱ：火山砂防技術ｾﾝﾀｰ）
８）火山地域における土砂災害予測手法の開発に関する国際共同研究(ｲﾝﾄﾞﾈｼｱ：火山砂防技術ｾﾝﾀｰ)
９）日韓建設技術研究交流会議（韓国：建設技術研究院）
１０）都市河川の水環境改善システムの開発（韓国：建設部、建設技術研究院）
１１）熱帯林の変動とその影響等に関する観測研究（ﾀｲ：農業共同省王立灌漑局）
１２）ﾏｲｸﾛ波ｾﾝｻﾃﾞｰﾀ利用等によるﾘﾓｰﾄｾﾝｼﾝｸﾞ高度化のための基盤技術開発(ﾀｲ:農業共同省王立灌漑局)

これらの個別課題の他、ＥＳＣＡＰやＲＥＡＡＡ等多国間の研究協力や国際会議にも積極的に参加している。

５．２　実施上の課題

現在、日本が海外からの要請を受けて実施する技術協力制度は既に確立されているが、国際研究交流については制度はあるものの非常に限られた予算であり、科学技術協力協定等の取り決めが行われている国との研究交流が中心となっている。現在、アジア地域の国との研究交流は、技術協力分野での活動が中心であり、研究者の交流は比較的少ない。

すなわち、これまでの我が国とアジア地域諸国との交流は、ＪＩＣＡを通じた技術専門家の派遣もしくは研修員の受け入れが中心であったり、技術移転を目的とした活動が行われてきた。しかし、一国のみでは解決できない問題や環境問題を含めた周辺諸国に大きな影響を及ぼす問題も増加しており、アジア地域の各国が一層協力して社会開発等を実施する必要性が大きくなっている。そのため、技術研究の情報ネットワークの強化、幅広い枠組みでの技術研究・開発分野での交流を一層進めることが必要であることから、技術研究の推進のための体制を確立する必要がある。

6．「災害・防災」についての取り組み状況

6．1　概要

我が国は、モンスーン性気候区分内にあり、国土の６７％は急峻な山地となっている。さらに、周囲を海洋に囲まれていること、環太平洋地震帯に位置していること等の自然条件により、多くの自然災害による被害を受けている。このような中、土木研究所では自然災害に対する被害軽減および防災に関して積極的に取り組んでいる。

本章では、我が国の自然災害を大きく以下のように分け、それらの現状と課題を把握するとともに、土木研究所の「災害・防災」に対する取り組み状況について述べる。

a)河川災害
b)海岸災害
c)渇水災害
d)土砂災害
e)地震災害

さらに、アジア各国の共通課題と考えられる以下に関する総合的対策について述べる。

a)総合的な治水対策
b)道路のり面災害に対する対策

6．2　我が国の「災害・防災」の現状と課題

1）河川災害

日本は、洪水の起こりやすい土地条件・気候条件を有し、古来より毎年水害に悩まされて来た。近年、治水投資の効果により、水害は着実に減少し、広範囲な地域が水没することは稀となり、死傷者数の減少には著しいものがある。しかしながら、依然として治水施設の整備水準は低く、特に、1960年代以降、日本経済が急速に発展し、人口・資産が都市域に集中した結果、年間の氾濫面積は減少傾向にあるものの、一般の資産の被害額はむしろ若干の増加傾向が見られる。こうした状況の下で、経済的制約等を考慮すれば、河道および河川構造物計画、洪水防御計画及び構造物によらない防災対策をより一層合理的かつ効率的に進めることが今後の課題である。

2）海岸災害

我が国の海岸は過去から高潮・津波災害を繰り返し受けてきた。最近では、消波構造物や海岸堤防の建設によってこの種の災害が減少してきている一方、全国各地で海岸侵食が進み、自然海浜が急速な勢いで消失しつつある。この海岸侵食の原因は、

i)構造物建設による沿岸漂砂の連続性の阻止
ii)大規模な防波堤による波の遮蔽域の形成
iii)河川からの流出土砂量の減少

の３つに分類される。これらの原因によって侵食が生じている海岸は全国で多数にのぼる。

3）渇水災害

日本の年平均降水量は約1,750㎜で世界平均の約２倍と比較的多いが、人工１人当たりの降水量は世界平均の約1/4程度に過ぎない。また、地域別の格差が大きく、水資源の賦存と水需要の間に地域

的なアンバランスがある。一方、ここ数年の小雨現象による渇水により、改めて渇水対策の重要性が認識されるとともに、今後、さらなる水需要の増加が見込まれており、水資源開発のため現在実施中の事業を含め今後約340事業のダム等水資源開発施設が建設されることになっている。

4）土砂災害

我国の地形は急峻で、地質は脆弱であり、さらに豪雨、台風、地震、火山噴火等の自然現象が起こり易く、山地の開発が進み，斜面や山地の近くに多くの人々が住んでいるため土石流、地すべり、崖崩れ等による災害、いわゆる土砂災害が発生しやすい。また、山岳道路沿いにおいてのり面・斜面の崩壊、落石、地すべり、土石流等が発生し易く、道路交通が影響を受け易い。このようなことから毎年、各地で土砂災害が発生し、自然災害による死者、行方不明者のうち、土砂災害によるものの割合は約６割にも達している。このような土砂災害を防止・軽減するために我国においては、砂防法、地すべり等防止法、および急傾斜地の崩壊による災害の防止等に関する法律に基づき、主として建設省および都道府県が災害防止施設の設置を始めとする種々の対策を実施してきている。

5）地震災害

日本は世界有数の地震国である。ごく最近も1993年１月に釧路沖地震(M7.8)、同年７月に北海道南西沖地震(M7.8)が発生し、後者においては津波・火災などにより死者・行方不明者合計約 250人の犠牲者を出している。わが国における地震災害を概観すると、被害形態が時代とともに変遷してきている。その特徴の一つとして、ライフラインの被害等の都市型災害が新たな被害形態として挙げられる。人口や社会経済基盤が集積しているわが国では、特に都市部での地震防災対策が急務となっている。北海道南西沖地震における大火災の発生は今後の都市防災への警鐘でもある。また、斜面崩壊、液状化、津波などの従来型の地震被害の防止・軽減をはかることも重要な課題である。

６．３　「災害・防災技術」に関する土木研究所の取り組み状況

1）河川災害・防災技術

わが国では最低限の治水安全度は確保されつつあるが、現在はより安全度の高い、川本来の魅力を生かした川づくりのための研究を進めている。また、水災害を防ぎ、水資源を確保することによって豊かで安全な生活環境を創出するためには、自然界における水の循環を調べ、工学的な手段を講じて制御する事が必要であり、1)水文観測技術の開発、2)河川の流出に関する調査研究、3)地球環境変化の影響に関する調査研究を実施している。さらに都市河川とその流域における治水上の問題に対処するためには、河川改修はもとより、流域内においても多面的な施策を実施していく必要があることから、このような総合的な治水対策に関する諸問題についての調査研究も行っている。

2）海岸災害・防災技術

海岸侵食対策としてはヘッドランド工法が、高潮対策としては人工リーフ工法があげられこれらに関する研究を実施している。ヘッドランド工法とは、長い砂浜海岸に適切な間隔で人工的に岬群をつくり、波によって移動する砂を岬と岬との範囲内に止め、海岸線を安定化させる工法である。人工リーフ工法とは、沖合の海底面に捨石やブロックを積みあげることにより浅海域を形成し、波を砕波させることにより消波し、後背域の静穏化を狙ったものである。

3）渇水対策技術

水資源開発施設であるダム等の建設事業は、種々の土木事業の中でも多種多様な分野にわたるも

のであり、建設技術上の課題も多岐にわたっている。土木研究所では、このような技術的問題に対して、水資源開発施設の計画・運用に関する研究、地球温暖化が水資源に及ぼす影響に関する研究、ダム堤体および基礎岩盤の設計法に関する研究、ダム材料および施工法の合理化に関する研究、水理構造物の設計法に関する研究、ダムの安全管理に関する研究、堆砂対策に関する研究等に取り組んでいる。

4）土砂災害・防災技術

土石流，地すべり，崖くずれ，道路のり面・斜面の崩壊等による土砂災害の防止・軽減対策の技術の向上を図るために，土木研究所では以下のような項目に関する研究を実施している。まず，土砂災害の原因となっている土砂移動現象の機構を現地観測，模型実験，コンピューターシミュレーション等により検討するとともに，それらの成果を用いて，危険区域の調査法，危険度の判定法および土砂災害の発生予測手法の開発を行っている。これらの成果は土砂災害発生危険時の警戒・避難体制の整備および合理的な対策施設の計画・設計に利用されている。また，施設による土砂災害対策を効率的に進めるために，模型実験，現地試験施工等により各種の新工法を開発するとともに，合理的な調査，設計，施工法に関する研究を実施して，各種の技術指針を作成している。

5）地震災害・防災技術

地震防災技術の総合化を図るため、建設省総合技術開発プロジェクトでは、「新耐震設計法の開発」(1972～1976年度)、「震災復旧技術の開発」(1981～1985年度)、「災害情報システムの開発」(1987～1991年度)が実施されており、幅広い研究成果が得られている。また、1992年度からは新たに「大都市地域における地震防災技術の開発」が５年間の予定で進められている。また、道路、河川、ライフライン施設等の耐震設計法の開発研究が別途実施されており、これらの成果は各種の耐震設計基準に反映されている。最近では、橋梁の免震・制震設計、地盤流動対策など、新しい地震防災技術の開発にも取り組んでいる。

6．4　総合的な治水対策

1）はじめに

わが国の河川、特に都市部の河川は、近年、洪水時の流出量の増大、平水時の流量の著しい減少という水文循環の変化を経験した。わが国は第2次世界大戦後、急速な経済的発展をとげたが、それは、一方では、大都市や地方の中枢都市などの都市部に人口と資産が高密度に集積し、他方では、農山村、漁村等の過疎化を生んだ。その過程において宅地開発、農地転用といった河川流域の土地利用の変化は、流域が本来持っていた保水・遊水機能を減少させた。

こうした土地利用の変化は、治水事業の効果を減少させることともなった。開発および都市化が急激に起こった地域では、都市近郊の土地需要が増加したため、都市域の地価が上昇し、より廉価な土地を求める人々は、かつての低湿地でもある水害常襲地帯に土地を購入することとなった。また、都市近郊の台地や丘陵地では、農地や林が徐々に姿を消し、これらに代わって大小さまざまの宅地が開発され、事務所・工場等が立地することとなり、氾濫が与える影響が変化したのである。

１９７４年７月、静岡市および清水市を流域とする巴川一帯に、7時間で４４４mm、１２時間雨量４９７mmという集中豪雨が発生した。この豪雨は、両市で床上浸水１万６千戸、床下浸水約2万戸といった流域面積１００ｋｍ２の小河川にしては極めて甚大な被害をもたらした。このとき、河川の上流部にあった低地にかなりの氾濫、湛水があり、下流部での被害を軽減する効果がみられた。こうした低地の調節機能を十分に考慮した治水対策、すなわち流域治水対策に取り組まなければならないという認識が高まった。

それまでにも、土木研究所の研究者を中心に、１９６０年代半ばに始まった米国での氾濫原管理への新しい動きが注目され、河川改修のみで治水を完結させることに疑問を呈する意見が出始めていた。この巴川の洪水被害、および、これに続く１９７６年の台風による各地の都市型洪水は、この新しいアプローチの必要性を認識させ、総合的な治水への動きに拍車をかけたものと言える。

１９７６年１０月、河川審議会の中に、「総合治水対策小委員会」が設置され、都市水害問題を含む近年の水害に対して検討が加えられた。翌、１９７７年６月に河川審議会より建設大臣あて提出された総合的な治水対策の推進方策についての中間答申には、わが国の総合治水対策の基本理念が述べられており、その骨子は、保水・遊水機能の確保、洪水氾濫予想区域及び土石流危険区域の設定および公示、治水施設の緊急整備計画の策定、水害に安全な土地利用の方式と建築方式の設定、関係部局、地方公共団体との協議体制の整備等からなる。この答申を踏まえて、建設省河川局は、関係省庁、建設省内部での協議を重ね、１９７９年度より「総合治水対策特定河川事業」を発足させた。本制度は、従来河川空間のみを扱ってきた河川行政がはじめて真正面から流域に対して積極的な発言を試みたという点で画期的なものである。これは、それまで、地方自治体が要綱その他で模索し、建設省の内部でも検討されてきたものを発展・総合化した制度であると言える。ここでは、この総合治水特定河川事業の概要を述べ、わが国において導入された総合的な治水の考え方、及びこれを支援するために土木研究所で実施された研究の一部を紹介する。

２）総合治水対策特定河川事業

流域において都市化が急速に進展している河川を対象に、１９７９年、総合治水対策特定河川事業が開始された。この事業においては、当面、概ね１０カ年程度で時間雨量５０mm相当（年超過確率５分の１～１０分の１）の降雨に対する治水上の安全を確保することを目標とした。そのため、i）積極的な河川改修事業の推進、ii）流域整備計画の策定、 iii）浸水実績の公表、iv)流域住民の理解と協力の働きかけ、を実施するものとした。

また、流域ごとに、流域内の地方公共団体等の合意に基づき、建設省地方建設局、都道府県及び市町村の河川担当部局、都市・住宅・土地担当部局等の関係部局からなる流域総合治水対策協議会を設置して、当該流域に係わる総合治水対策について協議し、効果的な対策の確立に資するものとし、その対策立案の方針として、次のようなものを示した。

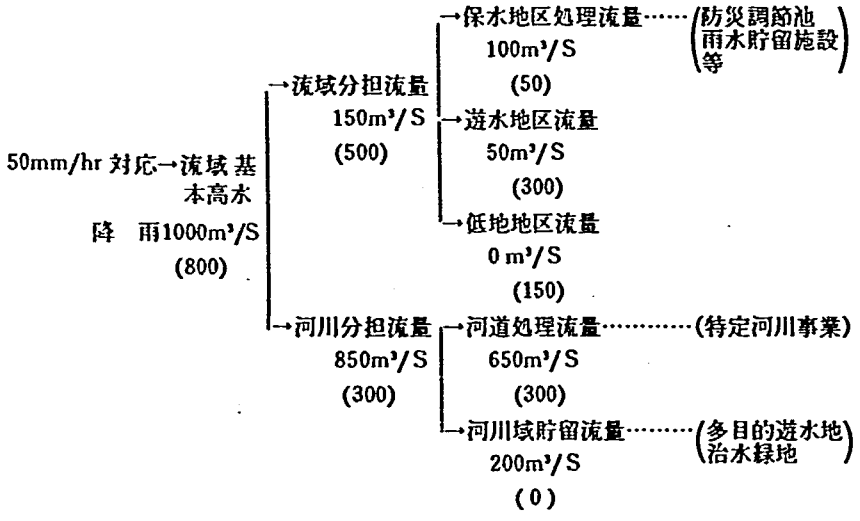
・流域総合治水対策協議会構成員間における行政資料として活用するため、浸水予想区域を設定する。
・既往の洪水による浸水実績を公表する。
・流域を治水対策上の役割に応じて保水区域、遊水区域及び低地地域に区分することを原則とする。
・遊水機能のある土地については、治水計画上必要な地域を、計画的遊水地として確保する。
・大規模宅地開発等に関連して治水計画上必要な調整池の建設費を補助する。
・保水・遊水機能の維持増大措置の一環として、雨水貯留施設の建設費を補助する
・保水・遊水機能の維持のため、団地の棟間貯留、運動場、広場等での貯留を促進する。
・歩道における透水性舗装の適用等保水機能の向上に努める。
・下水道においては、貯留機能等の確保のため、その方針を検討し、必要な措置を講ずるように努める。
・市街化調整区域のうち、保水・遊水機能を有する土地については、都市計画担当部局は市街化区域及び市街化調整区域の決定（変更）の際に十分配慮するものとする。
・流域の保水・遊水機能の維持の観点、及び治水施設の整備状況に対応した水害に安全な土地利用方式、建築方式の奨励の観点から、i）流域の保水・遊水機能の維持の必要性、ii）各戸貯留、高床式建築等の奨励、iii）地域の実態に応じた盛土の抑制、を内容とする流域総合治水対策協議会名のパンフレットを作成し、流域住民及び建築、宅地造成関係者に市町村を通じて配布する等理解と協力を求める働きかけを行う。
・災害危険区域の設定については、具体的箇所について河川部局と建築部局が協議を行う。
・市街化調整区域のうち、溢水、湛水、津波、高潮等によるおそれのある土地の区域については、概ね１０年以内に優先的かつ計画的に市街化を図るべき区域としての市街化区域への編入は原則として行わないものとする。

さらに、流域整備計画における流量分担計画の例として、図-6.1のようなものが示された。総合治水対策特定河川における、それぞれの流域での流量分担計画は、流域の特性に応じ、この考え方を参考として策定された。

図-6.1の例では、時間雨量５０mmの対応降雨に対して現状では流域の基本高水が８００m^3/sであ

り、このうち３００m³/sが河道で処理され、残り５００m³/sについては、うち５０m³/sが保水地区において防災調節池等で処理され、遊水地区では３００m³/sが遊水し、低地地区では１５０m³/sが湛水していることを示している。

これに対して流域整備計画の目標年度である１０年後には、その間の開発により流域の基本高水が１，０００m³/sに増加することが予想され、これに対しては、まず河川の分担として８５０m³/sを処理することとする。この場合において、河道を総合治水対策特定河川事業により３００m³/sから６５０m³/sに上げ、さらに遊水地区で遊水していた３００m³/sのうち２００m³/sを多目的遊水池事業等により処理することとする。しかしながら、これでも流域の基本高水１，０００m³/sには未だ及ばないので１５０m³/sは流域における流量分担を要請せざるを得ない状況にある。この場合において保水地区については、防災調節池事業等により５０m³/sから１００m³/sへと処理流量を上げることとし低地地区については、湛水していた１５０m³/sの流量を０m³/sにすることを示している。



(注) 上段は流域整備計画目標年度（10年後）
下段（ ）書は現況

図－６．１ 流域整備計画における流量分担計画例

なお、流域整備計画の構成については、次のような例が与えられた。

１．総説（計画作成の意義、計画の期間等）
２．流域の現況
（１）流域及び河川の概要（流域の諸元（面積、流路延長、人口等）、河川の現況）
（２）土地利用（都市計画の区域区分等、土地利用の現況）
（３）浸水実績（過去の主要洪水の概要、代表的水害の状況等）
３．流域整備の基本方針
（１）治水機能の地域区分（保水地域、遊水地域、低地地域の区分）
（２）流域整備の基本方針
(i)流域整備の前提（流域における市街化の見通し等の流域開発の想定）
(ii)治水計画の基本方針（長期的な治水計画（工事実施基本計画等）の基本方針）

(iii)治水暫定計画の基本方針（流域整備計画の計画期間に対応する治水施設整備計画の基本方針）

(iv)流域対策の基本方針基本方針（治水計画以外の流域における対策の基本方針及び土地利用についての基本方針）

4．河川の整備計画

（1）治水施設の整備状況（河川毎の改修状況等）

（2）治水計画（工事実施基本計画等）

（3）治水暫定計画（整備目標、事業内容、工期、事業費等）

5．地域毎の整備計画

（1）保水地域

(i)地域の概要（地域内の土地利用及び保水機能の概要）

(ii)保水機能保全対策（防災調節池、暫定調節池、雨水貯留施設、透水性舗装の適用等、下水道における貯留機能等に対する配慮等）

（2）遊水地域

(i)地域の概要（地域内の土地利用及び遊水機能の概要）

(ii)遊水機能保全対策（計画遊水池、多目的遊水池）

（3）低地地域

(i)地域の概要（地域内の土地利用及び浸水状況）

(ii)低地地域保全対策（排水対策（内水排除施設等）、災害危険区域の設定、土地利用における治水安全度の配慮等）

6．その他（警報避難、水防活動等）

１９７９年に総合治水対策特定河川事業が始まった時に、特定河川として指定されたのは１０河川であったが、その後、１９８２年までに１４河川に増加した。１９８８年になって、都市化が急速に進展している流域に加え、既成市街地が大部分を占める流域についても総合治水対策を計画的かつ重点的に実施することが求められたのに鑑み、新たに3河川を加えて現在１７河川において同事業が実施されている。

3）土木研究所における取り組み

土木研究所においては、総合治水対策の考え方をわが国に紹介し、これが治水事業の新しいアプローチとして認識されるにあたり大きな貢献をした。さらに、１９７９年に総合治水に関する調査・研究を行う組織として、総合治水研究室が新たに設置されてからは、一貫して総合治水対策の推進における技術課題の解決に努めたところである。総合治水研究室は１９９３年4月をもって、都市河川研究室として生まれ変ったが、ここでは、総合治水研究室が実施した研究の中から主要なものを紹介し、それらが総合治水対策のなかで、どのように活用されてきたかについて説明することとする。これらの研究課題を含め総合治水研究室の研究課題は、１９９３年4月以降、全て都市河川研究室に引き継

がれ現在に至っている。

(1) 氾濫予想区域図

洪水危険度を評価する一手法としての洪水危険度評価地図についての検討は１９８１年度に始められ、この年、地図作成のための手法として、地形学的方法、既往洪水による方法、水理・水文学的方法、被害による方法を比較・検討し、それぞれの方法の基本的な特性、有効性、治水対策との関連等を明らかにした。その後、数多くの河川を対象として、既往洪水による浸水実績図が公表された。１９８５年度からは、水理、水文学的方法による氾濫予想マップの作成方法とその応用に関する調査を開始し、その成果も含め、１９８７年には、新河岸川を対象に、我が国で始めて浸水予想区域図が一般住民に公表された。すなわち、当初、行政部局の資料として作成することとされていた浸水予想区域図が一般住民に公表されたのである。この地図は、概ね１００年に１回程度起こる大雨を対象として、流出計算、洪水流下計算、氾濫計算を実施し、浸水が予想される区域をその浸水深別に表現したもので、土地の形成要因からみて浸水の可能性のある地域も示されている。こうした浸水予想区域図の公表は、住民に、i)自分の住んでいる地域の浸水の可能性を認識させる、ii)水防への関心を深め、緊急時の水防活動、避難行動等に利用させる、iii)水害に強い生活様式を工夫させることを目的として実施したものである。公表に当たっては、土地価格に対する影響等が危惧されたが、特にこれに関する混乱もなく、住民には好意的に受け止められた。

なお、その後現在までに３河川において同様の地図が一般住民に公表されている。

(2) 流域治水施設の機能評価

総合的な治水対策において、主要な流域治水施設として位置付けられているものに流出抑制施設があげられる。我が国における流出抑制施設のはしりは、１９６０年代初めから主に日本住宅公団（現、住宅・都市整備公団）により造られ始めた防災調整池にあると言える。このような、貯留型の流出抑制施設は、技術基準等も良く整備され、施設個々の機能に関しても水理計算等により早くから把握されていたが、土木研究所では防災調整池の調整機能の実体把握のための現地観測を実施してこれを検証し、また膨大な実施例を分析して調整池の多目的利用への提言、維持管理等の問題点の把握を行っている。

一方、貯留施設と並んで流出抑制施設の主要な技術の一つとなっている浸透型施設に関する調査は、１９７８年になって水文研究室で始められた。１９７９年に総合治水研究室が発足してからは、浸透型流出抑制施設の機能評価のため、土木研究所において、施設の規模等を変え、それが浸透量に及ぼす影響について、まず目詰まりについての実験を行った。こうした中で、浸透型流出抑制施設をどう評価し、流出抑制施設としてどう位置づけたらよいのか解答が求められた。また現地施工の進展に伴い、種々の技術的また行政的な問題が起きてきたので、早急に本施設の技術的評価を行う必要が生じてきた。このような状況に鑑み、浸透型流出抑制施設の浸透能力評価マニュアル（案）の作成を試み、水理模型実験及び現地試験結果の解析をもとに、実務的な立場から簡易な現地浸透実験施設を提示し、その実験結果を用いて設計浸透量を算出する方法を提案した。

浸透型施設がどの程度流出量の抑制に寄与するのかは、いまだ定量的に把握されているとはいえず、

現在の治水上の位置付けは、計画上の余裕としている例がほとんどである。浸透型流出抑制施設を治水計画に取り入れるためには、現地に適用する上で必要な計画・設計浸透量の算出手法を確立しなければならない。このため、より詳細な現地実験を各地で実施し、浸透型施設の基礎的特性（地盤特性、施設形状、目詰まり特性等）を調査研究している。

(3) 水防

日本においては、古来より河川改修と水防を軸として、洪水災害に対処してきた。水田を中心とした農村社会において、農地の流亡・浸水を防止するための自主的な地先防衛としての水防活動はなくてはならないものであったと言える。しかし、１９６０年代からの経済成長に伴い社会の様相は変化し、産業構造も農業から工業へ、更にサービス業へという様に変革の波が押し寄せ、また都市化によって人口の流動化が激しくなってきたことなどにより、生活共同体的な意識が風化するなど、水防の組織体制・水防を取り巻く環境も変わり、水防のあり方も問い直されるようになった。また、避難、誘導、救援、救護は、水害に伴う人的な被害を軽減するために有効な手段であるが、河川整備の進捗により、河川の氾濫による被害が少なくなってきたことも相俟って、このような手段によって超過洪水などの不測の事態に対処するための住民の能力は減少しているものと考えられる。土木研究所では、水防体制、警戒避難体制などを含む水防災体制に関する各種研究を通じて、水防災体制の強化に寄与している。

4）おわりに

総合治水対策は、当初、限られた本数の河川において始められたが、その考え方は広く一般の河川においても採用されている。総合治水対策は、要するに、流域に降った雨に対処する方法として、河川改修以外のものも含めるというアプローチであり、治水を河川管理者のみが河川改修という観点からのみ進めるのではなく、流域内の多くの人々の種々の行為により分担しようとするものである。すなわち、堤防、ダム等の土木工学的構造物手段にばかり頼るのではなく、警報避難体制、耐水建築、住民へのＰＲといった非構造物手段や土地利用の制限といった社会的、制度的手段も含め総合的に対策を考えようとするものである。

わが国の場合、実際に展開されたものの特徴として、都市化に伴う流出増という点が中心的関心事であり、これに計画規模を越える洪水への対策である超過洪水対策、緊急にある程度の治水安全度を達成するための暫定対策、河川改修という線的なアプローチではなく、流域全体で面として対策を考える流域対策の３つの視点を持っていることがあげられる。総合治水対策をより一般的にとらえれば、河川管理者が、土木工学的河川改修にのみ重点を置いた治水事業を展開するのではなく、流域住民と河川との関係を深く保ちつつ、様々な手段で洪水の危険性を減少させようとする考え方とすることが出来、都市化が急速に進展している地域や、既に都市化された地域のみではなく、様々な自然、社会、経済的条件の下で、それぞれに適した治水対策の組み合わせを考えるアプローチとして適用が可能であると思われる。

６．５　道路のり面対策

１）道路のり面災害の現状

(1)地質的条件

我が国は、環太平洋火山帯の一部に位置し、しばしば大きな自然災害による被害を受けてきている。その地質構造は、本州の中央にフォッサマグナ（糸魚川－静岡構造線）により大きく二分されている。（図－６．２）

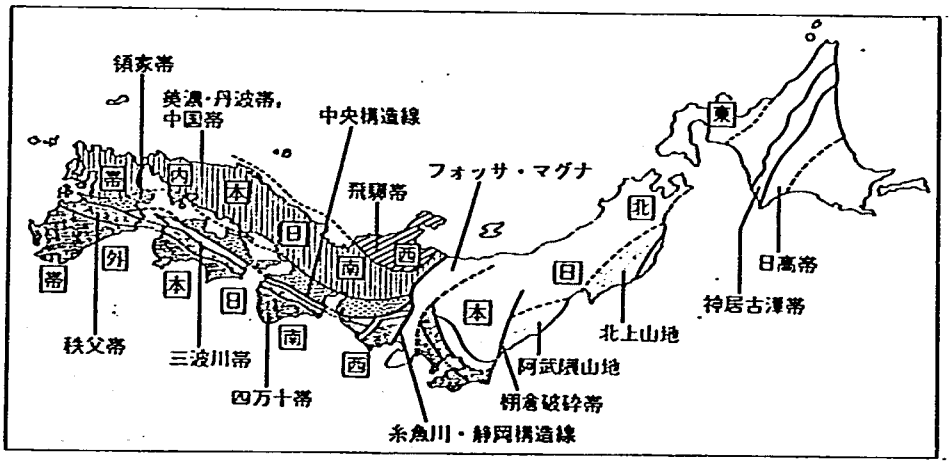
また、国土の67%は山地であり、急斜面も多い地形となっている。このため、道路建設およびダム建設の後に斜面崩壊、地すべり等の災害が発生することがあり、その被害を軽減すること、防災が急務となっている。

(2)気象条件

我が国はモンスーン気候に位置し、四季の変化が明瞭な気候である。また、６～７月の梅雨、９月の台風、１２月～２月の降雪により、年間を通じて降水量が多い。日本全体で年間降水量は1,800㎜であるが、特に多いところは4,000㎜程度となっている。このため、台風の上陸、強風、集中豪雨等により、しばしば土砂災害が発生し、道路施設だけでなく交通システム等に多大な被害を及ぼすことがある。

(3)災害発生形態と件数の推移

表－６．１は高速自動車国道から市町村道までを含めた、最近5年間（昭和62年～平成3年）の災害発生状況を示している。ただし、集計された災害は、台風・豪雨等の自然現象を原因として発生し、発生時に何らかの通行規制が実施されたものである。また、発生形態の分類は、「落石等」「盛り土及び斜面崩壊等」「擁壁等」「地すべり」「洗掘」「橋梁」「トンネル」「雪崩」「その他」とされている。災害発生件数は毎年15,000件～20,000件を推移しており、うち約50%が「盛土及び斜面崩壊」で占められている。



図－６．２　日本列島の地質構造図

表－６．１　道路災害の発生状況

災害種別	落石等	盛土及び法面崩壊等	擁壁等	地すべり	洗掘	橋梁	トンネル	雪崩	その他	計
昭和62年	2,691	7,825	2,737	233	774	206	11	86	895	15,458
昭和63年	3,737	10,706	3,809	250	980	238	22	19	636	20,397
平成１年	3,692	10,650	3,129	321	1,410	285	6	36	773	20,302
平成２年	4,208	11,455	3,017	349	1,428	298	5	40	981	21,781
平成３年	4,180	8,959	2,382	572	1,335	251	8	39	1,727	19,453
合　計	18,508	49,595	15,074	1,725	5,927	1,278	52	220	5,012	97,391

２）道路防災対策の現状と課題

(1)防災対策事業の実施状況

建設省では、昭和43年に104名の死亡者を出した飛騨川バス転落事故を契機として、落石等の恐れのある箇所の総点検（防災点検）を行ってきている。点検は高速道路、一般国道、都道府県道、主要な市町村道を対象に、各道路管理者が一斉に実施する形をとっており、以後、昭和45年、46年、48年、51年、55年、61年、平成2年に実施され、その結果をもとに道路防災対策事業計画の策定がなされている。表－６．２に各年代の点検の経緯、表－６．３に平成2年度の点検調査項目、表－６．４に要対策箇所数・対策事業費・各期間での事業進捗率の推移を示す。

(2)通行規制の実施

要対策箇所への対策の実施とともに、わが国では異常気象時の道路利用者に対する安全確保の観点から、道路の事前通行規制を併用している。事前通行規制は、昭和43年の飛騨川バス転落事故を契機に導入されたもので、「通行規制」と「特殊通行規制」に分けられる。前者は雨量等の基準を定めて事前規制を行なうもの、後者はパトロール等で現地の状況を判断して事前規制を行なうもので、規制の内容は「通行注意」「通行止め」となっている。また、規制区間外の場合でも必要と判断された場合には同様な措置をこうじている。表－６．５は日本全国における異常気象通行規制区間の実態、図－６．３は四国地方における通行規制区間の分布状況を示したものである。

(3)防災対策の分類

防災対策は、前記の防災点検結果をもとに対策箇所を選定し、道路土工指針に基づいて設計・施工・維持管理等を実施している。本指針中では、対策工を大きく「のり面工」「落石対策工」「地すべり対策工」「土石流対策工」「擁壁工」に分類し、各工種について具体的対策工法の一覧、対策工法選定手順等が記載されている。一例としてのり面工の工法一覧と工法選定フローチャートを表－６．６、図－６．４に示す。

表－６．２　主要な道路災害の発生と落石等の恐れのある箇所の総点検の経緯

時　期	で　き　ご　と
昭和43年８月	国道41号岐阜県飛騨川バス転落事故（104人死亡）
昭和43年９月	第１回点検実施（飛騨川バス転落事故に対応）
昭和45年10月	第２回点検実施（国道56号土砂崩落事故判決に対応）
昭和46年７月	国道150号静岡市大崩海岸岩石崩落事故（１人死亡）
昭和46年７月	国道250号兵庫県土砂崩落事故（３人死亡）
昭和46年７月	第３回点検実施（大崩海岸岩石崩落事故に対応）
昭和48年10月	第４回点検実施（昭和46年点検結果の見直し）
昭和51年７月	第５回点検実施（沿道状況の変化に対応し実施）
昭和55年３月	第６回点検実施（沿道状況の変化に対応し実施）
昭和61年９月	第７回点検実施（沿道状況の変化に対応し実施）
平成元年７月	国道305号福井県玉川地先岩石崩落事故（15人死亡）
平成元年７月	落石覆工設置箇所の緊急点検実施
平成２年９月	第８回点検実施

表－６．３　平成２年度落石等の恐れのある箇所の総点検調査項目

① 落石・崩壊	⑦ 擁壁
② 岩石崩壊	⑧ 橋梁（橋梁基礎の洗掘）
③ 地すべり	⑨ 地吹雪
④ 雪崩	⑩ 落石覆工
⑤ 土石流	⑪ トンネル[注]
⑥ 盛土	⑫ その他（降雨、波浪、湧水等）

注）トンネルに関する点検は、平成３年度に実施している。

表－６．４　防災対策の実施状況

（単位：箇所、億円、％）

	51点検	51～54実績	進歩率	55点検	55～61実績	進歩率	61点検	62～H2実績	進歩率	H2点検	H3実績	H4当初	4年末進歩率
事業量	75,765	27,070	35.7	77,044	49,186	63.8	67,282	34,480	51.2	74,085	9,509	8,308	24.0
事業費	11,831	4,297	36.2	14,836	11,013	74.2	16,429	9,980	60.7	24,005	2,699	2,733	22.6

表－６．５　通行規制区間

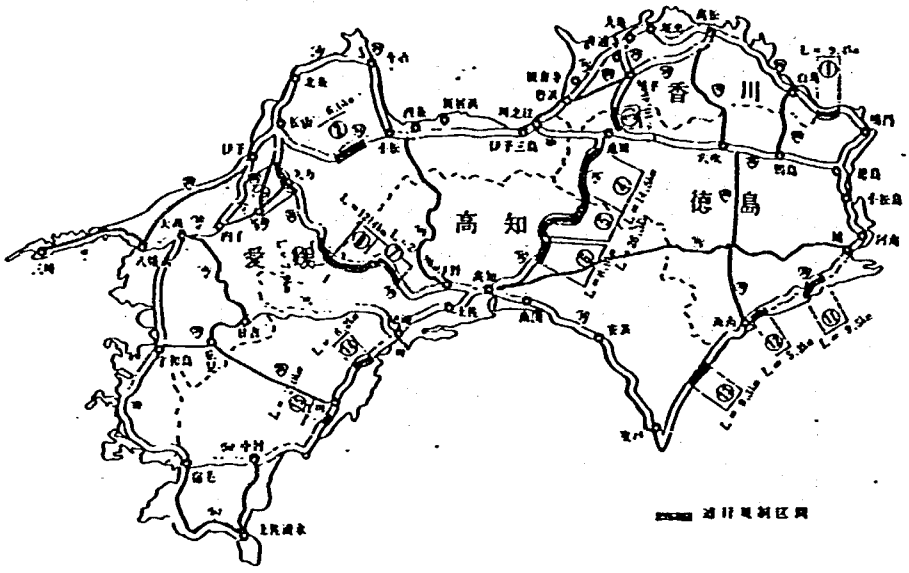
（平成３年４月１日現在）

道路種別	Ⓐ 管理延長（km）	規制区間 箇所数	規制区間 延長（km）Ⓑ	Ⓑ/Ⓐ（％）
高速自動車国道	4,869.4	0	0	0
本州四国連絡橋	107.4	0	0	0
都市高速道路	465.2	0	0	0
一般国道（指定区間内）	20,113.3	264	1,515.9	7.5
一般国道（指定区間外）	26,112.9	790	5,339.1	20.4
都道府県道	129,761.6	2,985	14,995.7	11.6
市町村道	963,745.1	15	28.6	0.0
一般有料道路	2,187.3	66	555.5	25.4
合　計	1,147,362.2	4,120	22,434.8	2.0

注）通行規制区間は、特殊通行規制区間（715箇所3,214.1km）を含む。

〈資料〉建設省道路局「道路交通管理統計」（平成元年度）

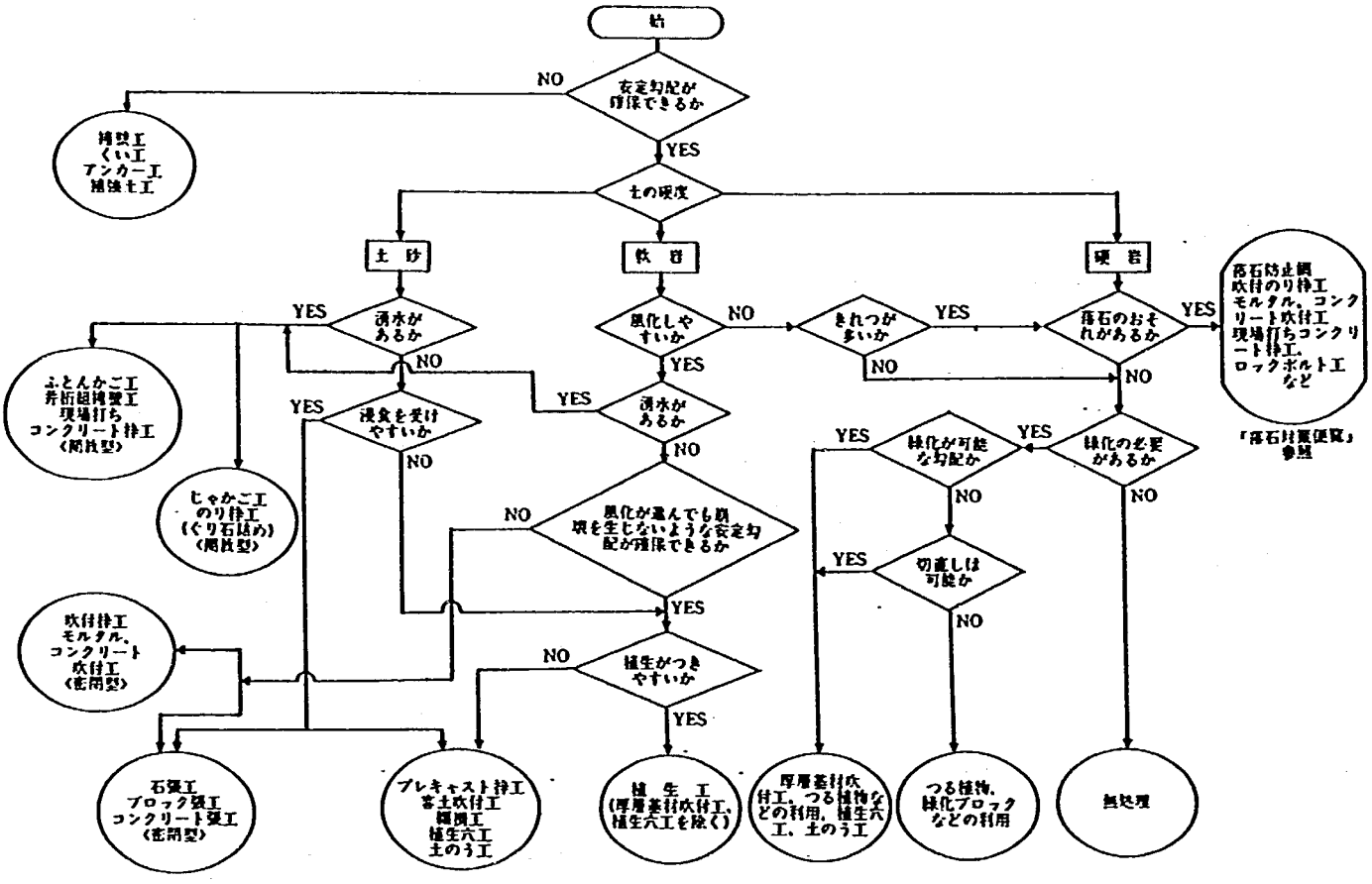
通行規制図



図－６．３　四国地方の国道における通行規制分布図

表－６．６　のり面保護工の工種と目的

分類	工種	目的・特徴
植生工	種子散布工 客土吹付工 厚層基材吹付工 張芝工 植生マット工	浸食防止，全面植生（緑化）
植生工	植生筋工 筋芝工	盛土のり面の浸食防止，部分植生
植生工	土のう工 植生穴工	不良土，硬質土のり面の浸食防止，部分植生
植生工	樹木植栽工	環境保全，景観
構造物によるのり面保護工	モルタル吹付工 コンクリート吹付工 石張工 ブロック張工	風化，浸食防止
構造物によるのり面保護工	プレキャスト枠工	中詰めが土砂やぐり石の空詰めの場合は浸食防止
構造物によるのり面保護工	コンクリート張工 吹付枠工 現場打コンクリート枠工 アンカー工	のり面表層部の崩落防止，多少の土圧を受けるおそれのある箇所の土留め，岩盤はく落防止
構造物によるのり面保護工	編柵工 じゃかご工	のり面表層部の浸食や湧水による流失の抑制
構造物によるのり面保護工	落石防止網工	落石防止
構造物によるのり面保護工	ブロック積(石積)擁壁工 ふとんかご工 井桁組擁壁工 コンクリート擁壁工 くい工 補強土工	ある程度の土圧に対抗（抑止工）



図－６．４　切土のり面におけるのり面保護工選定のフロー

(4)今後の課題

i)災害に強い道路ネットワークの形成

これまで対策事業が進められ道路整備水準が向上しているものの、通行規制区間の減少等が充分でない。また、現状では個別箇所単位の対策事業が中心的位置を占めているが、今後は生活基幹ネットワーク等、道路網としての信頼性向上を図るような対策事業単位の拡大が必要である。

ii)道路構造の強化

これまでの防災対策は防災対策工の枠内にとどまっているが、規格の高い道路構造（立体構造、大断面化等）の採用等、道路構造面及び道路計画・設計面の配慮が不可欠である。また、風化等が問題となる大規模な切土や、景観上好ましくないコンクリート構造物の多用等は極力避けるべきである。

iii)災害復旧や維持管理のし易い道路づくり

万が一被災した場合に復旧作業や交通処理が円滑にできるような道路構造、例えば、多目的な路肩幅員や中央帯の確保、待避空間の設置、崩落土砂捕捉帯や大断面排水路の設置等を考慮すべきである・沿道の保全、占用物件等の安全確保道路敷地外の周辺区域に災害の要因ができないように、沿道土地利用の制限等も考えてゆく必要がある。

iv)防災情報の収集・提供

情報収集の装置として、テレメータ、レーダー雨量計等の機器類が整備されているが、未だ

充分とは言えず、今後は地すべりや噴火等の大規模災害の監視体制の強化、迂回路情報の提供等の整備が必要である。また、道路利用者に対する情報提供方法の標準化を図り、利用者の意識を高めることも重要である。

3）土木研究所における取り組み

(1)斜面崩壊の災害危険性及び管理のための調査・観測手法

i)物理探査等による斜面地質の効率的な調査法の研究

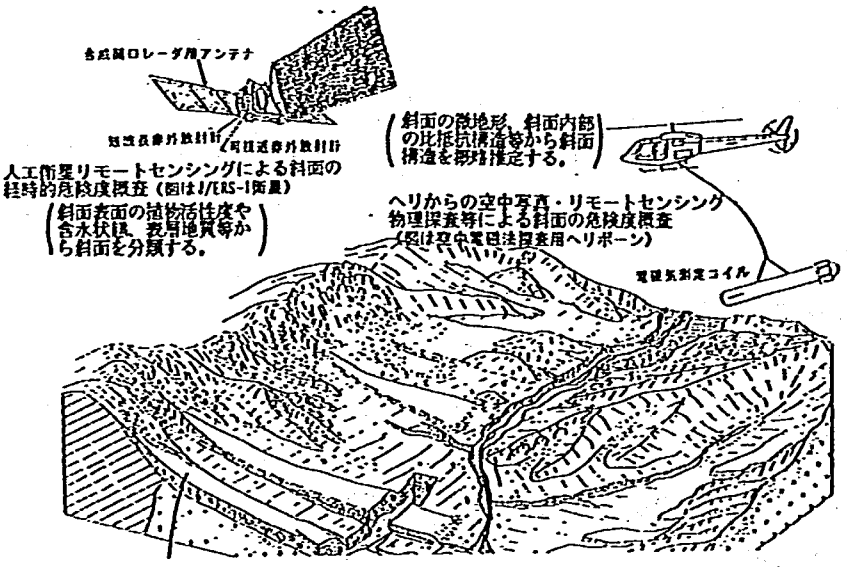
斜面崩壊の発生位置，規模，形態は、斜面の地形や地質に依存し、特に斜面浅部の地質構造を把握することは極めて重要である。しかしながら、急峻な山地での広域的な地質調査は非効率的で困難が伴うため、空中電磁波法や地下レーダー法等の物理探査技術を利用した効率的な斜面地質の調査法について研究を行なっている。（図－６．５）

ii)モニタリングによる斜面崩壊予知法の研究

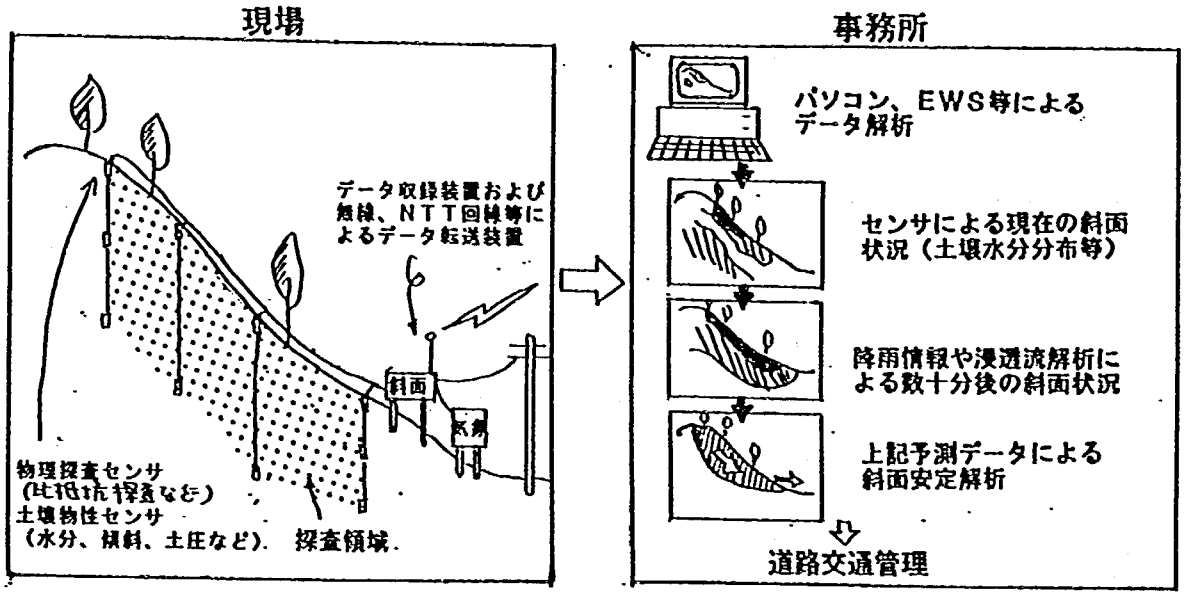
降雨に対する道路のり面及び斜面の安定度評価を、事前通行規制等の道路管理に役立てるためには斜面内部の土層構成や降雨によって不安定化する現象の把握が必要である。そのため、現在、降雨時の斜面の変化をモニタリングし、崩壊発生時期や形態を予測する方法の研究を進めている。モニタリングシステムは主に、土壌水分計等による表層部中の降雨の浸透状況、高精度傾斜計による斜面変形挙動の把握を目的としたものを対象としている。（図－６．６）

iii)吹付のり面の維持管理調査技術の研究

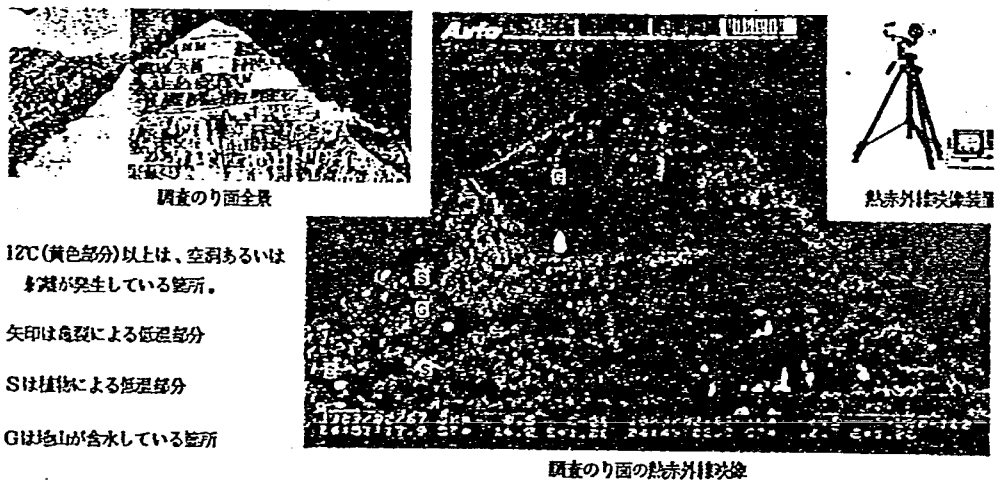
道路のり面の保護工としてコンクリートあるいはモルタル吹付工の実施例は多いが、背面地山の風化等により外観のみからでは判別し難い老朽化が進行し、機能の低下を招く可能性が増大している。現在のところこれらの維持点検作業は、現場技術者の目視等に頼る部分が大きく、莫大な点検箇所数に対処しきれなくなっている。そこで、当研究所では吹付を破壊することなく短期間で広範囲の点検を行うため、熱赤外線映像法の実用化に向けての研究を行なっている。（図－６．７）



図－６．５　道路斜面崩壊の災害危険性の調査観測手法イメージ図



図－６．６　斜面のモニタリングシステム（研究中）



図－６．７　熱赤外線映像法による吹付のり面老朽化診断技術

(2)落石・岩盤崩落対策の研究

i)落石、岩石崩落の危険性調査法の研究

落石、岩石崩落による道路のり面の災害を防止するため、当研究所では現在、熱赤外線リモートセンシングと地下レーダーとの２手法を対象として、岩盤斜面内の不連続面の分布及び性状を把握する手法について検討している。また、降雨及び地震等の外力と斜面の地形・地質要因から、個々の斜面の崩壊危険度を予測する手法として、ファジー理論に基づいた可能性線形回帰モデルより、地震に対する斜面の崩壊危険度を判定する手法の検討を行なっている。

ii)落石防護工の配置、荷重に関する研究

主に、落石の跳躍量に関する調査研究とロックシェッド上の落石衝撃力に関する調査研究を行なっている。前者跳躍量については、模型及び実斜面における落石落下試験を行い、これらの跳躍軌跡をもとに反発係数や摩擦係数を求め、数値シミュレーションによる落石跳躍量の予測を行なっている。後者衝撃力については、ロックシェッド屋根スラブ上に衝撃緩衝材（砂）

への落石衝撃力を算定するための理論式が導かれており、その適用性を実物大模型実験により確認をしている。（図－６．８）

iii)落石防護工の構造設計

構造設計に関しては、ＰＣ構造とＲＣ構造の両方の特性を備えたＰＲＣ構造に着目し、静的及び衝撃載荷試験を行い、ＰＲＣ製ロックシェッドの設計法提案へ向けて研究を進めている。

(3)地すべり対策の研究

i)地すべりに関する危険性調査法の研究

地すべり地調査については、現在、すべり面の強度特性を把握する試験手法、地下水の挙動・変動予測手法、地盤探査センサーを用いた広域かつ詳細な地すべり地探査手法の開発を行なっており、大深度すべり面に対しても適用できるよう考慮している。また、地すべり地の監視技術として、ＧＰＳやパルス型測距儀を用いて土塊の移動を把握する技術開発に取り組んでいる。

ii)対策工選定システムに関する研究

路線選定や地すべり対策工の効率化を図るため、前記、地すべりに関する危険性調査の結果をもとに、危険度診断システムと対策工選定システムの開発に取り組む予定である。

iii)地すべり抑止工法に関する研究

地すべりを直接止める抑止工法について、杭工の効率的な施工間隔・配列方法及び打設位置の確立を目指しての調査研究、アンカー工定着部の破壊機構の解明と設置手法の調査研究を実施している。（図－６．９）

(4)土石流対策の研究

i)危険渓流の調査手法及び危険度判定手法の研究

従来から用いられている現地調査を主とした調査・判定手法を改良して、航空写真や地形図を用いた、より簡便で精度の高い手法の開発を行なってきている。

ii)構造物等のハードな対策に関する研究

１つはまず、土石流に対する安全な構造計画・設計手法等、渓流部を横断する道路自体のあり方に関する研究、もう１つは土石流覆工や鋼製土石流捕捉工等の土石流対策工法の開発が行なわれている。この中でも、土石流とともに流下してくる多量の流木が道路のカルバートや橋梁を閉塞して土石流の氾濫を助長し、道路の被害を増大させている事例があるため、流木による被害を防止するための対策の開発が強く望まれている。

iii)道路管理等のソフトな対策に関する研究

斜面や土砂の移動を検知して、道路管理者に迅速に伝達することができる変状検知センサーの開発を行なっている。今後の課題としては、気象庁等の発表している短時間降雨予測データや、地盤水分量の観測結果を用いて土石流の発生をより的確に予測すること、また、これらの情報を解析して、通行規制の判断・実施が迅速に行える情報伝達手法の検討が必要である。

(5)擁壁、補強土工法の研究

i)擁壁に関する研究

コンクリート擁壁についてはこれまで、重力式擁壁や逆Ｔ型擁壁等の静的土圧や地震時土圧、排水施設の効果等を、大型擁壁実験や現場計測で確認し、現在の道路擁壁の設計手法が確立さ

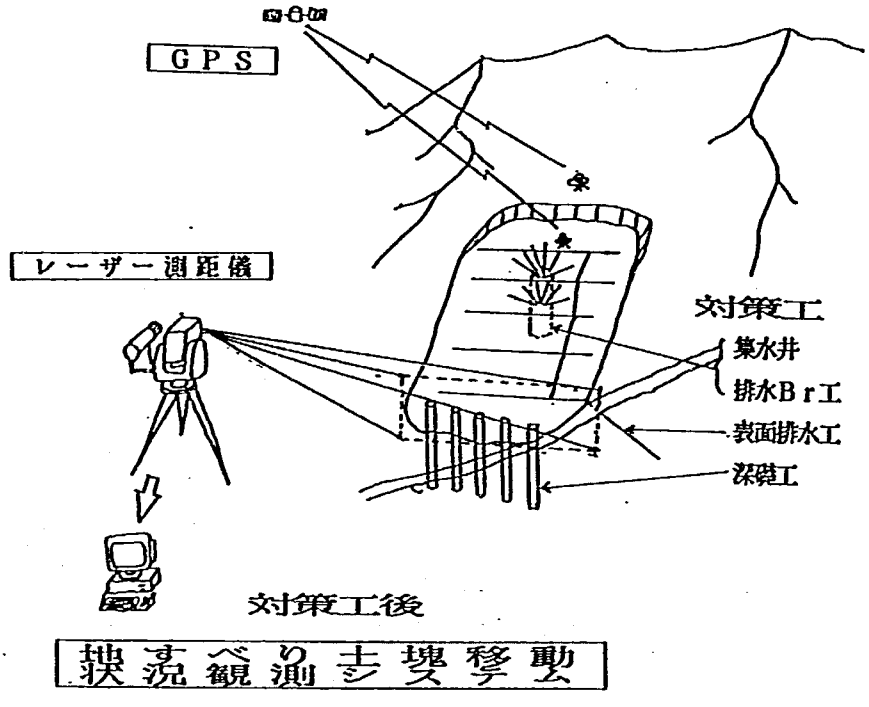
れている。また、最近では、粘性土等の現地発生土を改良または流動化して裏込めに用いる方法や、裏込め土を発砲スチロールで置き換えて土圧を低減する方法、裏込め土にジオテキスタイルを敷設して補強を行なう方法、コンクリートに替わる新たな壁面工の研究等が進められている。

ii)切土や自然斜面の補強土工法の研究

斜面内に鉄筋等の補強材を挿入しその周囲をグラウトする地山補強工法について検討を行なっている。今後は、周辺景観を考慮し植生を施した地山補強工法の開発等が課題となっている。



図－６．８　落石覆工による落石対策



図－６．９　地すべりに関する研究

7．「環境と社会資本整備の調和」についての取り組み状況

7．1　概要

我が国の社会資本の整備は、従来その整備目標の達成に主眼がおかれ、ややもすれば人々に多大な恵みをもたらす環境に対する配慮が十分であったとはいえない。このため、環境の保全と調和を保ちながら社会資本整備に努めることが求められている。このような中、土木研究所では、環境の保全、回復、創造技術の開発に関して積極的に取り組んでいる。

本章では、以下に示す分野の我が国の現状と課題を把握するとともに、土木研究所の取り組み状況について述べる。

a)河川環境
b)ダム環境
c)下水道
d)道路環境
e)都市環境

さらに、アジア各国の共通課題として考えれる地球環境及び生活環境を考慮した社会資本整備への取り組みとして、以下について述べる。

a)ダム湖や河川の水質保全対策
b)都市部における道路交通による大気汚染及び騒音への対策

7．2　我が国の「環境と社会資本整備の調和」の現状と課題

戦後、高度経済成長等を経て国民の所得水準は上がったが、都市への人口集中、急激な都市化の進展などから、都市や水域における自然環境の悪化、生活環境の整備の立ち遅れが顕著になり、このため、国土の環境を保全することが急務となっている。

1）河川環境

近年のこのような都市化の進展にともなって、河川等の公共用水域では水質の悪化、親水性の低下、自然的な環境の喪失等の問題が生じており、水環境の改善及び河川環境の保全・整備について、国民の要望は増大かつ多様化している。このような状況のもと建設省では種々の施策を展開している。基礎調査として、河川の生物の生息状況や河川空間の利用実態について「河川水辺の国勢調査」を、河川環境の保全と創造に関わる施策を総合的かつ計画的に実施するための河川環境管理基本計画の策定を、さらに、河川事業の実施にあたっては、景観の保全・創造、また親水性を高めるための種々の事業を行っている。また、水質に関しては浄化用水の導入、汚泥浚渫、礫間接触酸化法等による直接浄化を行っている。

2）ダム環境

ダム湖の環境に関する課題としては、「水質保全」、「自然環境の保全・創造」、魚釣り・水遊び・ピクニック・スポーツなどの「親水環境の創造」があげられる。近年、人々の生活行動様式が拡大・多様化するとともにダムのもつこのような環境機能を向上し、活用しようという要請が高まってきている。このようなダムの環境機能をより高めるため、種々の水質保全対策やダム周辺環境整備事業を実施している。

3）下水道

平成３年度（1991）からは、新たに策定された第7次下水道整備五箇年計画（総額16兆5,000億円）に基づいて、都市の基礎的な施設である下水道の緊急かつ計画的な整備を推進することとしている。同計画では、快適でうるおいのある生活環境と清らかな公共用水域を創出する観点から、普及が後れている中小市町村の下水道整備及び未着手市町村における新規着手の推進、水質保全のための高度処理の積極的導入をはじめ、浸水防除のための下水道事業、大都市等における下水道の質的向上、下水道の資源・エネルギー等の多目的活用を推進することとしている。

4）道路環境

自動車騒音や大気汚染などの環境問題に対しては、これまでに各種の対策や努力が行われているが、環境基準の達成率は今なお厳しい状況である。大気汚染については、固定発生源と自動車の排出規制等が行われ、これまでにSO_2、CO、HCの濃度は低下した。しかし、NO_2濃度は長期にわたって改善されていない。騒音については、単体規制が順次強化されるとともに道路施設による対策等を実施してきた。しかし、依然として多くの測定点で環境基準を超えている。

5）都市環境

都市景観の形成については、建設省が1987年に「都市景観形成モデル都市制度」を、さらに1990年に「うるおい・緑・景観モデルまちづくり制度」を創設し、モデル的に都市景観の形成を推進しているほか、各都市において良好な都市景観の形成に配慮した都市整備が推進されているところである。

都市緑化については、建設省は1977年に「緑のマスタープラン策定要綱」を、1985年に「都市緑化推進計画策定要領」を通達し、都市緑化を推進している。今後は、地球的規模での環境問題への対処、都市におけるヒートアイランド現象の緩和等に資するため、都市緑化をより一層推進するための制度の充実、緑化が困難とされてきた場所の緑化技術の開発、民有地の緑化を促進させるための制度の確立と適切な運用等が必要になっている。

以上のように、環境に対する国民の要望はますます増大しつつあり、社会が資本整備に対する課題も広範で山積みしているのが現状である。

７．３　「環境の保全、回復、創造技術」に関する土木研究所の取り組み状況

土木研究所では、1993年4月に新たに環境部が発足し、環境計画、地質、河川環境、交通環境、緑化生態の５つの研究室で、公共事業に係わる環境の保全、回復、創造技術について重点的に研究を実施している。

特に1993年4月より総合技術開発プロジェクト「美しい景観の創造技術の開発」が開始され、建築基準法や道路構造例の改正をも含めた、建築物と道路施設との調整方法、自然的な河川風景の創造技術、景観素材としてのコンクリート材料の開発、景観シュミレーター、景観データベースの開発など、社会資本整備に係わる景観の課題を広く、集中的に取り扱っている。

また、社会資本整備における環境に関するデータベースの作成、環境影響評価の基本的考え方、手法についての研究にも着手した。

自然環境の保全に関する国民の期待の中で、河川、湖沼、ダム湖、海岸、道路、公園などを対象に種々の事業が展開しつつあるが、新しい分野であり、技術的課題も多い。そのための調査方法、保全

技術について研究を実施している。

平成３年度（1991）には、河川生態系実験施設が完成し、魚類の遊泳速度、遡上に関する基礎的研究を実施している。水質に関する課題としては、公共用水域の水質保全のための管渠敷設が困難な場所の輸送システムの開発、下水の高度処理技術に関する研究、下水汚泥の有効利用技術の開発、公共用水域の水中有害微量物質に関する研究、河川・湖沼の直接浄化工法の開発に関する研究などを行っている。

道路の環境保全に関しては、これまで大気汚染や騒音に関する予測と対策に重点をおいて研究を進めてきた。予測手法としては一般的な構造の道路における自動車排出ガスの拡散予測手法や沿道騒音予測手法がマニュアルとして確立されており、環境影響評価に用いられている。今後とも予測手法の充実を進めていく予定である。

環境保全対策としては、樹木等の大気汚染物質吸収量、大気拡散効果の把握、NO_x除去技術の調査、遮音壁、吸音対策、低騒音舗装等についての調査、実験、自然環境と調和した道路整備手法についての調査を行っている。

緑化技術については、大気浄化（CO_2の吸収、紛塵捕捉等）、微気象緩和、景観形成等の緑化の効果を把握するとともに、植栽技術、緑化用樹木の性状、コンテナ栽培樹木、草本類の維持管理技術に関する調査研究等を行ってきた。また、「道路緑化技術指針」、「のり面工・斜面安定工指針」等の技術体系のとりまとめを行っている。

公園緑地の整備・管理手法については、海洋性リゾート計画、大規模公園の整備手法、芝生広場の草地復元等計画、整備、管理の各分野に関する調査研究を行っている。

7．4　ダム湖や河川の水質保全対策

1）ダム湖の水質現象

ダムの建設によって大規模な貯水池が出現した場合、河川の流水が滞留することによって水理学的な変化が生じ、ダム建設前と異なった水域環境を呈することがある。その結果生じる主な水質現象としては、冷水現象、濁水長期化現象、富栄養化現象がある。この中で、今日、富栄養化現象が大きな問題となっている。

(1) 富栄養化現象

流域の開発等に伴い、貯水池内に流入する栄養塩類の量が飛躍的に増大すると生物生産が活発となり、藻類（植物性プランクトン）の現存量を高めることとなる。ここでいう富栄養化とは、このような貯水池の生物生産性の人為的な増大を指す。河川のように流速が比較的速い水域では増殖に必要な時間がないまま流下してしまうので、藻類の大増殖というような形での富栄養化の影響は顕在化しないが、ダム貯水池のように滞留時間が自然河川に比較して長い水域では、温度、日照など他の条件が好都合であれば、富栄養化に伴い、藻類の大増殖に起因する淡水赤潮、水の華などの種々の現象が生じる。これらの現象を富栄養化現象と言う。藻類の増殖に必要な栄養塩類のうち、ある物質の濃度が他の物質の濃度に比べて相対的に低いとき、他の物質の濃度がいくら高くても、その物質濃度によって藻類の増殖が制限されることが知られている。このような物質を制限因子と呼ぶ。日本の河川及び湖沼では、藻類の増殖に必要な栄養塩濃度と比較すると燐と窒素以外は十分に存在し、このため、燐または窒素が富栄養化現象を考える上で重要である。ダム貯水池の場合、燐が制限因子になっている例が多く、燐濃度が富栄養化状態の重要な目安となる。

富栄養化に関する問題としては、淡水赤潮による貯水池水面の変色や、水の華による貯水池水面の変色、浄水場における異臭味、凝集沈澱障害、濾過池障害、上水の着色障害等が発生することがある。

これらの淡水赤潮や水の華は、単に物理的・水理的条件の他に生物的要素が大きいことが特徴である。従ってこれらの発生機構には、前述の燐、窒素の栄養塩類の他に、水温、日射、流速などの影響も大きく、藻類の発生状況も年によって異なる。

2）ダム湖の水質保全対策

(1) 水質保全対策の基本

水質上の問題が発生するおそれのある場合や、すでに水質問題が発生したり、進行している場合には水質対策を実施する必要があるが、この場合水質問題の発生は汚濁特性など流域の自然的、社会的条件に大きく左右される。このため、濁質、有機汚濁物質、栄養塩類といった原因物質の貯水池への流入負荷削減を抜きにした貯水池及び流入河川における対策のみでは自ずと限界があり、関係機関との連携により、流域における対策を基本とする総合的な対策の展開が必要とされる。

水質保全対策として、「冷水対策」「濁水長期化対策」及び「富栄養化対策」があるが、以下今日大きな問題となっている「富栄養化対策」について述べる。

(2) 富栄養化対策

富栄養化対策は、藻類増殖のメカニズムを踏まえて、それぞれの貯水池に適した対応をとるこ

とが必要である。藻類増殖の要因をまとめると、次のようになる。

①栄養塩類の流入

②光合成反応に必要な環境条件（光、水温）

③増殖に必要な滞留時間

i)流域対策

富栄養化対策として、根本的には①の栄養塩類の流入であり抑制する必要がある。そのため、基本的には汚濁発生負荷源を対象とする流域対策（流域からの流入負荷削減に係わる対策）を実施することが最も効果的であるので、流域関係機関と密接な連携をとり、その推進に努める必要がある。ダム流域での栄養塩類の発生負荷量としては、畜産によるもの、生活系排水によるものの割合が高い場合が多々有る。そのため、家畜糞尿のコンポスト化、下水処理の高度化が重要である。また、栄養塩類の土壌吸着を図るために、処理水の陸地散布や土壌浄化施設を設けることも有る。また、畑地からの流出土壌には多量の栄養塩類が含まれており、表土の流出を防ぐことは濁水対策としてだけでなく富栄養化対策としても重要である。一方、流域対策は、対象とする負荷源が広範囲にあるため、この対策には長年月と多大な投資が必要となることから、必要に応じ、流域対策と合わせ河道内や貯水池内において対症療法とも言うべき対策がとられる。

ii)河川内対策

（イ）前貯水池

流入河川の河道内における対策としては、前貯水池による栄養塩類の沈降促進などがある。日本の河川では前貯水池として十分な栄養塩類の沈降時間を取れる容量を確保できるケースは少ないと思われるが、次項の迂回水路と組み合わせて用いることができる。また、前貯水池は水位変動が少ないことから、湖岸植生による水質浄化やレクリェーション利用に使うことも可能である。

（ロ）貯水池迂回水路

貯水池への負荷流入が一部の小河川に限られる場合にはバイパス水路により貯水池内に流入させないか、または貯水池内の取水口付近に流入させて貯水池内での滞留時間を短くさせる方法もある。

iii)貯水池内対策

貯水池における対策としては、貯水池内での富栄養化現象のメカニズムを踏まえて、次に示す手法がある。

（イ）浚渫

ダム貯水池での底泥からの溶出負荷は、一般には流入河川負荷に比べてかなり小さいが、底泥を浚渫し、汚濁物質を除去することにより底泥からの溶出を制御する手法がある。

（ロ）循環

貯水池表層は一般に光が届き（有光層）、比較的水温が高いため、藻類の増殖に適した環境条件下にある。そこで、曝気やポンプにより貯水池内に強制循環を生じさせ、表層水の水温低下を図るとともに表層水の一部を有光層より下まで押し下げることにより、藻類の増殖を抑制する方法である。

（ハ）噴水

循環を発展させたものとして噴水の利用がある。これは循環の効果の他に、噴水のポンプを通る時の圧力の急変により藻類を死滅させる効果を考えたもので、さらに湖面上に新しい景観を創る効用も評価される。

(ニ) 表面取水

藻類の増殖に適した貯水池表層での水の滞留時間を短くするために、表層から取水を行うものである。

(ホ) 藻類増殖後の対策

上記の対策をとってもなおかつ藻類が異常増殖した場合には、次のような対策が取られる。

a) 選択取水

利水障害を減らすために貯水池内の藻類の少ない深さから選択取水を行う方法がある。

b) 藻類除去

発生した藻類を機械的に除去する方法があるほか、生物的に補食作用による制御及び化学的制御などが考えられるが今後さらに検討を進める必要がある。

(3)ダム湖の新しい水質保全対策の研究開発

土木研究所では、好ましくない浮遊藻類の異常増殖を阻止する画期的な対策方法を開発している。本システムは流入河川水及び湖水の流動を制御して浮遊藻類の増殖し難い環境を作り出す「流動制御システム」と糸状藻類を活用して流入水及び湖水から栄養塩類を除去する「糸状藻類活用システム」からなる。

3) 河川の水質浄化事業の概要

建設省による水質保全対策事業は、1958年度の東京都の隅田川汚泥浚渫事業により始まる。1958年には秋ヶ瀬取水堰から隅田川への浄化用水の導入が行われた。その後1969年より河川環境整備として事業の進捗が図られている。現在行われている建設省の浄化事業としては次の4つである。

①浄化用水導入

②底泥浚渫

③礫間接触酸化法等による直接浄化

④流水保全水路（汚水分離）

4) 河川における浄化対策の原理及び問題点

上記4つの浄化事業について、簡単に方法、原理、問題点などを解説する。

(1)浄化用水導入（流量増強対策）

汚濁の進んだ河川に比較的水質のよい水を導水し、水質濃度を希釈する方法である。また同時に、底泥等の汚濁物質をフラッシュさせることを目的とすることもある。直接負荷量を減少させることにはならないが、現在約30の河川で実施・計画されており、魚が戻ったなど予想以上の効果をあげている事例もある。水質の良好な大河川からの導水が可能な中小河川に有効である。逆に、対象河川の近傍に比較的水質のよい水がある程度多量になければならない。浄化用水源として下水処理水や地下水も実施・検討されている。

(2)底泥浚渫

溶存酸素の減少により生物的な分解が行われなくなった場合、分解されない汚濁物質が底泥

（ヘドロ）となって河床に堆積する。底泥（ヘドロ）の浚渫は汚濁負荷量そのものを減少させるため効果は大きい。しかし、浚渫した底泥の乾燥や処理に莫大な時間と費用がかかることが大きな問題となっている。現在、ヘドロを固化して除去する技術の開発が行われている。

(3) 直接浄化

i)エアレーション

水中の溶存酸素を増やし、生物的な分解を活発にさせるものである。曝気方法としてはエアポンプ等を用いる他に、噴水や落差などを活用する場合もある。エアレーションのみでの効果は小さい。

ii)薄層流・せせらぎ等の河床改造

薄層流法、せせらぎ河床、玉石や人工芝を河床に張る等の河床改造による浄化対策は、水深を浅くあるいは流れを乱すことにより水中の溶存酸素を増加させ、自浄作用を促進しようとするものである。大和川支川西除川の薄層流施設では、330mの区間においてＢＯＤ除去率14%、ＳＳ除去率41%という結果を得ている。これらの方法は出水に対する河道の維持の問題、出水時の土砂による閉塞、維持管理等の問題がある。

iii)接触酸化法

接触酸化法は接触材の間に汚水を通水し、接触材の表面に繁殖した生物膜（微生物、バクテリア等）による酸化・分解、接触材への吸着、沈澱等の効果を利用した方法である。一般に接触材として礫が用いられる礫間接触酸化法が多い。また曝気装置を併用してエアレーションを行い、生物膜の活動を活発にさせる曝気付礫間接触酸化法は一般に効果が高い。直轄の礫間接触酸化施設は現在８施設が稼動している。接触酸化法の留意点、問題点としては、接触材を敷き詰める広い敷地が必要であること、微生物による酸化に頼るため一度に多くの水を処理することはできないこと、出水時の対策やゴミ土砂対策に配慮しなくてはならないこと、汚泥の引き抜きが必要なことなどがあげられる。

iv)開発中の技術

現在開発中、実験中の浄化技術として以下のものがある。

（イ）木炭を用いた昇降流型浄化システム

木炭をろ材とするろ層に2～4m／分の速度で汚濁水を通水し、微生物膜による酸化・分解やろ過などにより浄化を行う。上下方向に流れを起こすことで目づまりを少なくすることができる。

（ロ）多自然型浄化施設

瀬や渕の創造、砂州上への浸透型水路、植物を使った浄化手法など河川の自然のシステムと利用した浄化技術を開発中である。

(4)汚水分離（流水保全水路）

対象区間の水質保全のため、河道内に分水路を設けて排水を別に流下させるものである。汚水だけを地下の水路に流す二層式の水路もこれに該当する。汚水を分離して流下させるため効果はあるが、閉鎖性水域などの浄化に対しては有効ではない。

7．5　都市部における道路交通による大気汚染及び騒音への対策

1）概要

日本では1960年頃から顕在化した環境問題に対応して、良好で快適な環境を保全すべく、様々な制度や対策が実施されてきた。まず、公害対策の総合的推進を図り、生活環境を保全することを目的とする公害対策基本法が1967年に定められた。また、個別の対策法として「大気汚染防止法」、「騒音規制法」などが定められた。これらの法律に基づいて、人の健康を保護し、生活環境を保全する上で維持されることが望ましい基準として環境基準が定められ、さらに環境の測定・監視が行われている。自動車交通による大気汚染、騒音等の環境問題に対しては、自動車構造の改善や道路ネットワークの整備、遮音壁・環境施設帯等の設置、緑化の推進等の道路構造面での対策、大規模な道路事業の実施に際しての環境影響評価など、道路と環境の調和を図るべくさまざまな努力が重ねられてきている。

2）環境基準

道路交通に関係するものとして大気汚染、騒音にかかる環境基準がある。（表－7．1，7．2）

表－7．1　環境基準（大気汚染）

物　質	二酸化いおう	一酸化炭素	浮遊粒子状物質	光化学オキシダント	二酸化窒素
環境上の条件	1時間値の1日平均値が0.04ppm以下であり、かつ、1時間値が0.1ppm以下であること。	1時間値の1日平均値が10ppm以下であり、かつ、1時間値の8時間平均値が20ppm以下であること。	1時間値の1日平均値が0.10mg／㎥以下であり、かつ、1時間値が0.20mg／㎥以下であること。	1時間値が0.06ppm以下であること。	1時間値の1日平均値が0.04ppmから0.06ppmまでのゾーン内又はそれ以下であること。

1　浮遊粒子状物質とは、大気中に浮遊する粒子状物質であって、その径が10ミクロン以下のものをいう。

2　光化学オキシダントとは、オゾン、パーオキシアセチルナイトレートその他の光化学反応により生成される酸化性物質（中性ヨウ化カリウム溶液からヨウ素を遊離するものに限り、二酸化窒素を除く。）をいう。

表－7．2　環境基準（騒音）

地域の類型		時間の区分		
		昼間	朝・夕	夜間
AA		45ホン(A)以下	40ホン(A)以下	35ホン(A)以下
A		50ホン(A)以下	45ホン(A)以下	40ホン(A)以下
「道路に面する地域」の特例	2車線	55ホン(A)以下	50ホン(A)以下	45ホン(A)以下
	2車線を越える車線	60ホン(A)以下	55ホン(A)以下	50ホン(A)以下
B		60ホン(A)以下	55ホン(A)以下	50ホン(A)以下
「道路に面する地域」の特例	2車線	65ホン(A)以下	60ホン(A)以下	55ホン(A)以下
	2車線を越える車線	65ホン(A)以下	65ホン(A)以下	60ホン(A)以下

(注)　AA　特に静穏を要する地域
A　主として住居の用に供される地域
B　相当数の住居と併せて商業、工業等の用に供される地域

3）環境影響評価

道路の整備に当たっては環境への配慮が必要不可欠であり、環境影響評価は重要な手段である。1984年の政府の閣議決定を受けて1985年に「建設省所管事業に係る環境影響評価実施要綱」が定められ、これに基づいて環境影響評価を行うこととなった。この実施に必要な技術的事項が「建設省所管道路事業環境影響評価技術指針」に定められており、その解説書として「道路環境整備マニュアル」が刊行されている。

(1)大気汚染

自動車排出ガスによる大気汚染の予測項目は、CO及びNO_xとされている。予測手法は、拡散式としてプルーム、パフ式を用いることとし、汚染物質の排出係数（自動車から排出される汚染物質の単位走行距離当たりの量）や拡散パラメータが整備されている。

(2)騒音

道路交通騒音の評価値は、騒音レベルの中央値（L_{50}）とされている。予測手法は、音響学会式といわれる一列等間隔等パワーモデル式を基本とし、騒音規制を考慮したパワーレベルや予測位置別補正係数などを用いている。

4）自動車排出ガスによる大気汚染対策

図－７．１に、自動車排出ガス対策を含む沿道環境保全対策の分類を示す。具体的な対策の例を以下に示す。

(1)自動車構造の改善

自動車による大気汚染に関して最も基本的な対策は発生源対策であり、1973年以降、段階的に規制強化が行われてきた（表－７．３，図－７．２）。 ガソリン乗用車の対策は三元触媒を中心としたシステムで、未規制時に比べると飛躍的に改善されている。しかし、ディーゼル車で採用可能な対策は限られており、決定的な改善にはつながっておらず、さらなる技術開発が期待される。さらに排出量を減少させる試みとして電気自動車、メタノール車等のいわゆる低公害車の開発も行われているが、普及レベルには至っていない。

(2)道路網整備

図－７．３に示すように、汚染物質の排出係数は車速によって異なり、低速時に高い。このため、できるだけ渋滞をなくし、車を円滑に流すことによって排出量を抑制することが可能である。具体的にはバイパス、環状道路の整備や交差点の立体化などが有効である。

(3)道路構造による対策

図－７．４に示されるように、道路から放出された汚染物質の濃度は、移流拡散により、道路から離れれば離れるほど低くなる。このため、幹線道路では環境施設帯が設けられる場合がある。また、道路の構造を平面から盛土や高架にすることによって地上濃度を低くすることが可能である。

(4)植物によるNO_xの吸収

植物は全般に大気汚染物質を吸収、吸着する機能を持っていると考えられ、道路沿いに植樹帯を設置することによる大気浄化が期待される。ガスチャンバーを用いた暴露実験の結果（図－７．５）によれば、NO_x濃度が高いほど植物中のN蓄積量は増加する。また、これに基づいて緑地帯によるNO_xの吸収量を試算すると、両側各７mの緑地帯は、３万台／日の交通量の自動

車から排出されるNOx の約5%を吸収することになる。

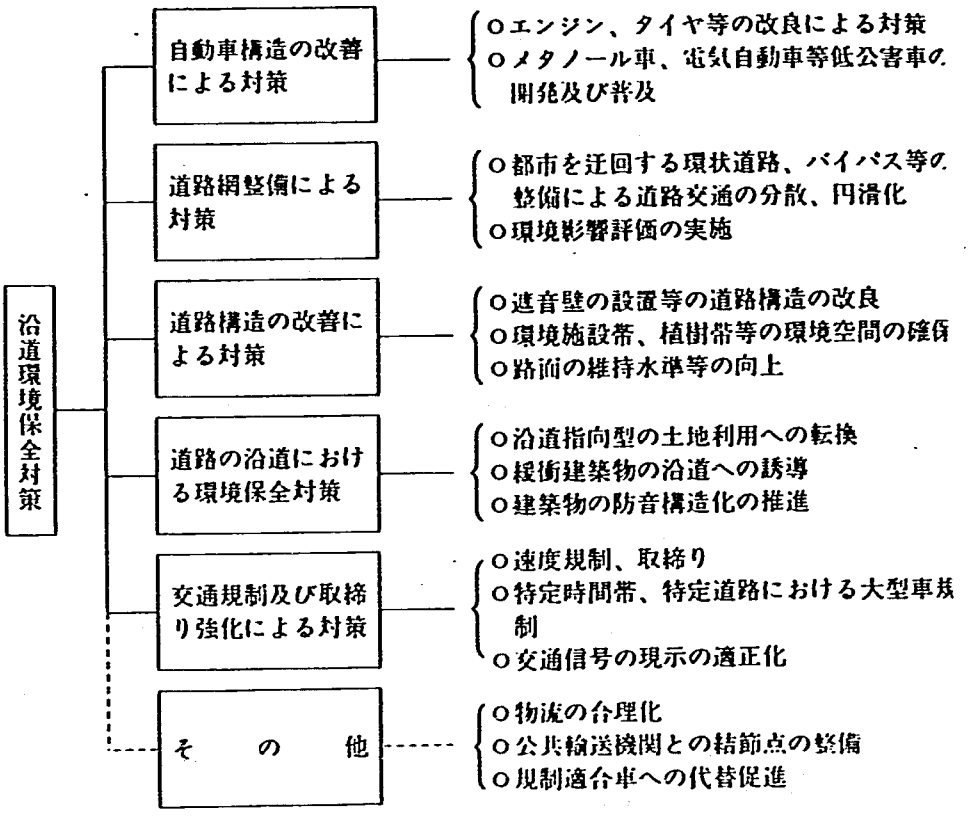
(5)植物によるCO2 の吸収

CO2 に関しては、光合成により生じた炭水化物が植物体の構成材料として蓄積される点に着目し、植物体の各器官の重量を測定することにより、CO2 の固定量を推定する研究を行っている。ちなみに、4～8年生のケヤキ(Zelkova serrata) で、約21kg／年、7～9年生のユリノキ(Liriodendron tulipifera)では約26kg／年、11～15年生のシラカシ(Querucus myrsinaefolia)では約27kg／年のCO2 固定能力があると推定されている。また、胸高直径とCO2 固定量の間には図6の関係があり、次の近似式が得られている。

Log(CO2固定量)＝A・Log(胸高直径)＋B　（A、Bは樹種により異なる定数）

(6)低濃度脱硝装置

大都市圏における大規模道路の計画では地下化する例があり、その際、換気塔から拡散する自動車排出ガス対策として、低濃度脱硝装置の検討を行っている。脱硝技術は工場等の産業公害対策として既に実用化されているが、トンネル換気ガスは低濃度、常温、大風量等の特徴を持っており、これらの課題を克服する必要がある。

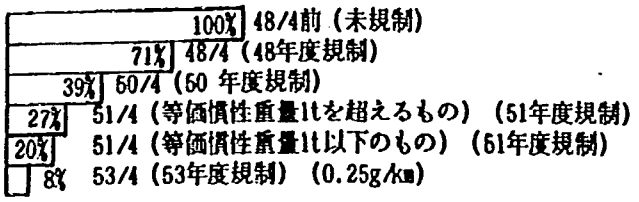


図－7．1　沿道環境保全対策

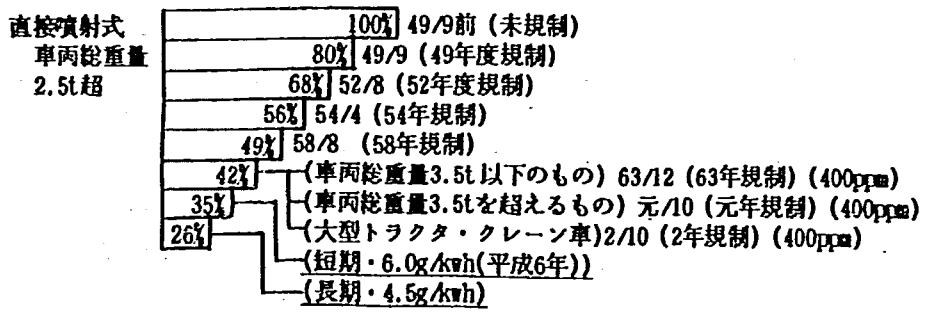
表－７．３　道路運送車両の保安基準における新車の自動車排気ガス規制の概要

燃料	自動車種別		一酸化炭素	炭化水素	窒素酸化物	測定方法
ガソリン又は液化天然ガス	1　乗用定員10人以下の普通車、小型車及び車両総重量が１．７ｔ以下のもの及び乗用の用に供する軽自動車		2.7g/km	0.39g/km	0.48g/km	10モード 15モード
	2　車両総重量が１．７ｔを超え２．５ｔ以下の普通車、小型車		17.0g/km	2.7g/km	0.98g/km	
	3　軽自動車（1に該当しないもの）	四サイクル			0.74g/km	
		二サイクル		15.0g/km	0.50g/km	
	4　車両総重量が2．５ｔを超える普通車、小型車	ガソリン	136g/kwh	7.9g/kwh	7.2g/kwh	13モード
		液化天然ガス	105g/kwh	6.8g/kwh		
軽油	1　乗員定数10人以下の普通車、小型車のうち等価慣性重量が１．２５ｔ以下のもの		2.7g/km	0.62g/km	0.72g/km	10モード 15モード
	2　乗員定数10人以下の普通車、小型車のうち等価慣性重量が１．２５ｔを超えるもの				0.84g/km	
	3　専ら常用に供さない車両総重量１．７ｔ以下の普通車、小型車					
	4　車両総重量が１．７ｔを超え２．５ｔ以下の普通車、小型車				1.82g/km	
	5　車両総重量が2．５ｔを超える普通車、小型車	直接噴射式	9.2g/kwh	3.8g/kwh	7.8g/kwh	D１３モード
		副室式			6.8g/kwh	

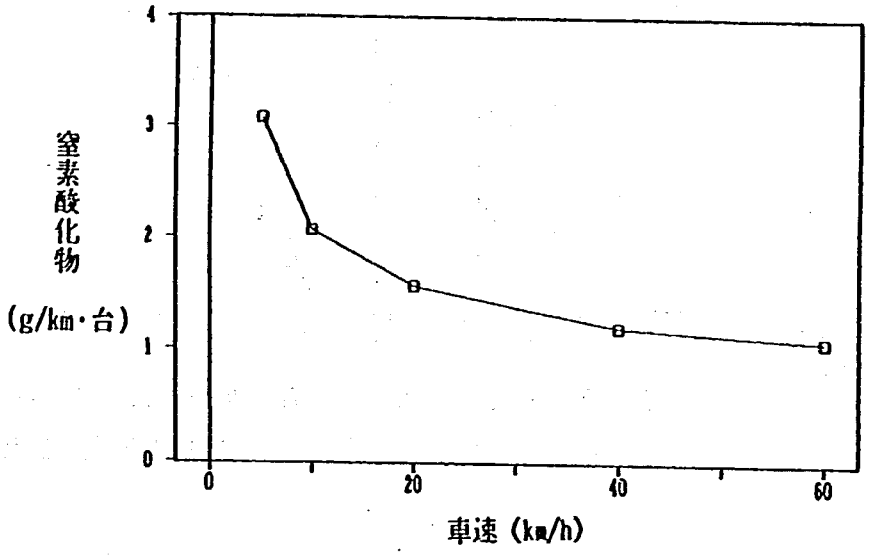
(1)ガソリン乗用車



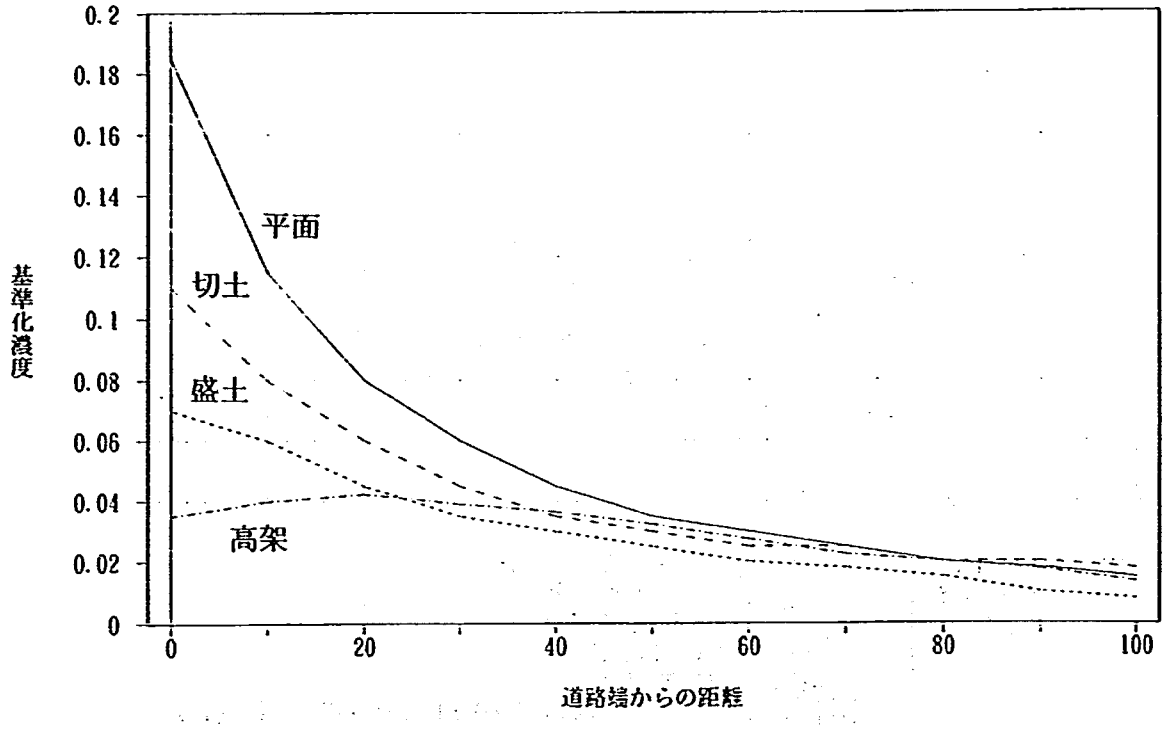
(2)ディーゼルトラック・バス



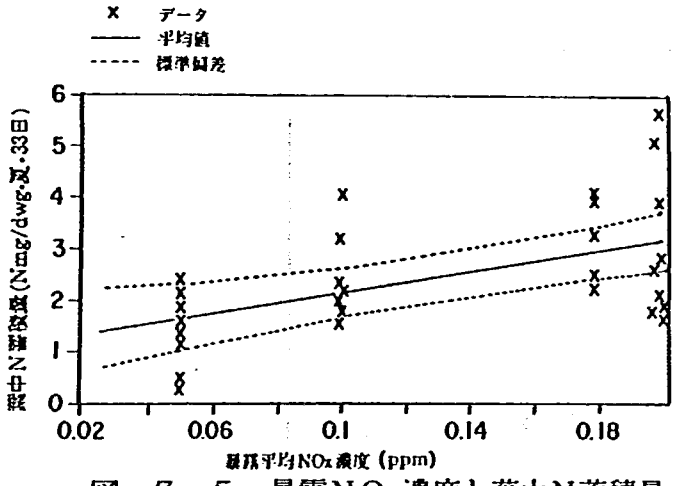
図－７．２　自動車排出ガス規制に係るＮＯ$_x$排出量（平均値）低減効果の推移
（代表的２車種の例）



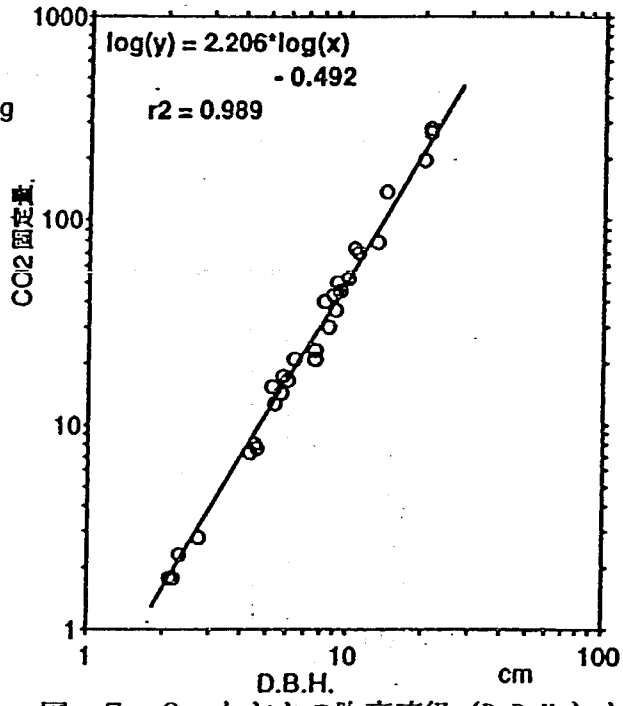
図－７．３　速度別排出係数の一例
（重量ディーゼル63年規制車）



図－７．４　汚染物質基準化濃度の距離減衰（地上1.5mの高さ）
（排出量１ml／m･s、風速１m／sのときの濃度）



図－７．５　暴露ＮＯｘ濃度と葉中Ｎ蓄積量



図－７．６　ケヤキの胸高直径（D.B.H.）と
CO_2固定量の関係

５）自動車交通騒音対策

自動車騒音対策の分類は図－７．１に含まれる。以下に具体的な対策の例を示す。

(1)自動車構造の改善

自動車交通騒音に関して最も基本的な対策は発生源対策である。加速走行騒音は1971年の規制

開始以来３回にわたって規制強化が行われてきた（表－７．４）。騒音の発生源はエンジン音、冷却ファン音、吸排気音、タイヤ音等があり、これまでに制防振、各種カバー、ファンや排気管の構造変更など多くの対策が行われている。

(2)道路構造による対策

騒音も大気拡散と同様に距離によって減衰する。このことから幹線道路では環境施設帯を設置することによって沿道環境の保全がなされている。また、高架裏面や壁面の吸音対策についても研究を行っている。

(3)遮音壁

遮音壁は効果が確実（図－７．７）である。このため、日本では自動車専用道路を中心に多く設置されており、その総延長は1992年度には約3100kmに達している。従来型の遮音壁は、遮音あるいは遮音＋吸音の性能を持つ壁であるが、騒音低減量を大きく確保するために高さを高くすると、日照・景観・基礎構造の問題が生じる。このため、従来の遮音壁と同じ高さでより効果の大きい遮防音施設や、透光型で日照や景観阻害の軽減を図る遮音壁の開発研究が進められている。

(4)低騒音舗装

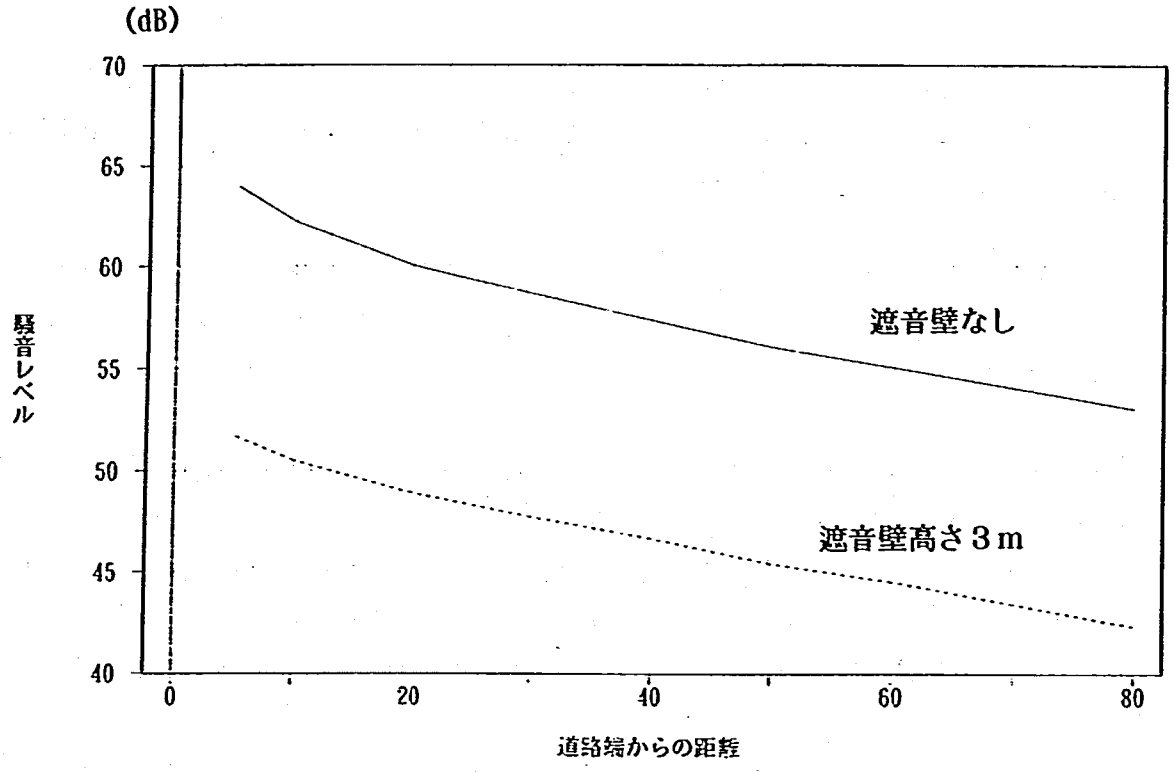
低騒音・吸音性舗装として、注目を集めているのが排水性舗装である。道路関係の各方面で試験的に施工され、排水機能の調査とあわせて騒音低減効果の測定が行われている。土木研究所でパワーレベルを測定した実験結果を図－７．８に示す。密粒アスファルトと比較して排水性舗装の場合のパワーレベルは小さく、速度が大きいほどその差は大きい。

表－７．４　自動車騒音規制の経緯

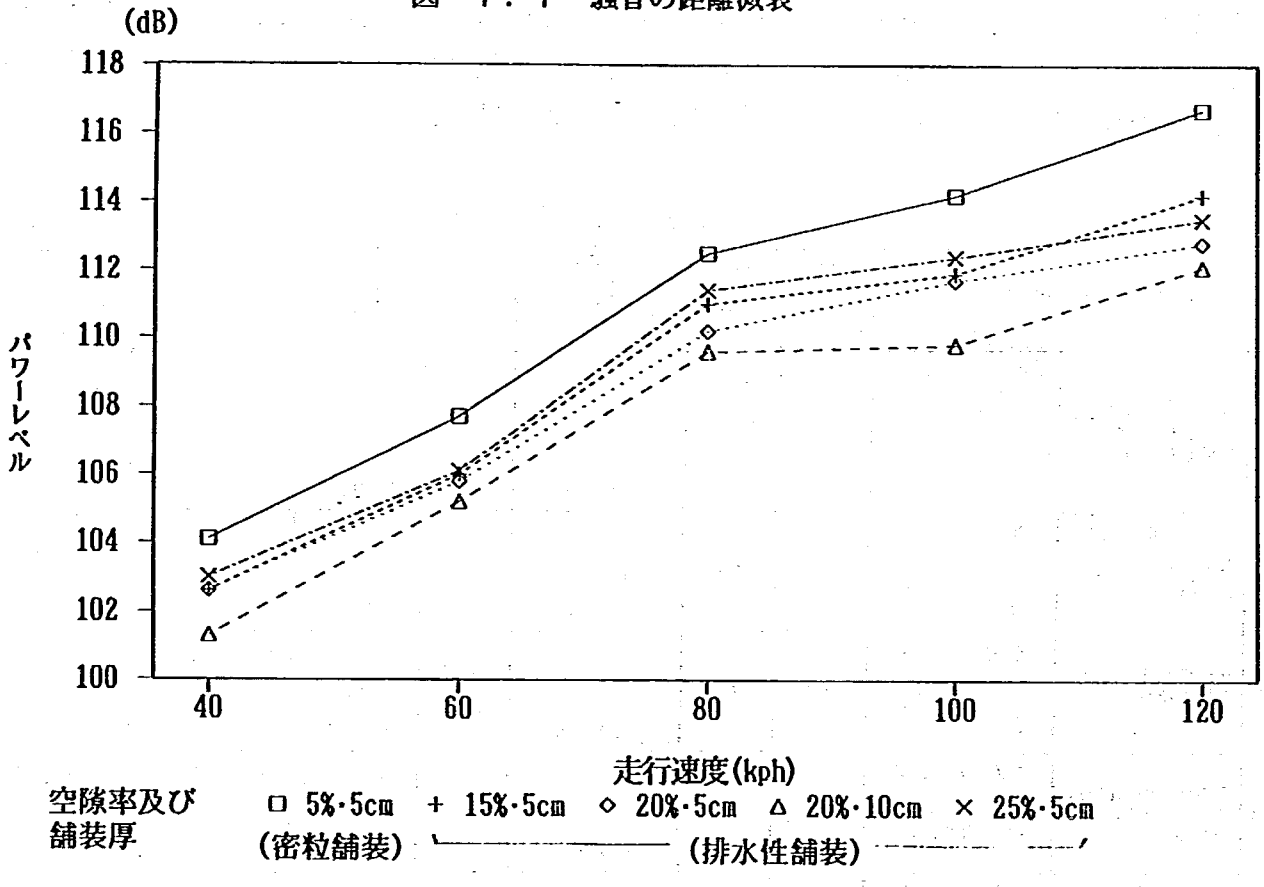
（単位：デシベル）

自動車の種別			定常走行騒音		近接排気騒音	加速走行騒音				
			26年制定	46年規制	61～元年導入	46年規制	51～52年規制	54年規制	57～62年規制	低減目標
大型車	車両総重量が3.5トンを超え、原動機の最高出力が200馬力を超えるもの	全輪駆動車、トラクタ及びクレーン車	85	80	107 元年導入	92	89 51年規制	86	83 61年規制	82 10年以内
		トラック							83 60年規制	81 10年以内
		バス							83 59年規制	81 6年以内
中型車	車両総重量が3.5トンを超え、原動機の最高出力が200馬力以下のもの	全輪駆動車	85	78	105 元年導入	89	87 51年規制	86	83 58年規制	81 10年以内
		トラック バス								80 10年以内
小型車	車両総重量が3.5トン以下のもの	全輪駆動車	85	74	103 元年導入	85	83 52年規制	81	78 60年規制	76 10年以内
		トラック バス							78 59年規制	
乗用車	専ら乗用の用に供する乗車定員10人以下のもの	乗車定員6人超	85	70	103 63年導入	84	82 52年規制	81	78 57年規制	76 10年以内
		乗車定員6人以下								76 6年以内
二輪自動車	二輪の小型自動車（総排気量250ccを超えるもの）及び二輪の軽自動車（総排気量125ccを超え250cc以下のもの）	小型	85	74	99 61年導入	86	83 51年規制	78	75 62年規制	73 10年以内
		軽				84			75 60年規制	73 6年以内
原動機付自転車	第一種原動機付自転車（総排気量50cc以下のもの）及び第二種原動機付自転車（総排気量50ccを超え125cc以下のもの）	第二種	85	70	95 61年導入	82	79 51年規制	75	72 61年規制	71 10年以内
		第一種				80			72 59年規制	71 6年以内

（注）・近接排気騒音規制は、昭和４６年以降の生産車（使用過程車を含む）に適用。
・低減目標は、平成４年答申（４．１１．３０）による値及び時期。
・低減目標については、「２００馬力」を「１５０キロワット」と読み替える。



図－７．７　騒音の距離減衰



図－７．８　舗装種類別走行自動車のパワーレベル

8．今後議論したい課題

各国が土木技術研究開発を推進する上での共通の課題として、以下のものをあげる。

(1)国立研究機関の役割とそのあるべき姿

(2)国立研究機関の研究者の資質向上手法

(3)アジア地域における研究情報交換体制の確立

また、分野別の課題として、以下のものをあげる。

(1)各国の水質保全対策と下水道の取り組み（下水道部）

(2)各国のダム技術開発に関する取り組み（ダム部）

i)堆砂対策

ダム貯水池の堆砂に関しては、ダム計画における堆砂の的確な予測とダム管理におけるダムの適正な運用を図る必要がある。そのため、正確な堆砂量・形状の推定法と堆砂の抑制、排除や有効利用等に関する調査、計画、設備設計、管理運用などの総合的な堆砂対策が求められている。この問題は、日本のみならず、アジア各国のダムにおいても共通する研究課題と考えられる。

ii)小規模ダムの設計と施工法

わが国では、山間部や半島部、島しょ部等の地域における局所的な治水対策や水需要の高まりにより、小規模なダムを数多く築造することが必要となっている。このような小規模ダムの需要については状況の違いはあるものの、アジア各国で共通する課題となると考えられる。

(3)各国の災害情報に関する取り組み（砂防部）

i)地球規模での災害監視システム

人工衛星からのデータを用いた洪水・土砂・火山・地震災害の監視手法および、災害の予知・予測・警戒・避難手法を検討する。

ii)広域的なハザードマップの作成手法

人工衛星・小縮尺の地形図等からのデータを用いた洪水・土砂・火山・地震等に関するハザードマップの作成手法を検討する。

(4)各国の道路技術開発に関する取り組み（道路部）

i)舗装の合理的な維持管理

舗装ストックの増大に伴い、その維持管理は重要な課題となっている。そこで、アジア各国の取り組みについて情報交換するとともに、合理的な舗装の維持管理のあり方について、舗装データベース、評価手法、最適工法選定等を含めて議論する。

ii)道路交通渋滞対策

近年の都市部への人口集中、モータリゼーションの進展に伴い、都市部等での交通渋滞がアジア各国においても社会的な問題となっており、ハード、ソフト両面での対応策を検討する。

iii)道路交通安全対策

道路交通の進展に伴い、交通事故の削減は各国共通の深刻な課題である。このため、道路や交通事故に関するデータベースの作成やこれを活用した事故分析を着実に進めるとともに、道路構造や交通運用面での対策を個別に実施していくことが必要であり、これらについて各国の実状を踏まえて対応策の検討を行う。

iv)トンネルの計画、設計、施工

都市内道路トンネルの計画、設計、施工及び道路トンネルの合理的な換気、照明、防災設備について検討する。

(E) 視 察 旅 行

Ⅰ．視　察　旅　行

視察旅行記

アジア地域土木研究所長等会議は、会議中の平成５年１１月２０日（土）～２４日（水）、および２６日（金）に、四国・中国、九州および関東方面の主な社会資本の整備状況について視察を行った。

以下に視察日、視察先について示す。

１１月２０日（土）	移動（つくば→東京→高松→岡山）	
	瀬戸大橋視察	（岡山泊）
２１日（日）	移動（岡山→福岡）	
	海の中道海浜公園視察	
	福岡タワー視察	（福岡泊）
２２日（月）	オリエンタル建設㈱福岡工場視察	
	第２回ｱｼﾞｱにおける国土開発と土木技術に関する国際ｼﾝﾎﾟｼﾞｳﾑ	（福岡泊）
２３日（火）	移動（福岡→佐賀→長崎）	
	吉野ヶ里歴史公園事業視察	
	六角川改修・軟弱地盤対策事業視察	
	長崎市内視察	（長崎泊）
２４日（水）	移動（長崎→東京→つくば）	
	雲仙復興事業視察	（つくば泊）
２６日（金）	移動（つくば→東京）	
	建設大臣表敬訪問	
	東京湾横断道路視察	（東京泊）

なお、視察に際しましては、本州四国連絡橋公団第二管理局、九州地方建設局、海の中道海浜公園事務所、オリエンタル建設㈱、佐賀国道工事事務所、武雄工事事務所、長崎工事事務所、雲仙復興工事事務所、日本道路公団東京第一建設局、東京湾横断道路㈱をはじめ多くの方のご協力を頂きましたことを深く感謝致します。

１１月２０日（土）　瀬戸大橋視察

８時３０分につくば第一ホテルをバスにより出発、ＪＲ、モノレールにより羽田空港へ１１時頃到着した。羽田空港内で昼食後、１３時００分発のＪＡＳ３９３便にて高松空港へ向かった。

高松空港到着後、マイクロバスにより坂出インターチェンジ内の本州四国連絡橋公団坂出管理事務所で原崎所長と合流し、昭和６３年４月１日より供用している瀬戸大橋（坂出－児島ルート）を視察した。原崎所長からは、橋梁建設に至る経緯、供用による経済効果、本州四国連絡橋建設の全体将来計画について説明を頂いた。岡山へ向かう途中、与島パーキングエリアに寄り、かん臨丸に乗船した。

１８時００分頃に岡山ターミナルホテルに到着した。

１１月２１日（日）　福岡市内視察

９時３０分に岡山駅発の新幹線ひかり１５３号により博多駅へ向かった。１２時頃博多駅に到着し、九州地方建設局企画部の直江企画調査官、尾澤企画課長等と合流した。昼食後、海の中道海浜公園を視察し、ここで担当者より公園事業の概要、整備効果等について説明を受けた。

その後、福岡タワーと福岡ドームを見学した。

１８時頃にはハイアット・リージェンシー・福岡に到着し、一日のスケジュールを終えた。

１１月２２日（月）　第２回アジアにおける国土開発と土木技術に関する国際シンポジウム

８時００分にホテルを出発し、９時００分から１０時３０分までオリエンタル建設㈱福岡工場を訪問し、橋梁の床版等広く土木構造物に用いられるプレストレスコンクリート（ＰＣ）の製造工程、品質管理等について視察した。

その後、ソラリア西鉄ホテルに移動し、シンポジウム打合せ、昼食の後、１４時００分から「第２回アジアにおける国土開発と土木技術に関する国際シンポジウム」が開催された。このシンポジウムは、建設省土木研究所・九州地方建設局の主催によるもので、福岡県、福岡市、土木学会西部支部の後援を受け開催されたものである。会場には、官・民・学の各界および報道関係の参加があり、総勢約２００人に上った。シンポジウムは、第１部に九州大学工学部 樗木教授による「九州の地域開発と土木技術」と題した基調講演が行われた。第２部では、「より良い生活環境の創造　－地域開発、防災、環境－」をテーマとしたパネルディスカッションが行われ、住吉土木研究所長をコーディネーターに、７ヶ国の海外参加者と荒牧九州地方建設局長をパネリストとして、各国の生活環境改善のためのプロジェクトについて発表と討論を行い、各国の現況について相互に理解を深め、今後の国際協力について積極的に意見交換がなされた。

１７時３０分にシンポジウムが終了し、その後九州地方建設局長主催のレセプションが行われた。

１１月２３日（火）　福岡→佐賀→長崎視察

８時００分にホテルをバスにより出発し、まず最初に吉野ヶ里歴史公園整備事業現場を訪問し、佐賀国道工事事務所の担当者等より日本の古代弥生文化、公園事業計画、整備効果等について説明を受けた。

昼食後、武雄工事事務所の六角川改修事業現場を訪問し、担当者より洪水対策事業および軟弱地盤対策に対する取り組みについて説明を受けた。

九州縦貫自動車国道の大村インターチェンジで長崎工事事務所の瀬戸所長、喜安調査課長と合流し、その後、長崎市発展の歴史を紹介しているグラバー園を訪問した。

１８時３０分頃長崎グランドホテルに到着した。

１１月２４日（水）　雲仙復興事業視察

８時１０分にホテルをバスにより出発し、島原市の雲仙復興事務所に向かった。ここで、松井所長より、平成３年６月からの雲仙・普賢岳の断続的な噴火により発生した土石流・火砕流による地元住民、道路橋梁等への被害状況について説明を受けた。さらに、なお続けられている観測体制と防災対策の視察を通じ、広く意見交換を行った。

定刻より１時間遅れの１５時２０分長崎空港発のＡＮＡ６６６便により羽田空港に向かい、１８時３０分頃再びつくばに戻った。

１１月２６日（金）　建設大臣表敬・東京湾横断道路視察

８時３０分につくばを出発し、霞ヶ関の建設本省へ向かった。１１時００分から約３０分間、五十嵐建設大臣を表敬訪問した。はじめに住吉所長より海外参加者の紹介と第２回会議の開催報告がなされた。つづいて、建設大臣より社会資本整備事業を支える土木技術の研究開発と国際研究協力の推進として、この「アジア地域土木研究所長等会議」の益々の発展に期待が寄せられた。海外参加者からも日本のアジア地域への技術協力に対する期待が寄せられた。表敬は、終始穏やかな雰囲気の中で行われた。

その後、東京湾横断道路㈱技術部の高野次長と駄竹課長代理の案内により川崎マリンプラザへ向かった。昼食後、川崎からは船に乗り、全体概要、川崎人工島、木更津人工島など横断道の建設状況について説明を受けた。

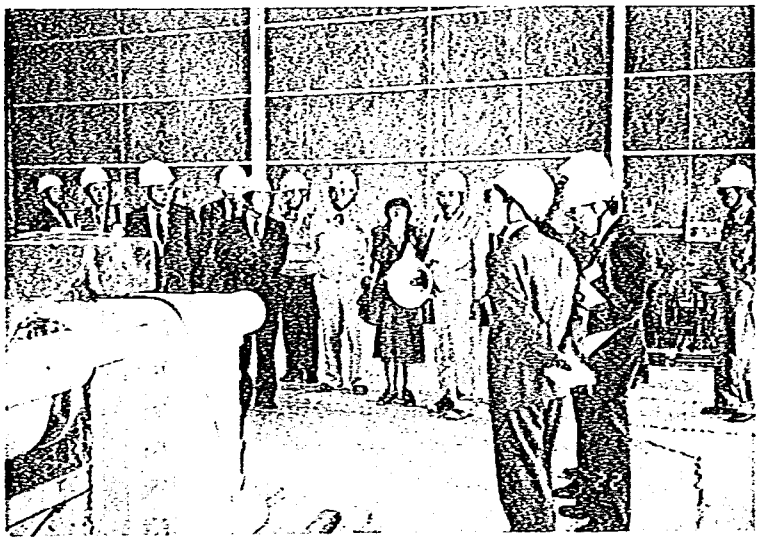
１８時からは虎ノ門パストラルにて住吉土木研究所長招待によるフェアウェルパーティが行われ、建設本省、外務省、科学技術庁、国際協力事業団、各国在日大使館等をはじめとして、多数の出席者により行われた。



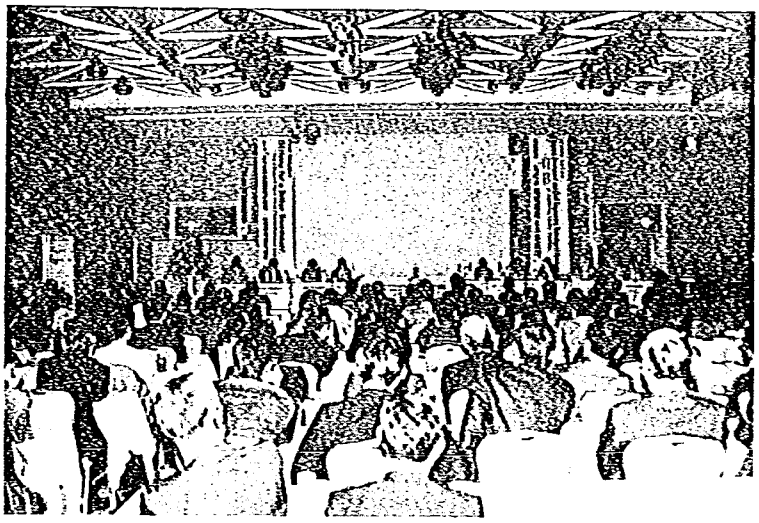
図－１　瀬戸大橋　（平成５年１１月２０日）



図－２　福岡ドーム（平成５年１１月２１日）



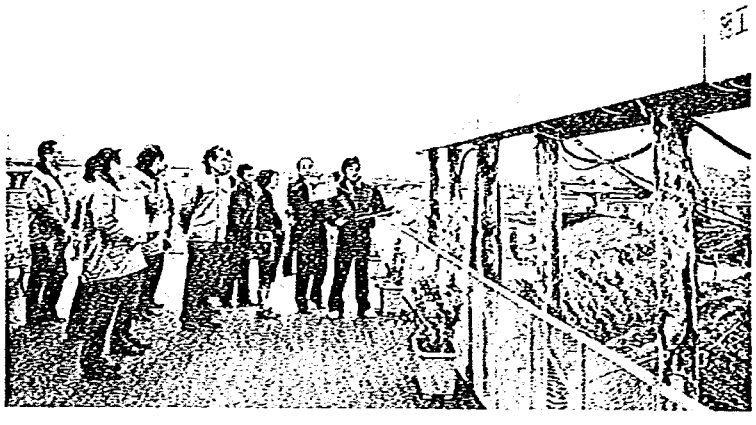
図－３　オリエンタル建設㈱ＰＣ工場（平成５年１１月２２日）



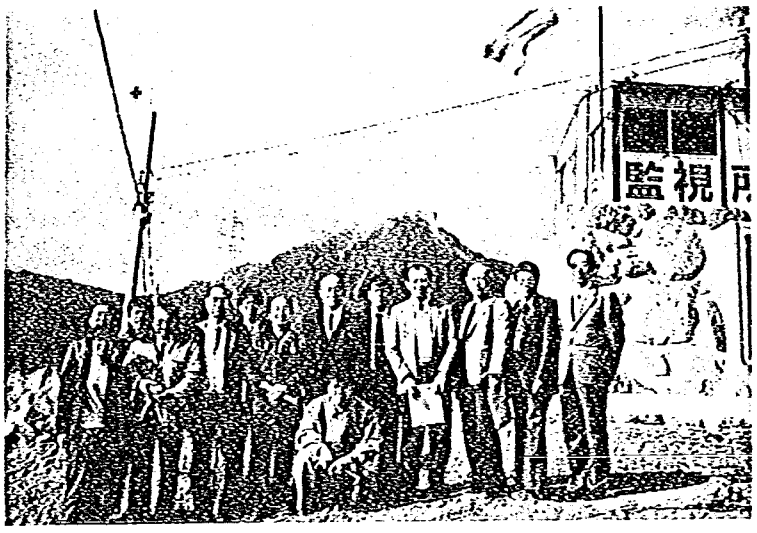
図－４　第２回アジアにおける国土開発と土木技術に関する国際シンポジウム
（平成５年１１月２２日）



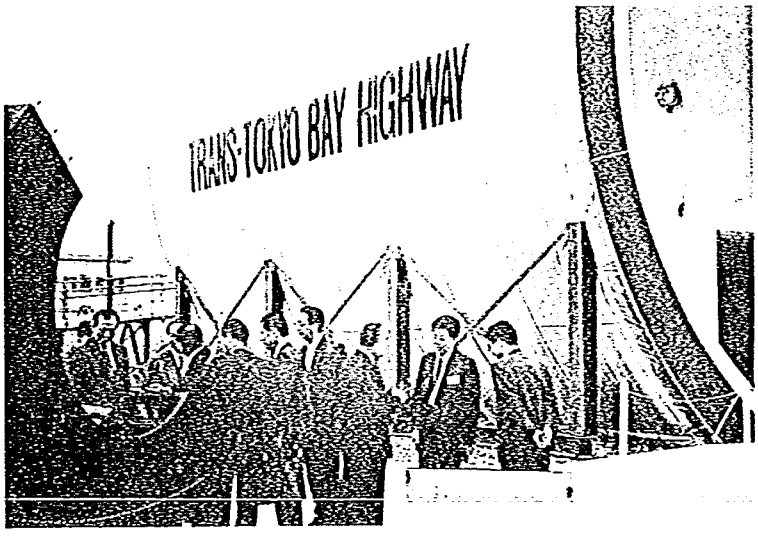
図－５　吉野ヶ里歴史公園（平成５年１１月２３日）



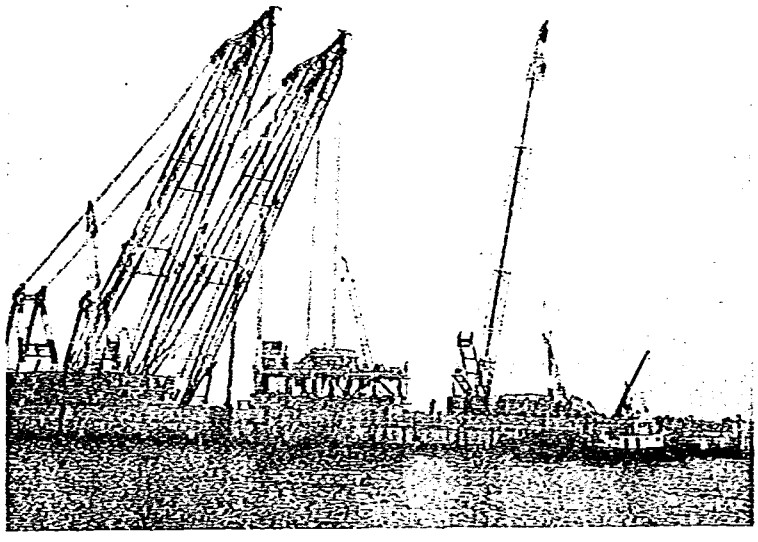
図－６　六角川改修事業　（平成５年１１月２３日）



図－７　雲仙防災事業　　（平成５年１１月２４日）



図－８　東京湾横断道路　（平成５年１１月２６日）



図－９　東京湾横断道路・人工島（平成５年１１月２６日）

II.「第2回アジアにおける国土開発と土木技術に関する国際シンポジウム」

プログラム

14:00　開会の辞

14:00～14:15　挨　拶　建設省九州地方建設局長　荒牧英城

建設省土木研究所長　住吉幸彦

14:15～15:05　基調講演　九州大学工学部教授　樗木武
演題「九州の地域開発と土木技術」

15:05～15:15　―― 休　憩 ――

15:15～17:00　パネルディスカッション

テーマ　「より良い生活環境の創造
―― 地域開発、防災、環境 ――」

コーディネーター　建設省土木研究所長　住吉幸彦

パネリスト

建設省九州地方建設局長　荒牧英城
「九州地方における社会資本整備」

中国科学院成都山地災害及び環境研究所長　呉積善
「総合的土石流制御対策」

インドネシア公共事業省研究開発庁次長　Soedarmanto Darmonegoro
「水質保全対策」

韓国建設技術研究院企画調整室長　金亘煥
「韓国の主要河川の洪水確率分析」

マレーシア農業省灌漑排水局河川部長　Teh Siew Keat
「クラング川清浄10ヶ年計画」

フィリピン公共事業道路省研究基準局長　Jose H. Espiritu
「南ルゾン高速道路計画」

シンガポール国家開発省公共事業局土木技術担当課長　Khor Poh Hwa
「シンガポール地下道路システム」

タイ内務省公共事業局材料研究部長　Anusornant Mahavinichaimontri
「都市大気汚染対策」

17:00　閉会の辞

1．基調講演「九州の地域開発と土木技術」

九州大学工学部土木工学科教授　樗　木　　武

九州の地域開発と土木技術



九州大学　　椹木　武

1。はじめに

前回の本シンポジウムは北海道で開催されたと言うことですが、九州はその北海道とは日本の首都東京を挟んで反対の西南端に位置し、九州島と琉球列島からなります。九州本体そのものが島ですが、それにしても島の数が大変多いことが特色の1つです。日本全体で約７０００弱の島々がありますが、そのうちの実に１／３近い２５００程の島々からなるものでして、まさに多島国土であり、それが九州の姿であります。

この九州は、面積的には北海道の約半分であり、全国の１２％のシェアを占めるものですが、人口の上では、北海道の約２．５倍の１４００万人を擁しております。加えて、標高１００m未満の土地面積にしても、可住面積にしても、国土面積以上の対全国シェアである１４～１５％を占めます。あるいは海に目を転じますと、九州の海岸線の延長は約１２千kmに及び、そうした中で、準国土とも言うべき水深２０m未満の沿岸海域面積は対全国シェア２０％を占めています。こうしたことから、九州の国土は我が国の中でみると大変利用しやすいものであるといえます。

また、亜熱帯から温帯までの多様で温暖な気候に恵まれ、あるいは活火山を擁して海に山に変化に富む自然があります。さらには、我が国の中では中国大陸、アジア諸国に近いという地理的条件から、古来から国際交流の窓口として重要な役割を果たしてきました。

この様な諸条件から、九州は早くから人々が住み着き、村づくり、地域づくりに励んできたところで、そのことに土木事業ひいては土木技術が深く関わり、大いに貢献してきたことはいうまでもありません。

2。吉野が里遺跡と土木技術

ところで、九州ではこの福岡県の隣にあります佐賀県の古代遺跡、吉野が里遺跡をはじめ、福岡県内にあります平塚川添遺跡や板付遺跡の発掘が続いています。これらは、いまから１７００年ほど前の紀元3世紀頃の遺跡ですが、我が国の古代国家の成立に関わるものとして全国的に注目を集めています。とく

に吉野が里遺跡は、中国の歴史的書である「三国志」の中のいわゆる「魏志倭人伝」に記された古代国家「耶馬台国」を彷彿とさせるものものがあり、また多くの遺跡や遺物が見られることで高い関心を呼び、１９８９年の発見以来これまで７百万人を越える人々が見学に訪れています。その中で、土木的な関心事となると、集落の周りに２重に（一部では３重、４重に）張り巡らされた環濠であるかと思います。あるいは、物見やぐらや高床式倉庫などの建造物であると思います。

環濠のうち外濠は延長２．５kmに及び、また、断面形状は上端幅７m、深さ４mの逆三角形で、これより求められる土量は３５，０００m³に達します。当時この環濠集落にどれ程の人が住んでいたかは定かではありませんが、一説によれば１０００人程度でないかと言われております。その中の働き手はたかが知れており、しかも掘削機械や定規等の機器類が十分に発達していない時代に、こうした濠やその周りの土塁、さらには木柵などの土木工事を完成させるには相当の年月と苦労を要したものと推察されます。

一方、物見やぐらについては、その跡が内濠内の２ヵ所で見つけられています。６本の柱からなる建物で、地中に柱を埋て立てられていることは確かです。しかし、その姿はこの写真のように想像され現地に復元されていますが、確たるものではありません。高さ１０mを越える大型の建物であったであろうと推察され、地中には柱と柱を貫いて横木が通され、建物の沈下防止、補強上の工夫がなされた事が明らかにされています。いわゆる一種の「地中梁」といえるものですが、こうした発想は今日でも高架構造物の設計に採用される地中梁に相通ずるものとして大変興味をそそるものです。

我が国の古代遺跡は、メソポタミア文明や古代エジプト、中国文明に比較すれば歴史が浅く、土木事業もピラミッドや万里の長城という程に高度で大規模というわけにはいきません。しかし、ここに述べた事は我が国の中で見れば、極めて早い時期から九州においても土木事業があり、その技術があったことの証であります。したがって、九州の土木事業、土木技術は、少なくとも古代国家以来の長い歴史の中で培われたものであるということができます。

３。橋梁技術に支えられた九州の地域開発

この古代国家の時代から現代に至るまで、九州は様々な場面で我が国の歴史の表舞台に立たされながら、あるいはその陰になりながら地域的に発展を遂げてきました。そして、その過程で、我が国の中でも他地域と特に異なる点は何

かといえば、九州が地理的に我が国の国際交流の要の位置にあったことから、国際交流により得られる知識を十分に吸収しながら九州の地域文化をつくりあげてきたということです。

古くは古代国家の時代から、九州－朝鮮－中国という図式のルートによる国際交流が活発でありました。その多くは使いの者と貢物を送り、それと同時に多くの僧侶や留学生、技術者が往来し、文明がもたらされたといえます。あるいは不幸にして、中国と日本、朝鮮と日本など国と国との間で戦いの歴史もありましたが、これとて九州の地域文化の形成に影響があったと見ることができます。

このような中国大陸や朝鮮半島からの交流の他に、我が国は南方諸国との交易による交流もありました。これも九州を拠点とするものであったといえます。これは九州本島、琉球列島と九州から南方に向けて島々が連なる地勢的な条件と、黒潮という潮流を利用した航海術からくる必然であります。

いづれにせよ九州は、大陸と南方との2方向からの交流ルートが交差するクロスポイントであります。孔子の教えも、仏教やキリスト教の伝来も、蘭学の教えも、その殆ど全てが九州を窓口にして受け入れられ、日本全土に広まったといっても過言ではありません。あるいは、朝鮮から渡来した陶工とその技術は今なお我が国の文化と産業を支えるものであり、また南方から伝えられた薩摩芋が鹿児島ならば、長崎にカステラが伝えられ、九州の食文化をいまなお賑わしています。

（九州で始り全国に展開した石造アーチ橋技術）

さて、こうした国際交流の中で、九州に培われた土木技術の典型的で代表的なものとして橋梁技術の例を上げることができます。

我が国は、木材が豊富で至る所にあり、また加工がしやすいこと、架設が容易であること等から、古くは木橋が主体であり、九州もその例であったといえます。しかし、九州は台風銀座といわれるほどに台風の常襲地であり、しばしば洪水に見舞われるなど、水との戦いの歴史でもありました。こうした状況で架けても架けても流される木橋に人々は多大の犠牲を強いられ、そのことが地域発展の阻害になっていたことは容易に想像つくところです。またその一方で、狭い国土の中で平地や台地を有効に利用し農耕をより広め活発にする上から水田の開発が求められ、そのための水の確保に重大な関心があったことも事実です。

こうした背景からか、九州には、我が国の中でも例を見ないほどに木橋に換えて多くの石造アーチ橋が架けられ、その堅固さから、交通路として、あるい

は水路として今日なお残され利用されています。

いうまでもなく石造アーチ橋は古代ローマで発達した技術であります。それが我が国にもたらされ、さらに独自の発展を遂げたのが九州の石造アーチ橋の技術ですが、この技術の渡来には２つのルートがあるといわれています。１つはシルクロードを経て中国にわたり、それが１５世紀の中ごろに沖縄に伝えらえれ、鹿児島に上陸したというものです。

いま１つは、それから遅れること１８０年あまり後の１７世紀の珠印船貿易時代に長崎にもたらされたものであり、長崎の眼鏡橋がその最初のものであります。つまり、石造アーチ橋の伝来にも、先に述べた大陸ルートと黒潮ルートの２つの国際ルートが有り、そのいづれもが九州にもたらされたといえ、土木技術の国際交流が他の分野の国際交流と同じ道を歩んだことを物語るものです。

長崎の眼鏡橋は、今から約３６０年前の１６３４年に築かれており、これがその後の九州の石造アーチ橋の原点となりました。そして、そのおよそ40年後に今の福岡県大牟田市に我が国最初の水路橋としての眼鏡橋がつくられております。さらに、その約３０年後に平戸にも石造アーチ橋が架けられています。しかし、この渡来した石橋の技術に、さらに我が国独自のものとして改良を加えてその技術を高め、これが盛んに用いられるようになったのは、１９世紀になってからのことであり、それを担ったのが肥後の石工達、つまり今風にいえば熊本の石橋技術集団であります。国禁を犯したとして長崎奉行の役人を追われて熊本に移り住んだ藤原林七という人の一族が、石工として石橋の建造技術をみがき、それを秘伝として代々伝えながら、熊本県内に、あるいは鹿児島県内に次々に石橋を架けていきました。中でも有名なものは、熊本県の緑川に架かる霊台橋や、その支流に架かる通潤橋であります。あるいは今年の台風災害で被害を受けた鹿児島の甲突川の五つの石橋群も彼等のてによるものです。これらのうち通潤橋は大規模な石造の水路橋であり、逆サイホンといった自然の力をうまく利用した珍しいものであります。１日に１万４千トンの水を送ることができ、これによって水不足に悩まされてきた矢部南方の白糸台地が大いに潤い、その後の地域発展に役立ったことはいうまでもないことです。

このように、石橋の築造技術は九州の中で、九州人の手によって発展を遂げました。その最大の理由は何かと考えますと、要は石造アーチ橋の技術が最初に九州に伝えられたことと、もともと九州に石材があり、城を築く石工がいたこと、さらには先に述べたように九州が台風の常襲地であったこと等、九州の風土に合ったことであることはいうまでもありません。この技術は、その後１

９世期末の明治になって、東京など他地域にも広まり、二重橋や日本橋等の石造アーチ橋が完成するに至っております。

橋に関していえば、その後も九州は常に先進的であったといえます。例えば、長崎の「くろがね橋」は１８６８年の明治元年に完成した我が国最初の鉄の橋であります。あるいは鉄筋コンクリート橋についても我が国第２番目のものとしてやはり長崎県下（佐世保橋）に１９０６年に完成しています。

（離島振興と共に発展した戦後の近代橋梁技術）

冒頭にも紹介しましたように、九州は多島国土であり、多くの離島、半島をかかえており、また海峡をもっております。このことが、第２次世界対戦後の現代においても、我が国の経済発展の中で、全国に先がけて九州に近代的な橋をもたらす要因となっております。離島、半島であることによって、その生活、産業は厳しい環境におかれており、その不利を脱却し、地域発展を遂げることが島などに居住する人々の悲願でありました。このため経済、産業の振興による雇用の場の確保、生活環境の向上、保健・医療・教育の充実などによる島の活性化に強い期待が寄せられ、これを抜本的に解決する施策の１つが離島に橋をかけ本土と一体化を図ることであります。

九州における離島架橋運動のはじまりは定かではありませんが、その必要性はかなり古い頃からいわれており、恐らく２０世紀の早い段階からその主張があったものと推察します。しかし、具体的に実現するきっかけになったのは、１９４３年に制定された離島振興法であるといえます。例えば、離島を多くかかえる長崎県についてみてみますと、これ以降の架橋の実績はこの図のとおりであります。１９４４年から１９９２年までの４８年間に実に１６もの離島、半島架橋が実現しています。

こうした九州の離島架橋が進む中で、近代橋梁特に長大スパンの橋梁技術が発展し、我が国をその先進国へと飛躍させたということができます。特に、１９５５年に完成した長崎の西海橋は、我が国ではじめてスパン２００mを越えるアーチ橋であり（２１６m）、当時としては世界第３位を誇るものでした。次いで、１９６２年に、福岡でスパン３６７mの若戸大橋が完成していますが、これまた日本における本格的な吊り橋の第１号となった橋であります。

さらに、１９６６年に天草五橋が完成しています。これは、天草の島々と九州本島を一気に結ぶものであり、我が国の様々な橋梁技術を一同に集めた橋の見本市的な感がありますが、離島振興ということで真に効果のあった橋梁群であるといえます。ご承知の様に、天草は、漁業や農業中心の島であり、また観光資源に恵まれながらも、離島であるがゆえに十分に活かし切れず、地域の発

展という意味で必ずしも芳しいものではありませんでした。それが、橋が完成することにより、水産、農業といった地場産業の振興に貢献したことは当然であります。それと同時に、天草の観光資源の開発にはずみがつき、また橋そのものが大きな観光資源になるなどして、現在では年間４８０万人の観光客を引きつける九州の一大観光拠点となっていることはご承知のとおりです。

橋についていえば、さらにこの後の１９７３年に、下関と北九州を結ぶ関門橋が完成しています。つまり、この１１月で丁度２０周年を迎えたわけですが、全長１０６８mに及ぶものでして、当時としては東洋一の吊り橋であり、これによって我が国の長大橋の建設技術は完成したといえます。そして、この橋によって、それまでの関門トンネルと共に、現在では１日に約６万台の自動車が海峡を横断し、文字どおり我が国の大動脈として機能すると共に、その技術的な成果が本州四国連絡橋の建設につながったことはいうまでもありません。

以上の他にも、九州を舞台にして育った土木技術は多々あります。トンネル、人工島や海上空港、石油備蓄、有明粘土やシラスなどの特殊土処理技術、自然災害に対する防災技術、環境回復技術など枚挙にいとまがないところですが、その代表的な事例として橋梁について述べたところです。

４。中央対地方という構図の中で地域発展に苦しむ九州

このように、九州は土木事業、土木技術の上で、ある面では我が国の先進的、先端的地域であり、そのことが九州の地域発展に少なからず貢献をしてきました。しかしながら、それにもかかわらず今日に至って九州は地域発展という点で深刻な課題をかかえているのが正直なところです。すなわち、我が国おける中央対地方という構図の中で地域発展上の課題が新たに提起されるに至っています。１９５５頃から１９７０年にかけて、重化学工業が中心になり、我が国は高度の経済成長を遂げました。これで著しい進展をみせたのが首都圏、中部圏、近畿圏とそれらをつなぐ東海道ベルト地帯であります。この経済成長は、国内低開発地域である地方からの人口流出により支えられ、多くの人々が三大都市圏へと移動しました。九州もその渦中にまきこまれたことはいうまでもありません。すなわち、この図はその事を如実に示すものです。これは、各年度の九州８県合計の人口の流入量と流出量を示すものです。明らかに１９６０年代から１９７０年代前半にかけて激しい人口流出がありました。その後、１９７５年頃の低経済成長期には一時的に流入過多となり、これで地方の時代到来かと喜んだのです。しかし、それも束の間で、１９８０年代に入って再び流出

過多となり、その量は減ってきたもののそれが今日なお続いています。この結果、人口減少と高齢化が進行し、過疎市町村として社会存立の基盤が損われた地域も多数発生しています。１９７０年に制定された過疎対策緊急措置法によれば、九州全体の市町村のうち実にその６割近くが過疎地域と指定されており、その状態は途中一時的な変化はあるものの、基調としては今日まで変りなく続いています。

むろん、こうした状態に手をこまねいているわけでなく、１９６２年に制定された第１次全国総合開発計画をかわきりに、第２次、第３次、第４次と総合開発計画が策定され、国土の均衡ある発展を図るための努力がなされてきたところです。そして、その基盤整備の１つとして社会資本の充実があり、その実現のための土木事業の推進があったといえます。にもかかわらず、どうしてこういうことになったのでしょうか。それには２つの理由があると考えます。

１つは、現代の社会基盤の整備が本質的に需要追従であったことから、どうしても中央から地方へとの流れの中で推進されてきたことです。確かに、橋梁を例に先にも述べましたように、九州では先進的な土木事業が実施され、それに伴う先端的土木技術の開発がありました。しかし、これらはどちらかといえば、局部的、散発的な事業であり、あるいは一面では実験的であったといえ、系統的、システム的な整備ではなかったと思います。新幹線、高速道路のいずれにしても、首都圏から次第に地方へと展開する形式のものであり、地方への波及にタイム・ラグが発生したことが、九州地域の発展が首都圏に遅れ、その結果として人口の流出が続いたものといえます。

第２は、九州においても確かに社会基盤の整備が進みつつありますが、そのことによって地域が活性化するとの期待はあっても、社会基盤を積極的に活用するまでにいたっていないことです。すなわち、地域発展には社会基盤の整備は必要ですが、これは必要条件であって、社会資本を整備したから必ずや地域発展が進むという、いわば十分条件を満たすものではありません。社会資本の整備と共に、それをいかに使いこなすか、すなわち、ハードウェア、ソフトウェアだけでなく、これに加えてユーズウェア、つまり使いこなす技術が必要であり、それが十分でなかったということです。大都市圏では、ユーズウェアに配慮しなくても十分なニーズがあり、整備さえすればよいという環境にあります。しかし、地方ではユーズウェアを考え、ニーズを掘り起こすことが重要であり、これと社会基盤の整備が同時的でなければならないことであり、そこに難しさがあります。

以上のような点を踏まえると、土木事業そしてそれを支える土木技術の上で、地域発展をいかにとらえるかを明確にし、それに適した展開が必要なことであると考えます。その意味で、九州に関して、これからの地域発展はどういう内容かを考え、その上で求められる土木技術を考えることも大切であり、以下に簡単にふれてみたいと思います。

5。九州が求める地域振興

地域振興が目指すところは、豊かなコミュニティ、すなわち世代、立場を超えて誰もが充実した人生を送ることができる環境づくりであります。そして、その基盤としての社会基盤の整備が求められますが、その内容は地域振興策いかんによるといえます。これに大して従来の地方の振興策はどうであったかといえば、所得格差の是正と就業機会の増大による人口流出の阻止であり、そのための企業誘致を行政主導のもとに行うものでありました。工場誘致を図れば、そのことが職場を確保し所得向上につながり、また、地場産業も発展して地域の活性化につながるというものでした。しかし、これは必ずしも成功しなかったことは既に述べたとおりです。

これに対し、今日構想される地域振興は、従来方式を反省し、それだけでは十分でないとの認識から、地域のできる限りの自主性にもとづいた自力開発型の地域づくりと、快適でゆとりある環境の創出を行うことであると考えます。農林水産品の生産性の向上や高付加価値化、高度先端技術を中心とする産業構造への変革、中心都市の機能強化、豊かな観光資源の活用などが挙げられ、時代を先取りする総合的かつ積極的な攻めの振興策を模索しているといえます。

（1）地場産業の育成振興

まず、地場産業の振興についてですが、九州に存在する資源の最大のものは何といっても自然であり、これを生かした農林水産業は九州ならではの産業です。しかしながら、近年の農村と都市との所得格差や農村における自然条件の厳しさと重労働、都市的魅力の欠如から、農村からの若者の流出や後継者がいないといった深刻な課題を抱えています。こうした中で、都市の魅力に負けない、農村には農村なりの魅力があり、それを他に頼らず自らの努力で引き出し、身の丈にあった特産品を掘り起こすということから、「一村一品運動」や「日本一作り」などのムラおこし運動が九州から始まりました。その原点は、1951年の大分県大山町で起こった”ウメ、クリを植えてハワイに行こう”とい

うキャッチフレーズのウメ・クリ運動であり、これをもとに大分では「一村一品運動」が提唱され、以来全国的にも世界的にも注目の的になったところです。このムラおこし運動は、従来の工場誘致という他力型でなく、地域の特性を生かしながら自立的に地域振興を図る点に特徴があります。単に地場産品を1次産品のまま出荷するのではなく、地域で2次加工を行い、付加価値を高めるとともに、雇用の場を確保し、人口の定住化を促進するものであります。実は大山町も昭和40年代後半に、他地域で見られるように、縫製など3工場が誘致されています。しかし、そこでの雇用は主婦のパートに限られ、これだけでは真に地域振興に有効でないとの反省があったところです。この意味で農村が1.5次、2次、さらには3次産業へ自立的に転換することは、良質な雇用の場が創出され、またその波及効果に大きいものがあり、地域振興の上で効果を発揮するものであったといえ、その一層の推進が地域発展につながるものと考えます。

（2）産業高度化への対応

第2の地域展開は産業の高度化への対応であります。従来は重厚長大型、基礎素材型産業を中心に工場の地方分散を地域振興の目玉と考え推進してきました。しかし、低経済成長期に入ってからはそうした動きが少なくなり、これに代わって安い労働力を必要とする縫製や金属加工、あるいは部会では問題が多い食品加工などの工場が九州にも進出するようになりました。しかし、これとて、雇用が女子労働者、パートなどに限られることから、必ずしも地域振興の有力な手段にはなりえず、苦労を強いられているのが現状です。そうした反省の中から、今日の地域振興の主要な柱として、ＩＣおよびその関連産業やバイオテクノロジー産業など様々なハイテク産業を積極的に誘致し、あるいは既存の素材型産業を付加価値の高いハイテク型産業に転換し、産業の高度化を推進することが強く望まれるところです。その意味では、九州にはテクノポリスの展開、自動車産業およびその関連産業の進出などがあり、一応その緒についたといえる状態で、一層の発展が望まれるところです。

（3）自然および歴史的文化遺産の活用による観光開発

第3は、自然および歴史的文化遺産の活用による観光開発です。冒頭にふれましたように、九州には勝れた自然があり、また歴史的文化遺産も数多く残されているなど貴重な観光資源があります。一方、生活における自由時間の増大、所得水準の向上から、ゆとりとうるおいのある生活を求める潮流は今後さらに大きくなるものと期待されます。したがって、地域振興として観光事業が有力

な手段の１つになることはいうまでもありません。

観光については、今日二極化の傾向にあります。１つは海外旅行や目玉的な景勝地をめぐる大型広域観光であり、今１つは身近なレジャーやレクレーション、保養的要素の強い観光であります。前者に該当する大型観光地域は九州でも限られていますが、後者のリゾート・レクレーションは努力いかんによっては多くの地域で導入可能であります。また、今後の動向として、観賞し見物する観光から滞在し活動する観光へ、団体旅行から小グループあるいは家族や個人旅行へ、列車利用から自家用車利用へと観光の質の変化があります。これらのことからすれば、地域それぞれで多様な特色を持つ観光事業、観光開発を推進し、これを地域の活性化に結び付ける余地はあり、それゆえに模索が続いているといえます。折りしも、九州では北にハウステンボスなどのテーマパークの整備が進んでいます。また、南の宮崎に海をテーマとするリゾート地シーガイアが整備されています。一応こうした線に沿いながら、余暇時代の九州の地域発展策が展開されつつあることは、望ましい方向であるといえます。

（４）国際化への対応

第４は国際化への対応です。我が国は資源小国であるところから、海外との経済的つながりを深化させることにより国際化を図ってきました。その結果、今日では人口にして世界のわずか３％足らずであるにもかかわらず、世界のＧＮＰの約１割を占める経済大国に成長しました。しかしながら、その反面で深刻な貿易摩擦問題が提起され、また、新興工業国の激しい追い上げがあり、これらが九州の産業経済活動に脅威を与えています。このような困難に直面して、九州は独自に海外と交流を行って国際化を促進し、そのことを地域振興の一方の柱とする新たな局面を展開しつつあり、一層の促進が望まれるところです。

（５）地方中心都心の機能強化

最後に５つ目として、地方中心都市の機能強化があります。いうまでもなく地域は孤立して存在するのではなく、周辺地域と機能を分担・補完し合いながら、有機的結合関係を結んで圏域を構成するものです。また、各圏域が他と相互に交流し、地域全体の活性化につながるものです。こうした圏域の中心となり、発展の索引車となるのが地方中心都市です。この意味で、それぞれの地方中心都市の都市機能を強化し、足腰の強いものにすることも地域振興の上で強く求められるところです。

この地方中心都市に求められる都市機能は様々ですが、それらは行政、経済、情報、教育・文化と生活環境に大別することができます。これらの諸機能につ

いて九州における各都市をみてみますと、生活環境については、大都市と比較して各地方中心都市にさほど大きな開きはありません。しかし、行政、経済、情報、教育・文化の4機能は、人口比に対する機能の集積度という観点で見ればその水準は低く、地方中心都市の機能強化はこれらに関して求められるものであるといえます。

以上のような諸内容を踏まえますと、九州全体の地域展開のスケルトンはどうなるかというところをを私なりに描いたのが次ぎの2つの図です。

この図は九州の軸構成について考えるものです。従来からの九州の西を縦貫する国土第一軸の他に、九州を横断する第2軸を考え、これらと、これで不足するところを補間する九州東軸の展開、そして、国際化へ対応する国際軸の形成・強化が今後九州に求められる軸の姿ではないかと考えます。また、九州の地域展開はそれぞれの特色を生かすという意味では、この図のようなイメージが出来上がります。

九州は、大まかにいえば、北部に都市的展開があり、南部に自然が多く残されています。また、九州を単にそれだけで捉えるのでなく、我が国の中国地方および四国地方との連携の中で捉え、あるいは韓国や北朝鮮、中国、ロシア共和国といった近隣諸国との交流の中で、環シナ海、環日本海の要として捉え、ブロック間競争に対処する戦略が必要です。これらのことと現状を踏まえると、結局は、九州の中枢拠点として福岡都市圏を十分に機能させることが望ましいといえます。その上で、九州内の各地域が特色ある地域戦略を練り、互いにネットワークを形成して一体化する地域デッサンが現実のものと考えます。

九州北部は、いわば九州の顔を形成し、その骨格が東海道ならぬ九州道メガロポリスです。つまり、我が国の第2のメガロポリスであり、下関から、北九州、宗像、福岡、筑紫、鳥栖、久留米、大牟田、荒尾、熊本までの都市の連担性を生かすことによって、首都圏や近畿圏、あるいは釜山、ソウル、上海、台北、香港などの各都市圏に対抗できる規模と内容が形成できます。この九州道メガロポリスに求められるものは、のっぺらでなく、目鼻をはっきりさせた顔でなければなりません。すなわち、福岡都市圏の中枢管理機能と商業機能、国際機能が織りなすアジアメトロポリスであり、北九州、宮田、苅田で形成される北九州トライアングルの高度先端技術が集積するスーパーテクノポリスであります。また、熊本都市圏は、北部と中・南部の中継機能を果たすインターフェイス・シティとしての役割が期待されます。さらに、国際交通基盤（国際空

港、国際港湾、国際物流基地）、情報通信機能（テレポート、国際通信）、学術研究機能（北部九州研究学園都市、研究開発支援システム）、文化機能（国際コンベンション施設、国立博物館の設立、国際的都市文化の形成など）の強化が必要であり、これらを九州道メガロポリス全体で受けとめ展開することになります。

一方、長崎は九州の手です。ウォーターフロントおよび海を舞台とする多様な産業活動、余暇活動と、その異国情緒にもとづく特異なテーマの展開の上に成り立つマリンパークの構築が考えられ、長崎都市圏はその拠点マリノポリスとなるものと考えます。

また九州中部は、九州の胴体です。広大な森林と肥沃な大地が展開し、また、九州の心臓ともいえ、その鼓動が聞こえる活火山を抱きます。したがって、その基本戦略は、火山の恵を受け止めながらグリンパーク、アグリゾーンを形成することであり、これに先端技術を中心とするクリーンな工業の展開と都市アメニティを加えた田園工業都市テクノポリスが構想されます。そうした中で、熊本都市圏は、九州中部の拠点であり、また、大分都市圏は、東の玄関として、四国との連携強化の要となる存在です。加えて、島原、天草、川内を橋でつなぐことにより、有明海、不知火海を内海化し、第二の国土として、水産業、水産技術の革新に先導的役割を果たすマリノベーション・エリアの構築が考えられます。

九州南部は、九州の足であり、大地への踏まえとなる存在です。恵まれた自然環境を生かし、宮崎、鹿児島、沖縄を中心とするリゾート環境の創造は、南フランスに負けないアジアのリゾート・エリアを形成するものといえます。宮崎都市圏がリゾートポリスならば、鹿児島都市圏は、リゾート・エリアを束ね、九州南部の中心となるべき存在であり、九州の南玄関サウス・ゲート・シティとして機能するものと考えます。

こうした九州の地域デッサンは、その北から南にかけて、集積する都市活動をささえる人間感覚の都市形成——食糧基地としての大地や水面の有効活用と田園型工業の展開によるヒューマンスケールの街づくり——人間の保養と自然の保全を目指した感性の街づくり、というキャッチフレーズでスケルトンを描くものです。

地域の機能を分担させるならば、互いが補完し合い、交流するネットワークの形成が必要です。その主要なものとして、空間的には都市ネットワークや、緑、自然を繋ぐグリーンネットワークなどが考えられます。むろん、これらは

同種のものだけでなく、異種のものをも含む必要があり、このことを通して、ネットワーク間の重層性、連携性が強められます。また、情報、学術研究、文化といった機能ネットワークの形成が求められましょう。こうした地域と機能とを縦横に結ぶネットワークが張りめぐらされ、多様なポリスが展開するネットワークポリスランドの姿、それが２１世紀の九州であると考えます。

6。期待される土木事業、土木技術の発展の方向－むすびにかえて－

以上のように、２１世紀を目指した九州の地域開発戦略を私見として構想することができます。しかし、その実現のためには、要は各地域が特色ある魅力をもち、適正な規模で、適正な内容の地域開発を展開することであり、また自力的な熱意をもつて計画し推進することであると考えます。さらに、こうした九州の地域展開も、九州内は無論のこと、我が国のブロック間や近隣諸国との連携、ネットワーク化が重要であり、人、もの、情報の交流が強く望まれるところです。

このような九州の地域開発を真に効果あらしめるには、その必要条件として社会基盤の整備が重要であることはこれまでに述べたとおりです。それと同時に、これを十分使いこなす技術の展開も強くものめられます。そして、このことを推進する原動力が土木技術であり、土木事業であることはいうまでもないことですが、先に述べた地域開発の内容を踏まえるとき、これからの土木技術が目指すべき方向として次の２点があることを特に強調し、結びにかえたいと思います。

（１）価値観の変化と多様性に弾力性をもつ土木事業の展開と、そのための土木技術の確立。

その１つは、価値観の変化と多様性に弾力性をもつ土木事業の展開と、そのための土木技術の確立ということです。

即ち、先に述べた九州の地域開発に関する５つの視点は、大きくは社会の体質変化の中で、九州が時代を先取りすることを願っての私なりの意見であります。つまり、社会を全体として大きく見れば、この図に示しますような体質変化の流れがあります。

まずは狩猟型社会から農業型社会へと変化があり、そこでは、生きるためにという価値観が生まれると共に、定住型社会が実現し支配・非支配の関係が形成されたといえます。

次いで、エネルギー機関が発明され、産業革命が起ったことにより工業型社

会が実現しました。そこでは、労働を集約し、効率性を追及すると共に、便利さを追及してきたと見ることができます。このため、都市に人口を集め、それまでの主役であった農村の役割を低下せしめ、地域間の不均衡の拡大がもたらされたところです。しかも、都市の中でも、先に述べましたように、3大都市圏を中心とする中枢、中核都市のほんの一部地域にハイライトが当たり、他は軒並社会の発展、地域振興という点で苦しむ状況にあります。そして、この困難から脱却するために、九州の各地域は、先進地域へのキャッチアップあるいは全国並みからの遅れを取り戻すことを目標に努力してきましたが、それは必ずしも成功しませんでした。

この原因は様々ありますが、一言でいえばスケールメリットが強調される先進都市の後追いであったということです。先進都市が、工業化さらに脱工業化と進展する時、それよりも活力が不足し、不利な条件にある九州地域が、いくら追いかけても追いつくものではありません。結局はより引き離され、その結果として深刻な過疎問題の発生や、情報・サービスの立ち遅れ、ゆとりや文化の欠如といった諸課題を招いたにすぎません。

この反省に立てば、九州の地域開発は、決して先進都市、大規模都市の後追をするのでなく、他都市、他地域を超越した視点で時代の潮流を先取りするものでなければならないと考えます。その意味で21世紀が人間感覚、感性をもつ社会とみるならば、人それぞれがもつ感覚や感性に応えた多様なニーズの開発を可能にすることが土木事業に求められると考えます。すなわち、経済性を強調した画一的、効率的なものでなく、無駄はあっても個々人が主体的に感じ、触れ、知覚する社会の実現に貢献する土木事業であり、その事を考慮した土木技術の確立であります。

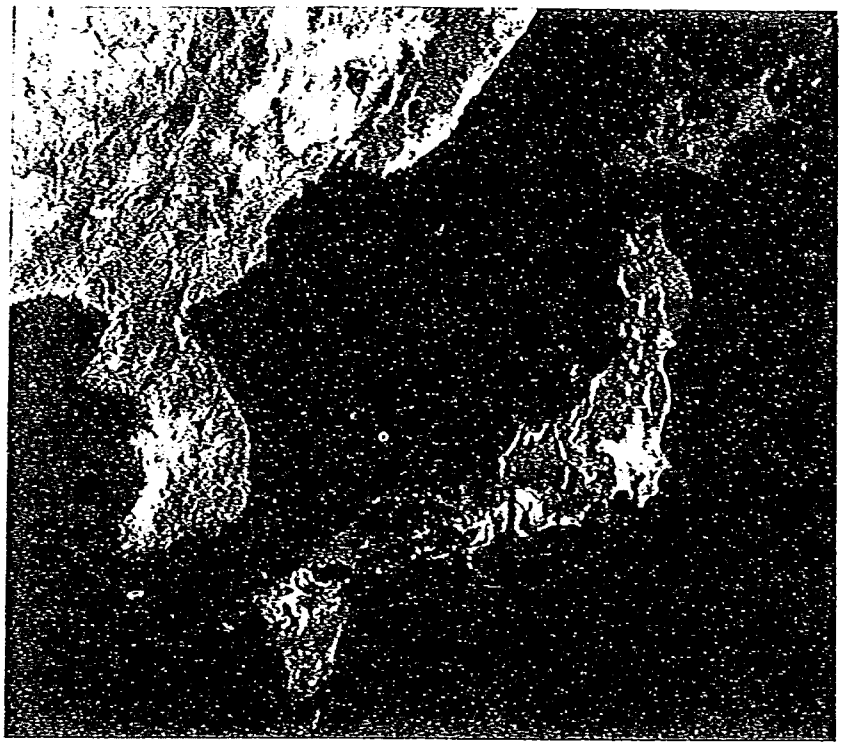
（2）環境をクリエイティブする土木事業、土木技術。

2つ目は、環境をクリエイティブする土木事業、土木技術ということです。最近土木事業、とりわけ大規模なプロジェクトに関し、地域住民から環境上の問題が提起され、紛争の種となるケースが増えています。本来、土木事業は、社会の諸活動に貢献することを願ってのものであり、その環境改善であることはいうまでもありません。にもかかわらずこうした問題の発生はどこにあるのかといえば、1つは、前述した価値観の多様化にあり、またそのなかでの価値尺度の不確実性、あいまい性にあるといえます。また、今1つは、これまでの土木事業、土木技術が、どちらかといえば経済性、効率性の追及に主眼があり、それ以外の価値、例えば文化性や芸術性、ゆとり、質的充実、多様で弾力的なユーズウェアへの対応、自然との調和など、極論すれば経済性、効率性の上で

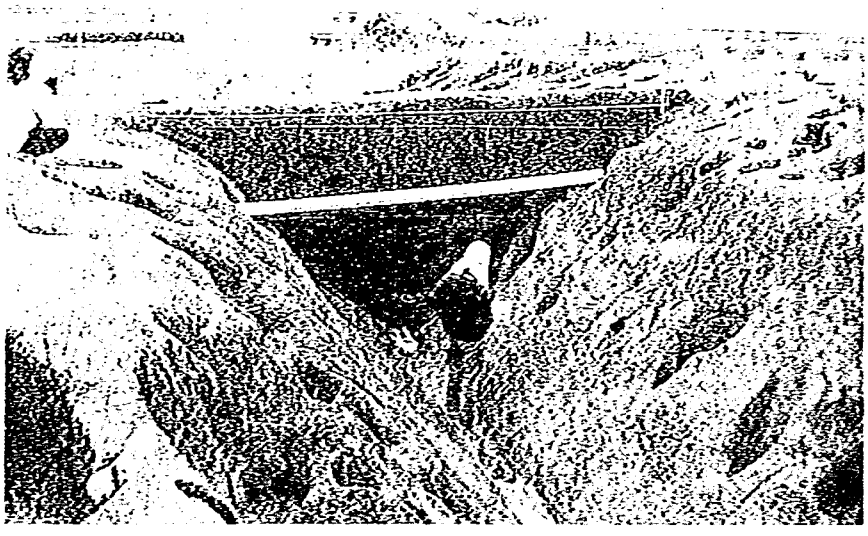
無駄と思えるものから生まれる価値観への配慮がなおざなりになってきたところにあると考えます。

必要最小限のものを得た上で、文化・感性の時代に向かうこれからの土木事業は、ある意味では経済性、効率性に加えて、それ以外の価値観が重視されるべきものと考えます。この事は、結局はよりよい環境をクリエイティブする土木事業の展開が求められていることを意味するものであり、そうした土木事業の在り方とそれを実現するための土木技術の発展が強く求められるものと考えます。

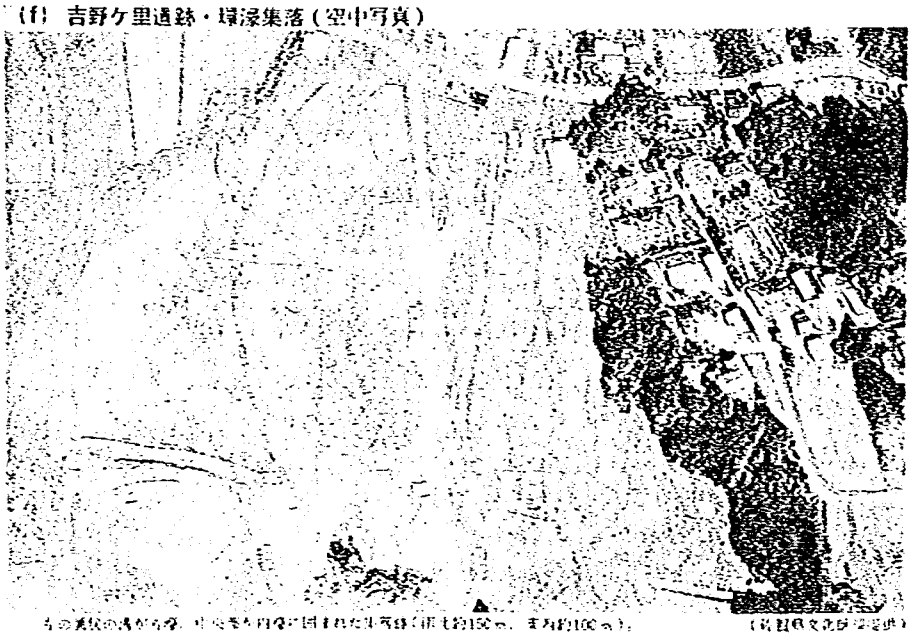
以上少々抽象的になりましたが、九州の今後の地域発展において土木事業及び土木技術の展開の方向について私見を述べ、結論とするものです。これらの話が少しでも皆様の役に立てばと願いつつ、私の話を終わりに致します。どうもご静聴有難うございました。



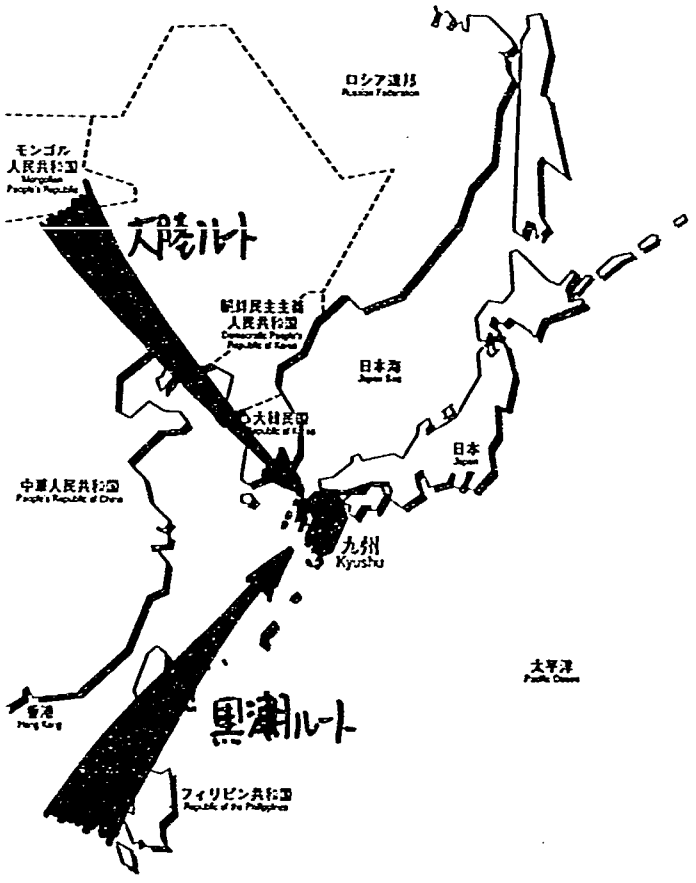
図－１　九州の位置



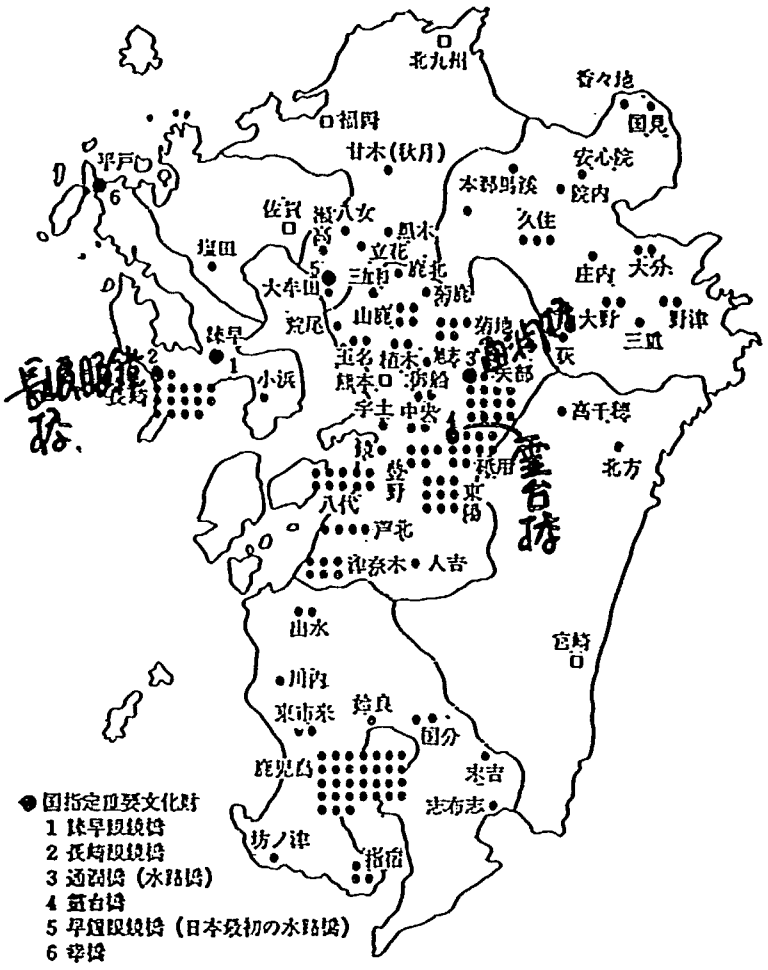
図－２　外濠の断面形状と発掘状況



図－3　吉野ヶ里遺跡

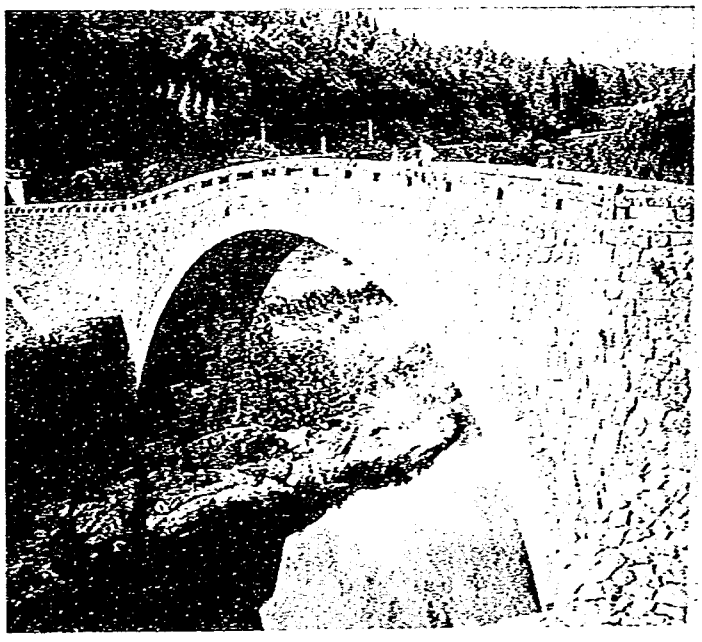


図－4　２つの国際交流ルート

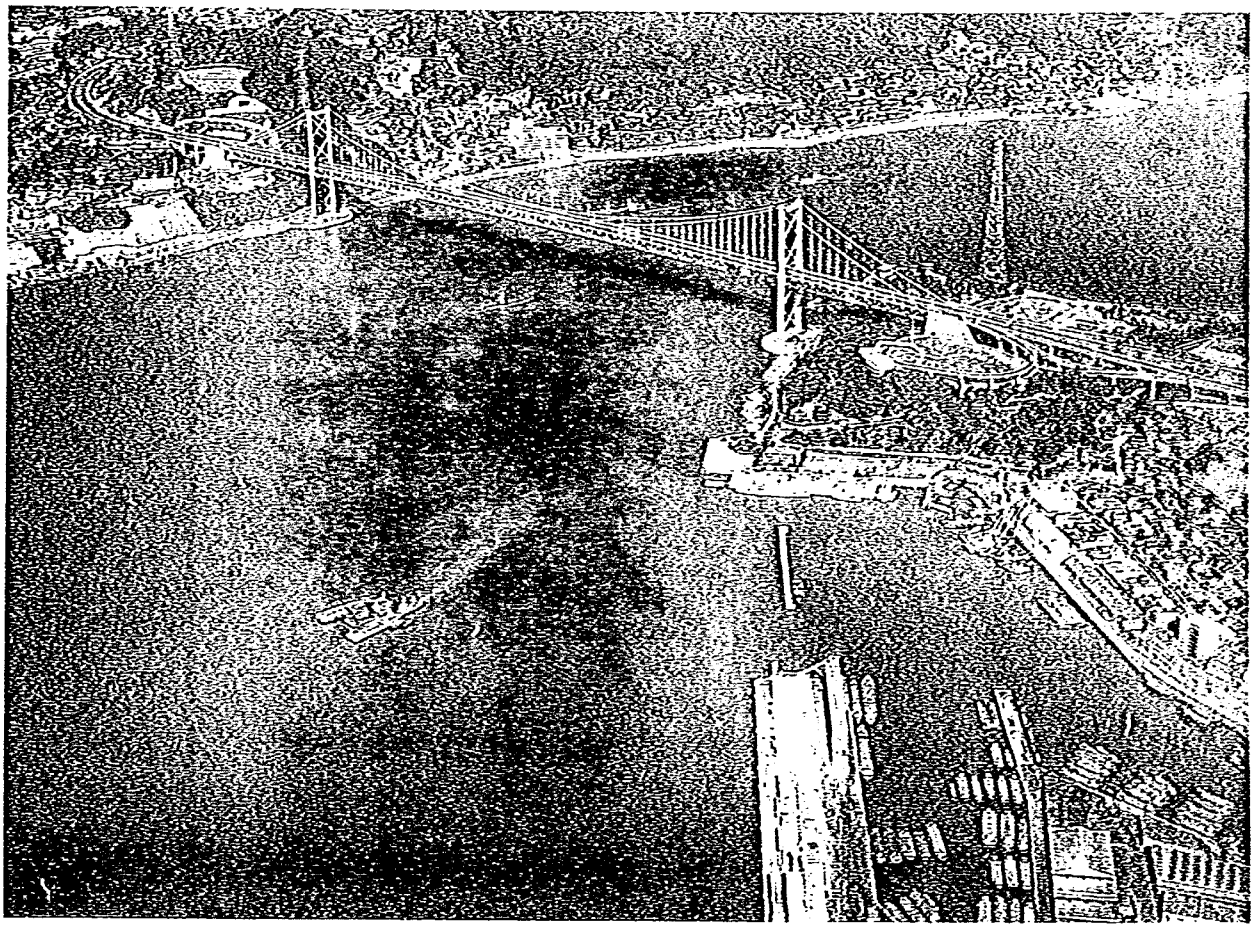


石造アーチ橋の分布

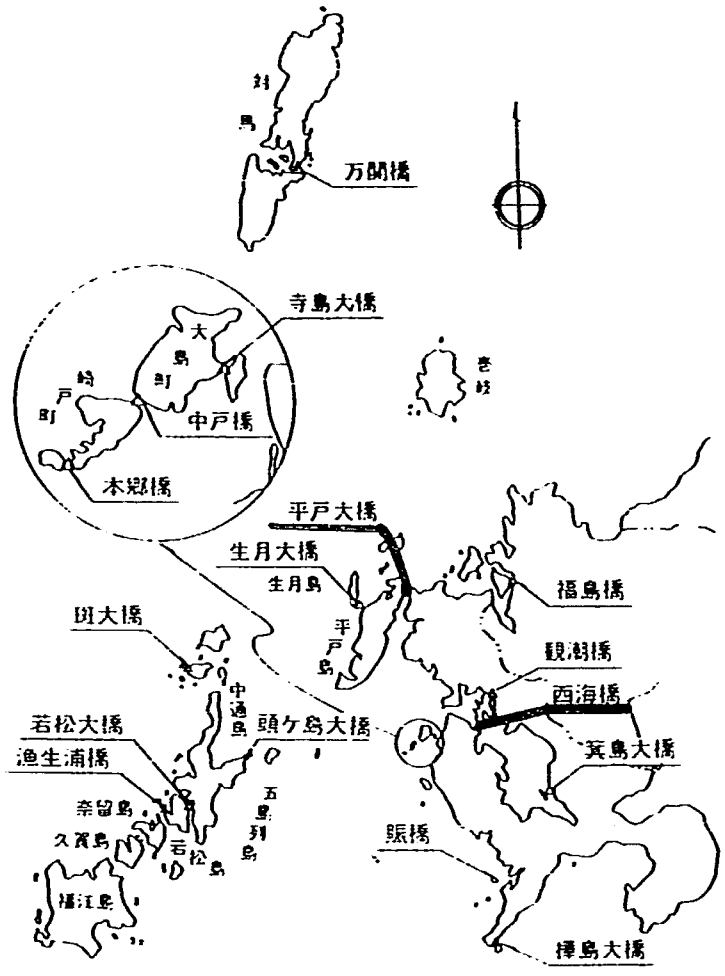
図－5　石造アーチ橋の分布

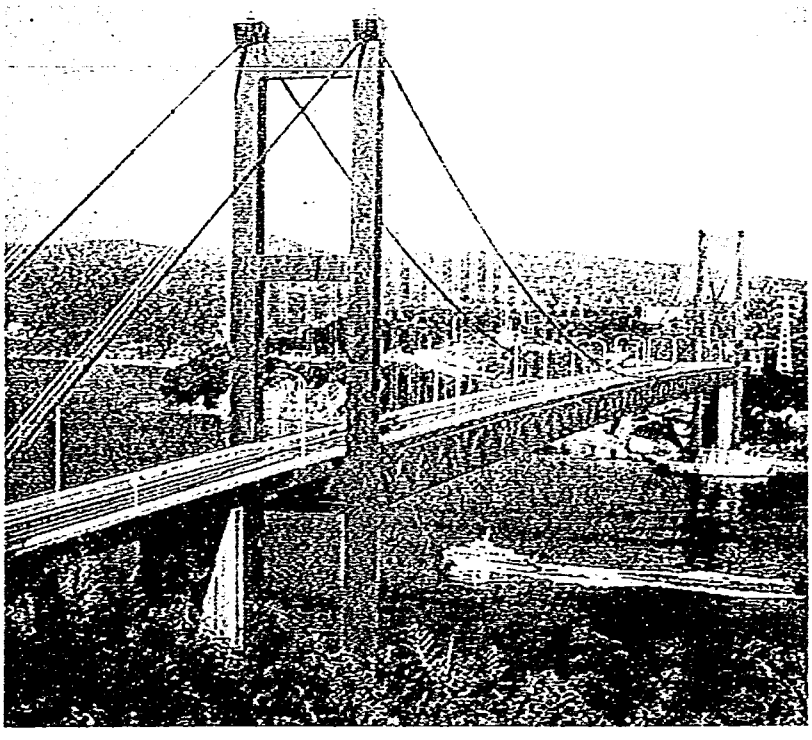


図－6　霊台橋（熊本県）

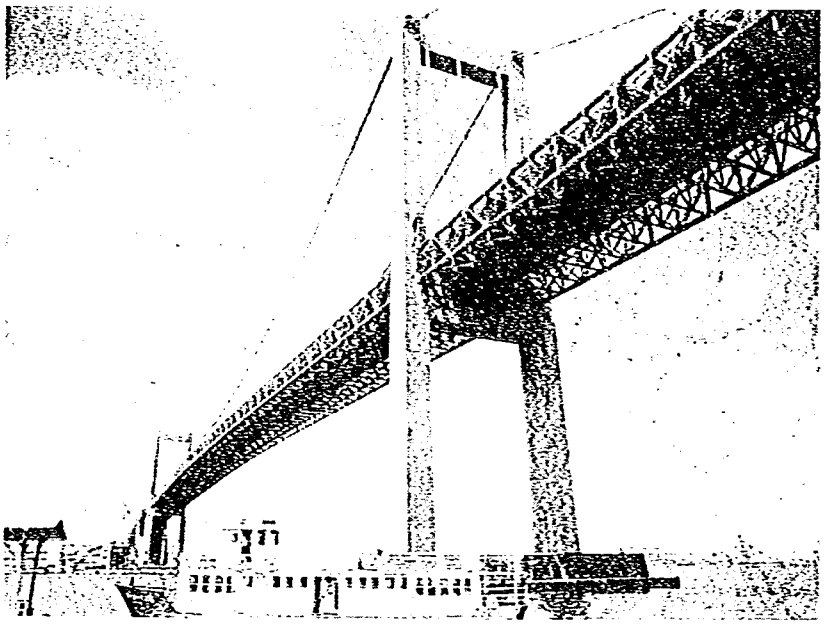


図－７　近代橋梁技術

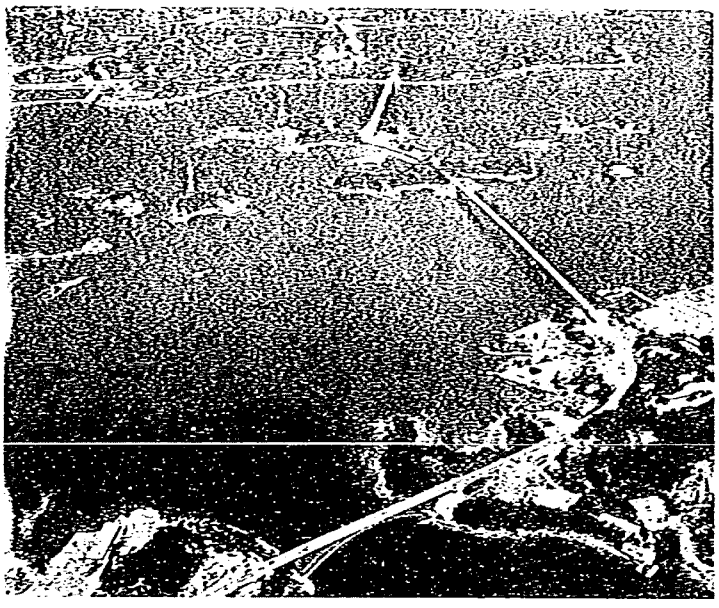




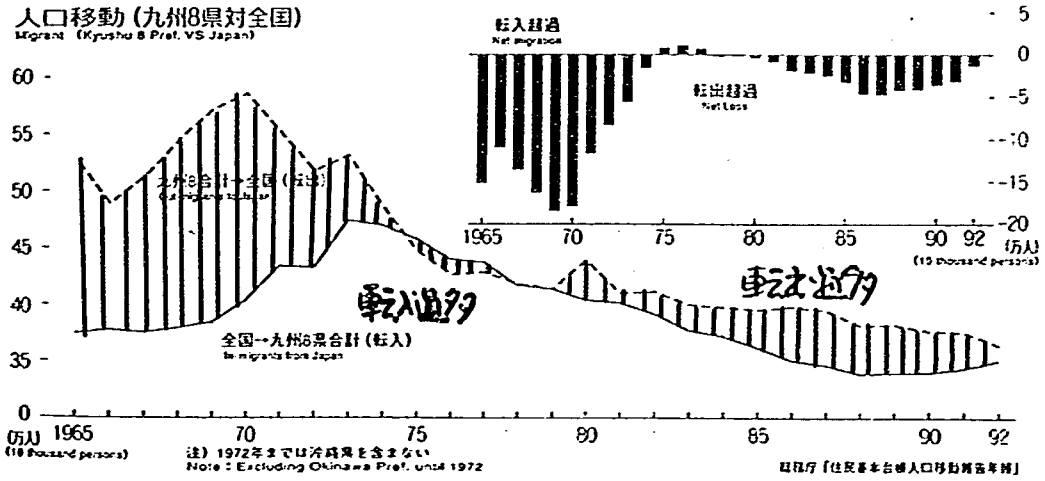
図－８　離島に架かる橋梁の位置、平戸大橋（福岡県）



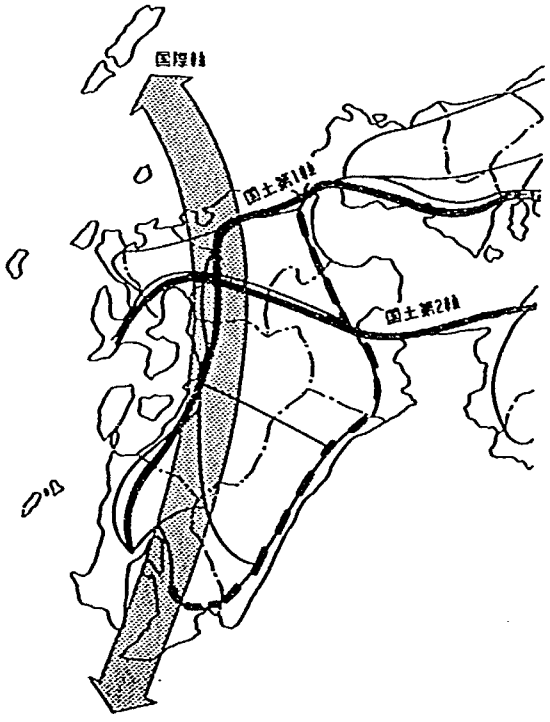
図－9　若戸大橋（福岡県）



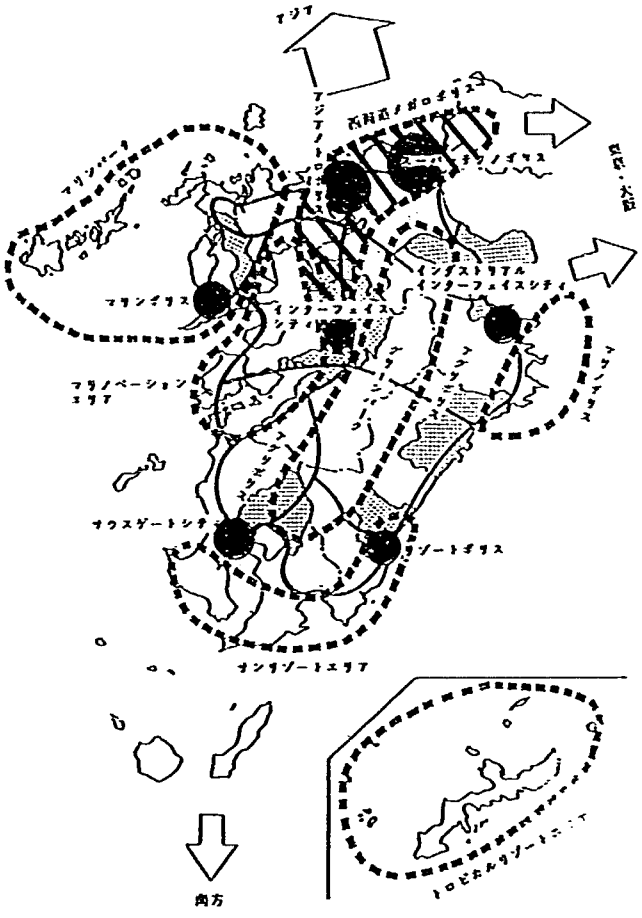
図－10　天草五橋（熊本県）



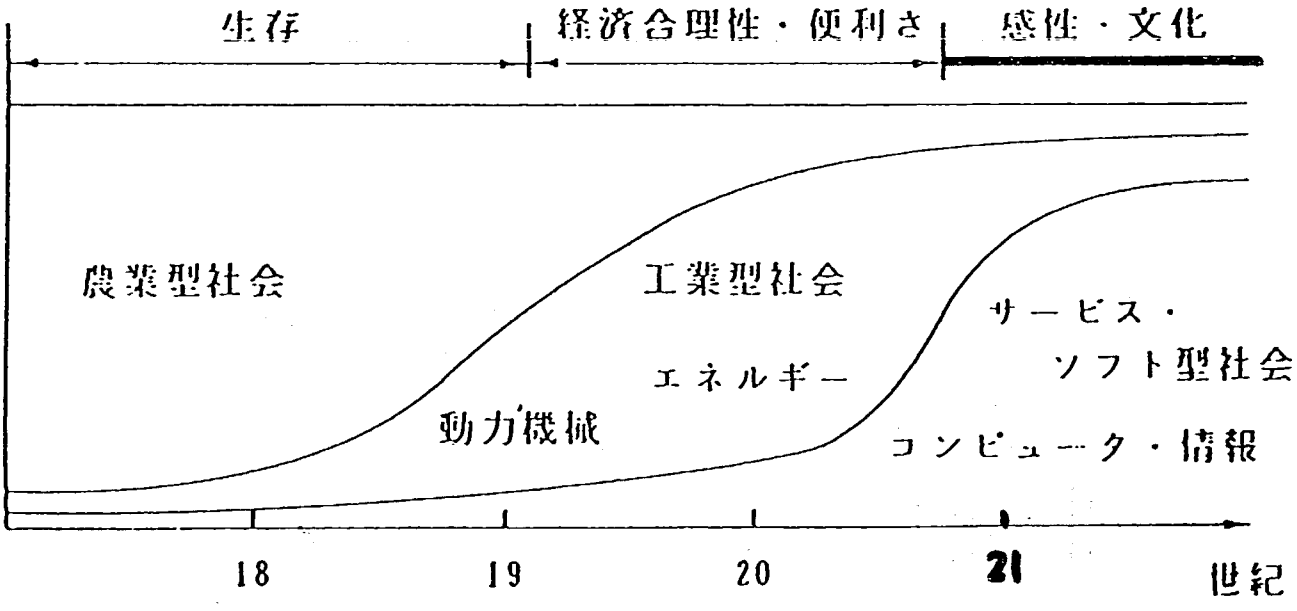
図－11　人口移動（九州８県対全国）



図－12　九州の軸構成



図－13　九州の地域展開



図－14　社会の体質変化

2．パネルディスカッション
「より良い生活環境の創造―地域開発・防災・環境―」

コーディネーター

建設省土木研究所長	住　吉　幸　彦

パネリスト

建設省九州地方建設局長	荒　牧　英　城
中国科学院成都山地災害及び環境研究所長	呉　　積　善 Wu Jishan
インドネシア公共事業省研究開発庁次長	Soedarmanto Darmonegoro
韓国建設技術研究院企画調整室長	金　　亘　煥 Kim Keung Hwan
マレイシア農業省灌漑排水局河川部長	Teh Siew Keat
フィリピン公共事業道路省研究基準局長	Jose H. Espiritu
シンガポール国家開発省公共事業局土木技術担当課長	Khor Poh Hwa
タイ内務省公共事業局材料研究部長	Anusornant Mahavinichaimontri

パネルディスカッション

「より良い生活環境の創造―地域開発、防災、環境」



コーディネーター
建設省土木研究所長　住吉 幸彦

（コーディネーター）
ただ今よりパネルディスカッションに入りたいと思います。私はパネルディスカッションのコーディネーターを務めさせていただきます建設省土木研究所長の住吉でございます。よろしくお願いいたします。

パネルディスカッションに入ります前に、８名のパネリストのご紹介をさせて頂きます。こちらから、建設省九州地方建設局の荒牧英城局長、中国科学院成都山地災害及び環境研究所の呉積善(Wu Jishan)所長、インドネシア公共事業省研究開発庁のSoedarmanto Darmonegoro次長、韓国建設技術研究院の金亘煥(Kim Keung Hwan)企画調整室長、マレーシア農業省灌漑排水局のTeh Siew Keat河川部長、フィリピン公共事業道路省研究基準局のJose H. Espiritu局長、シンガポール国家開発省公共事業局のKhor Poh Hwa土木技術担当課長、タイ内務省公共事業局のAnusornant Mahavinichaimontri材料研究部長でございます。

さて、先ほどの樗木先生の基調講演にありましたように、この九州地方は古代国家の時代から現代に至るまでの文化的発展、社会基盤に関する技術の発展につきまして、アジア地域との国際交流が大きな影響を与えたわけでございます。その形成の過程とこれから地域開発、地域振興を行うにあたりましては社会基盤の整備が非常に重要であるということ、そしてそれらを支える土木技術の開発が重要な役割を果すことが明らかにされました。また、九州の今後の発展の方向や土木技術の方向につきましては、多様な価値観に対応するような土木技術の発展、あるいは環境を創造するような土木技術が今後益々の発展が期待されるとのことでございました。おそらく本日のパネルディスカッションにおきましても、わが国あるいはアジア各国で取り組まれておりますそのような課題について色々御議論がいただけるのではないかと思います。

わが国におきましても、道路、橋梁、河川、ダム、砂防、下水道、都市、住宅基盤等の地域開発、防災、環境改善に資する事業は、国民のより良い生活環境の創出を目的として行なわれているものであります。これから、これらに関する各国の代表的な事業やプロジェクトについて御紹介いただきたいと思います。まず最初にそのような各国における生活環境の改善に関する相互理解を深めまして、今後の社会資本整備の方向を探ることとしたいと思います。

進め方として、各パネリストによる各国の生活環境改善のためのプロジェクトや計画について例をあげて６分ずつ最初に御紹介いただきたいと思います。その後、質疑応答を行いまして、さらに、各国におきまして、国の方針として力を注いでいる生活環境改善のための社会基盤整備の今後の考え方、方針、施策あるいはそれらを支える土木技術開発の方向につきまして各パネリストのコメントを３分ずつお願いしたいと思います。

それでは、まず日本の荒牧局長より「九州地方における社会資本整備」について御発表をお願いします。

（発言要旨は、44ページ以降を参照）

1)日本	「九州地方における社会資本整備」
2)中国	「総合的土石流制御対策」
3)インドネシア	「水質保全対策」
4)韓国	「韓国の主要河川の洪水確率分析」
5)マレーシア	「クラング川清浄10ヶ年計画」
6)フィリピン	「南ルソン高速道路計画」
7)シンガポール	「シンガポール地下道路システム」
8)タイ	「都市大気汚染対策」

（コーディネーター）

各国の御発表をコーディネーターとして簡単に取りまとめてみますと、

日本からは、九州地方の社会資本整備に関して、特に台風による大雨や風あるいは噴火等による自然災害とそれに対する対策の問題、高速道路の建設の重要性についての紹介がありました。

中国からは、総合的土石流防御工事に関して、ナンピン市において1980年以前は、土石流がしばしば発生し被害をもたらしていたが、その後土石流防御のための様々な工事を行うことにより、土石流による被害を防止できていることと将来の課題についての発表がありました。

インドネシアからは、水質保全対策に関して、産業排水や家庭排水によってひどく汚染されているシタラム川における、特に上流地域における一体的な下水収集処理システムの導入計画、パイロットプラントの概要及びこのシステムがうまくゆけば他の河川にも適用できるとの発表がありました。

韓国からは、主要河川の洪水確率分析に関して、地域的な河川の洪水頻度の予測をより正確に行うための新しい手法についての発表がありました。

マレーシアからは、クラング川清浄10ヶ年計画に関して、水質の悪化したクラング川をきれいにするために、ハードな対策よりは日本でも問題となっているソフトな対策を組み立てて10ヶ年計画で水質浄化を図りたいとの発表がありました。

フィリピンからは、南ルソン高速道路計画に関して、現在の環境問題への取り組み、最先端の情報を取り入れながら地域に合う環境問題をより配慮した高速道路計画についての発表がありました。

シンガポールからは、シンガポー地下道路システムに関して、自然環境や歴史的建物等への影響を極力抑え、狭い地域で400万人の人口を居住させるための交通計画の一つの要である地下道路計画についての発表がありました。

タイからは、都市大気汚染対策に関して、産業活動の発展に伴い悪化の一途をたどっている都市地域における大気汚染対策、これは第三世界に共通する汚染の問題であり、その取り組みについての発表がありました。また、わが国でもやっているような総合的な法律の改正も含めた対策が必要であるとのことでした。

各国の発表を聞いて参りますと、日本の発表の災害と高速道路の話を２件と数えますと、環境問題が３件、うち河川環境が２件、道路環境が１件。災害問題が３件、火山土石流、洪水確率等。道路問題が３件。たまたまこのような割合になったのは、現在日本を含めるアジア地域における社会資本整備上の課題、社会の動向を示しているものと思われ、興味深いものがあります。河川の汚染、下水道の未整備のような日本においても過去、現在も悩んでおり、研究開発を進めたり、政策あるいは法律を作り取り組んで改善してきた例もあります。土石流のような特に中国では大変な取り組みをやっておられますが、様々な技術の積み重ねを行い、対策を行っていますが、自然を相手にする気の長いものであり今後とも研究開発が必要となっている

ものもあります。また、大気汚染対策のように今まさにアジアや南米等の多くの都市、あるいは先進国の都市でも困っている問題で、今後とも取り組んでいかなければならない課題もあります。日本やフィリピンの高速道路の整備やシンガポールの地下道路システムのように国民生活の利便の向上や地域開発のために積極的に進めて行かなければならない課題についても紹介がありました。これらの諸問題について、アジア各国で取り組んでいる課題、技術開発、研究の進捗について情報交換は非常に有効なことと思います。

ここで、パネリストの方々の御質問、補足、あるいは他国の意見を聞きたいことがございましたら御伺いしたいと思います。

(パネリストのコメント)

・インドネシア：Mr. Soedarmanto

各国は貴重な経験を持っており、皆の問題は私の問題であり、詳細な情報を得たいと思っている。そこで情報交換システムを提案したい。アジア各国間で情報の交換、使用ができれば各国が悩んでいることへの取り組みに役立つと思う。

・韓国：Dr. Kim

各国は災害に苦しみ、災害対策を行い、インフラ整備により生活向上を図っている。持続可能な開発、発展のためには環境への配慮が必要であり、日本の経験、事例は良い参考になる。マレーシアの河川浄化10ヶ年計画は河川環境の美化を図る意味で有意義である。韓国では住民に親しみやすい河川づくりを行おうとしているが、着手できたのは全体の8%である。開発を行わなくてはならないものの環境への配慮を忘れないでいたいと思う。

・日本：住吉所長

インドネシアからの提案は第２回アジア地域土木研究所長等会議で議論され、今後研究開発情報のシステムづくりについて議論していくことなっております。

(コーディネーター)

さて、次に、各国において国家的観点から現在取り組んでいる社会基盤整備上の考え方、政策の重点や将来をどのような方向へ持っていくのかという点について各パネリストから３分程度の御発言を頂きたいと思います。

先ほどと同じように、日本の荒牧局長から順番にお願いいたします。

(発表要旨は44ページ以降参照)

1)日本	建設省九州地方建設局長	荒牧　英城
2)中国	科学院成都山地災害及び環境研究所長	呉　積善(Wu Jishan)
3)インドネシア	公共事業省研究開発庁次長	Soedarmanto Darmonegoro
4)韓国	建設技術研究院企画調整室長	金　亘　(Kim Keung Hwan)
5)マレーシア	農業省灌漑排水局河川部長	Teh Siew Keat
6)フィリピン	公共事業道路省研究基準局長	Jose H. Espiritu
7)シンガポール	国家開発省公共事業局土木技術担当課長	Khor Poh Hwa
8)タイ	内務省公共事業局材料研究部長	Anusornant Mahavinichaimontri

(コーディネーター)

各国で取り組んでいる社会資本整備の今後の方針をお聞きしましたが、期せずして環境問題に焦点が当てられています。環境と社会資本整備と言った場合に、１つには汚染等の悪い環境

を積極的に改善していくもの、もう１つには持続可能な発展のための社会資本整備を行う上で現在の環境を悪くしないことがあると思います。環境といっても大きく分けて２つの側面があると思います。国として基準、政策を作り、規制を行う上で、シンガポールや日本のように技術開発の裏打ちがないとそのようなものは進まないと思います。日本は約120年かけて現在のような状況になりましたが、後になって手を打ったものもあります。アジア諸国は30-40年の短い間で同様の状況を経験しようとしています。その時期に環境問題に対し、日本としては後追いとなったことを事前にアジアの国では予測しながら行っていることは心強いと思います。

それでは、会場の方やパネリストからのコメントを受けたいと思います。

（質疑応答）

・フィリピン：Mr. Espiritu

日本、アジア諸国の位置を考えると、より良い環境づくりをともに目指しているが、日本はハイテク技術が導入されている国ではあるが、単独の国ではありません。日本は技術移転という部分においてアジア諸国への手をさしのべる時期がきている。また、ベスト技術を社会基盤整備の分野で導入していく必要がある。過去10年のフィリピンの歴史を振り返ってみると、皆さんの経験を分かち合ってもらい、我々は非常に効率のよい社会基盤整備ができたのです。例えば災害分野においても火山爆発や震災への対策についてノウハウを教わりました。同様に、持続可能な開発に関するノウハについて伝授してもらいたい。つまり他の国が追従して成功して初めて日本も諸手を挙げて成功したと言える。日本だけが成功することは本当の成功とは言えない。本当の先進国とは言えない。日本はアジアのリーダーとして技術をアジア諸国に移転してもらいたい。そのことによりアジア全体の環境改善、持続可能な開発との環境の両立ができると思う。

・日本：荒牧局長

北九州市は七色の煙を誇りにしていた時があった。今はきれいな空を取り戻している。同じような状況が四日市にもある。日本では工場における大気汚染対策について、中国をはじめ色々な国と技術協力をしながら取り組んでいる。環境への取り組みは国レベル、市レベル、個人レベルでの協力が可能とになってくると思う。

・日本：菊池遠賀川所長

インドネシアではアセスメント要綱の中で、住民の意見をどのように取り込んでいるのか。その中で工事がストップすることがるのでしょうか。

・インドネシア：Mr. Soedarmanto

インドネシアでは、政府は土地利用について産業や住居の区画を決めているが、直接住民の意見を取り込むシステムはない。私の地域にある研究所の建設の際に直接住民に意見を聞いたことはある。これからは、よりよい環境づくりが重要であり、文化、習慣に由来する河川汚濁の問題があるが、国民全体として環境への理解を高めるために様々な計画を実施していきたい。

・フロアー：

環境問題について重要な点を指摘したい。これらを環境問題を考える上で考慮してもらいたい。開発に伴い大気汚染、水質汚濁、騒音等の環境破壊が生じる。経済発展には開発は不可欠であるが、自然資源と開発と環境のバランスが特に必要である。

・コーディネーター：住吉所長

自然資源と開発と環境のバランスをいかにとるかというためにこのような会議を行い、努力を払ってきているが、それらは社会資本整備に携わるの者のこれからの課題でもある。

（コーディネーター）

時間も参りましたので、この辺でまとめに入らせていただきたいと思います。本日は８名のパネリストの方々から最初に現在取り組んでいるプロジェクトの紹介、インフラ整備上の今後

の方向、施策について発表していただきました。

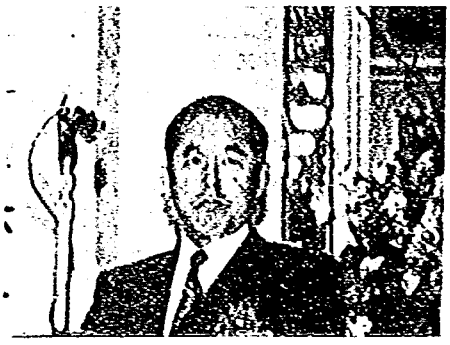
下水道のような我々の身の回りの環境から、道路や流域開発のような地域の開発、環境を扱う問題、そして大気汚染のような広域的な環境問題に対し、アジア各国が、各国の自然条件、経済・社会条件にあった対策をしています。本日は特に環境問題がクローズアップされました。今後社会資本整備を進めるにあたっては、各国で新しく開発された土木技術や研究の成果をアジア地域全体における共通の知的ストックとして、各国の土木技術の向上のために有効に活用できれば、非常に有意義であると思います。そのためには、情報のネットワーク、人のネットワーク作りが大切であり、それらを充実させていく必要があります。このシンポジウムもそうした活動の一環として行っており、このような機会を通じて皆様方の知的交流を図っていただければ幸いと思います。

フィリピンのエスピリツさんより、さらに一層の日本の技術の移転及びそれらをアジア全体のものとして欲しいとの発言がありました。皆様の胸の内で反すうしていただきたい。アジア各国はモザイク模様で彩られ、慣習、制度、文化的にも異なっており、そのような多様性を感じとっていただけたと思います。しかし、今日御紹介いただいた共通のプロジェクトや今後の方針については共通問題として認識されたものと思います。

アジア各国における国の発展に不可欠なインフラストラクチュアの整備上の多様な課題について認識いただいたとともに、各国とも一生懸命取り組んでおり、そのための技術開発の研究が大切あることがお分かりいただけたと思います。また、皆様にはアジアにおける課題が身近なものとなったことと思います。

最後に、この第２回の「アジアにおける国土開発と土木技術のシンポジウム」が盛会に終えることができましたのは、九州地建、福岡県、福岡市、土木学会西部支部の皆様の御尽力のお陰げであり、そのご苦労に感謝するとともに、非常に御熱心聞いていただきました皆様方に感謝いたしまして、パネルディスカッションを終了させていただきます。どうもありがとうございました。

「九州地方における社会資本整備」



建設省九州地方建設局長　荒牧　英城

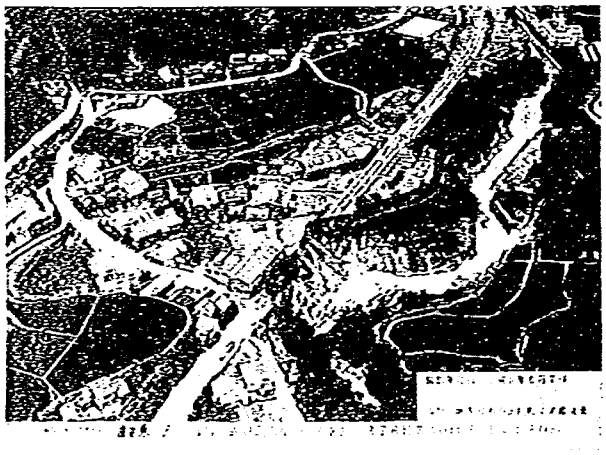
Ⅰ．プロジェクトの概要

九州は、海を隔てて東アジア大陸から分離して位置しており、歴史的にも中国および韓国と直接交流を行ってきた。1854年まで長崎は、250年間海外のオランダと中国に開かれた唯一の港でした。九州は、日本経済の約10%を分担していると言われており、面積と人口は日本の約12%を占めています。一方、国内総生産、年間の小売販売高、あるいは地方公共予算は、国全体の９～12%を占めています。しかし、九州のいくつかの産業は、国家的な生産の重要部分であり10%以上を供給しており、造船で38%、鉄鋼で31%等となっている。これを他国と比較すると、九州はオーストラリアやオランダとほぼ同等の経済力を有している。九州は豊かな自然美という財産を有しており、それはリゾート地域へ年々増加する観光客を魅了している。九州には活火山と温泉からなる３つの国立公園がある。一方、地質、気候、そして他の自然条件は、九州に大きな自然災害を引き起こしている。この地域には、季節的な長雨や台風だけでなく頻繁に火山災害をも含むたいへん厳しい自然条件がある。

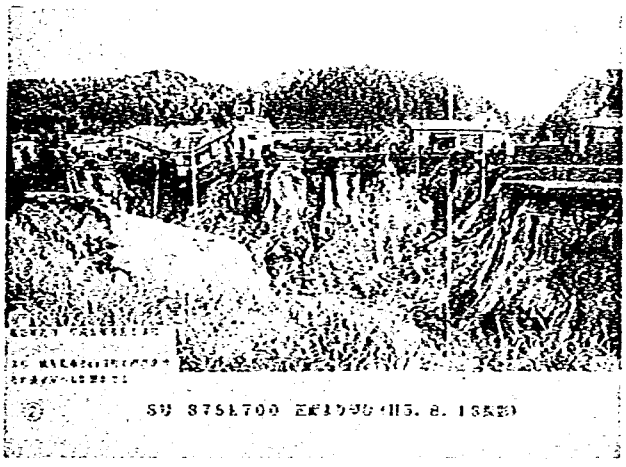


図－１　ランドサットより見る九州

去る８月、九州最南の鹿児島県は豪雨に見舞われ、住宅や社会資本に多大な被害がもたらせれた。スライドは、国道３号沿いのコツキ川の洪水による国道の被害区間を示しています。この被害の大きさは70mの長さと26mの高さに及んだ。これを「鹿児島のグランドキャニオン」と呼んでいる。

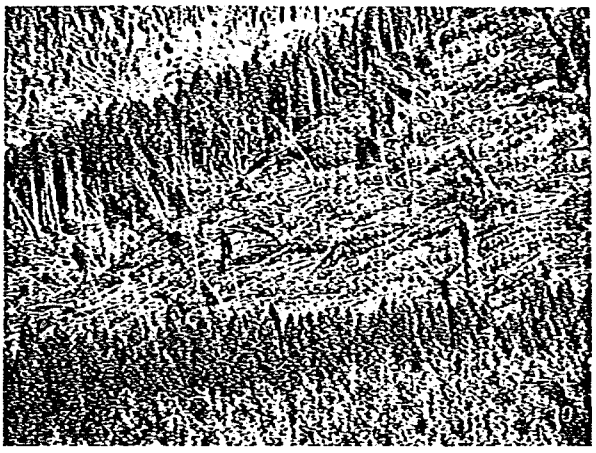


図－２　鹿児島豪雨（平成５年８月）

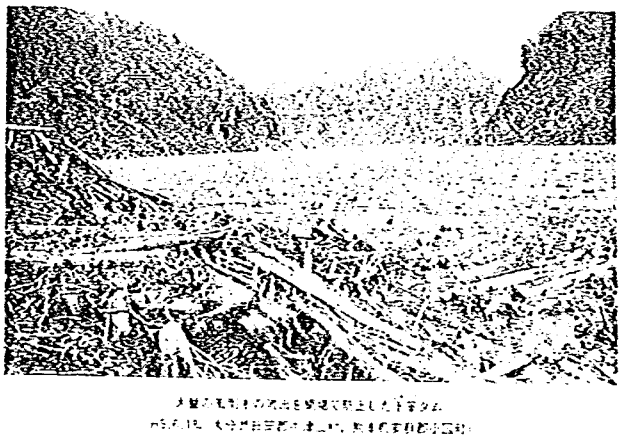


図－３　鹿児島豪雨（平成５年８月）

1991年に台風による風倒木は、その夏の集中的な洪水を引き起こした。それらは、全てダム湖において一掃された。

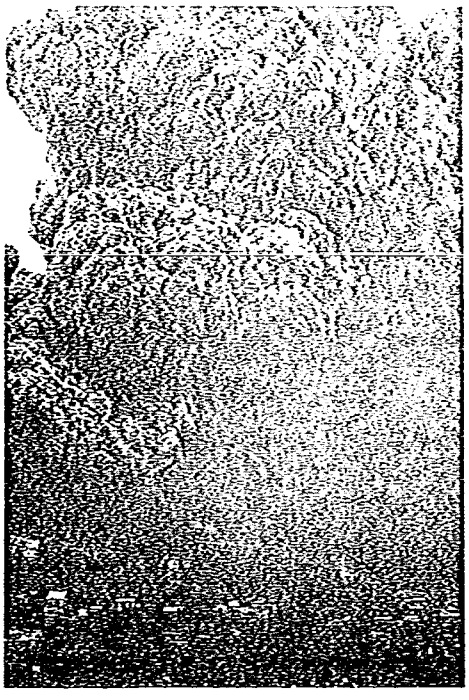


図－4　風倒木災害（平成３年９月）

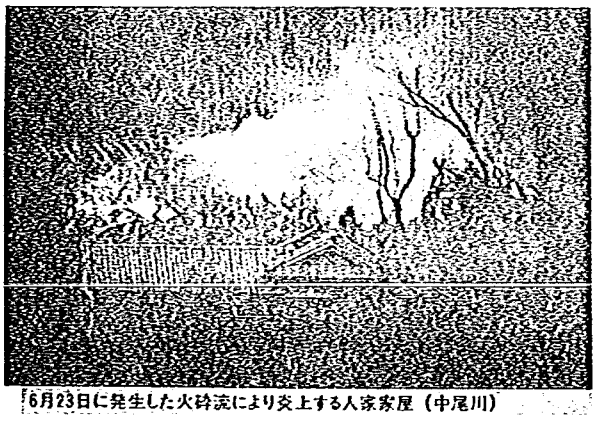


図－5　風倒木流出災害（平成５年６月）

普賢岳は雲仙国立公園の主要な山であり、200年前の最後の噴火後、1910年に活動的になった。それから、土石流と火砕流の源になった。熱ガスを伴うことから、約3600人が土地・住居から避難せざるをえなかった。



図－6　雲仙噴火による火砕流



6月23日に発生した火砕流により炎上する人家家屋（中尾川）

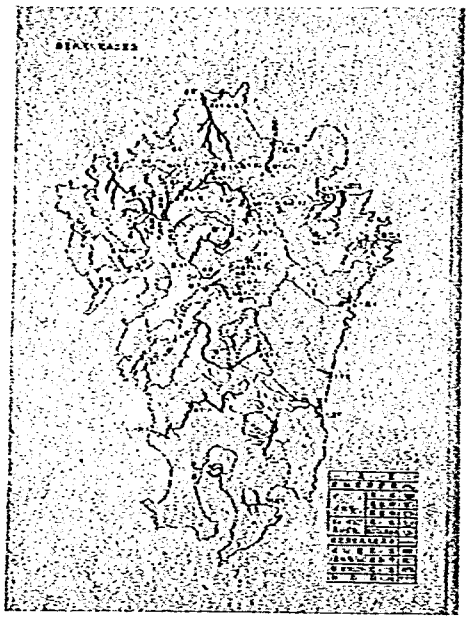
図－7　火砕流による災害（平成５年６月）



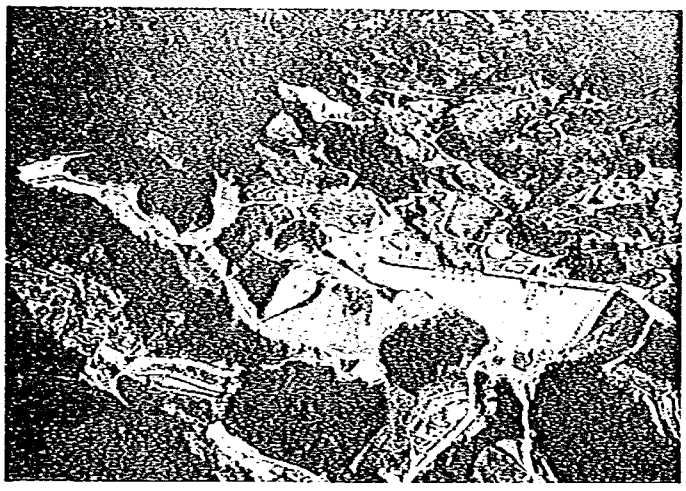
図－8　雲仙水無川周辺（平成５年）

九州地方建設局は、建設省の８地方建設局の１つであり、水管理、洪水防御、道路、公園、建築等の事業を実施している。

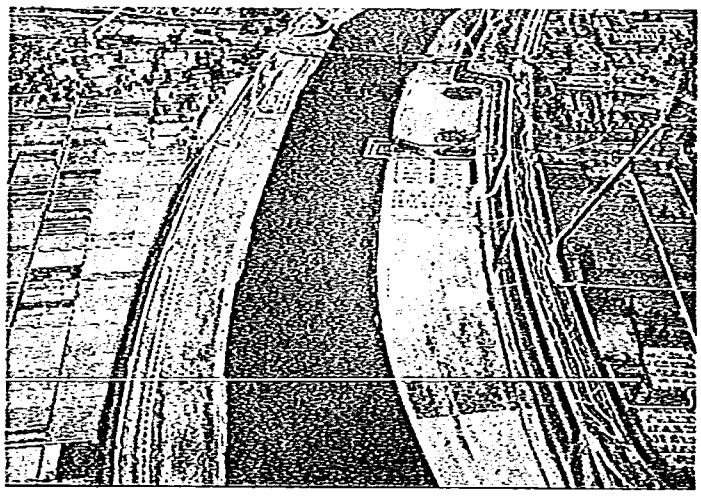
水管理と洪水防御としては、筑後川をはじめ２０の主要河川のダムや流路変更、維持等の洪水防御施設の機能的改善に取り組んでいる。



図－９　九州地方の河川位置図

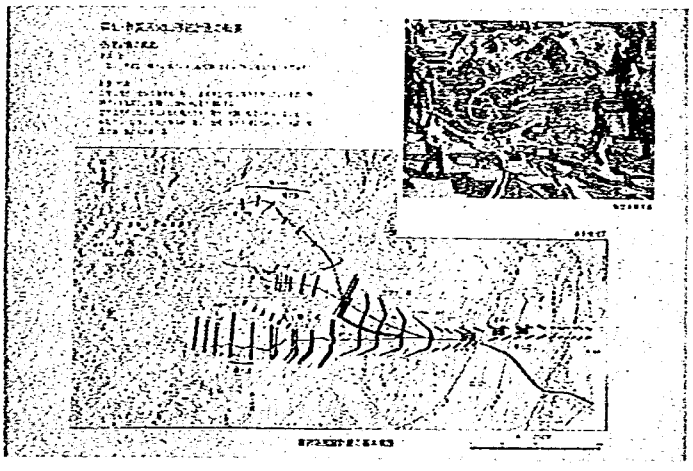


図－10　竜門ダム建設事業



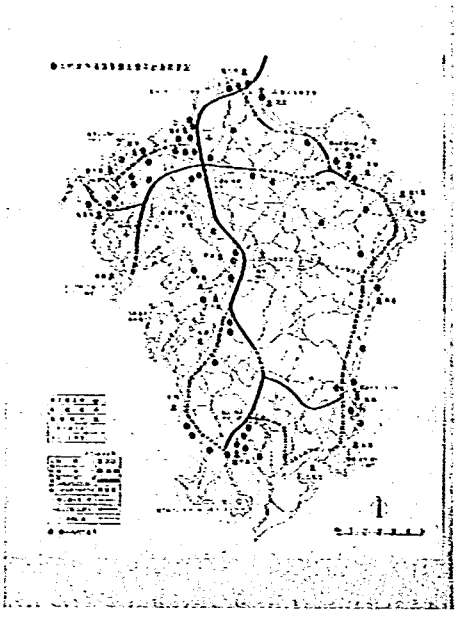
図－11　筑後川（久留米市：大規模引堤箇所）

火山活動地域における土石流災害を防ぐために、砂防ダムや導流堤、道砂地等の砂防事業を実施している。

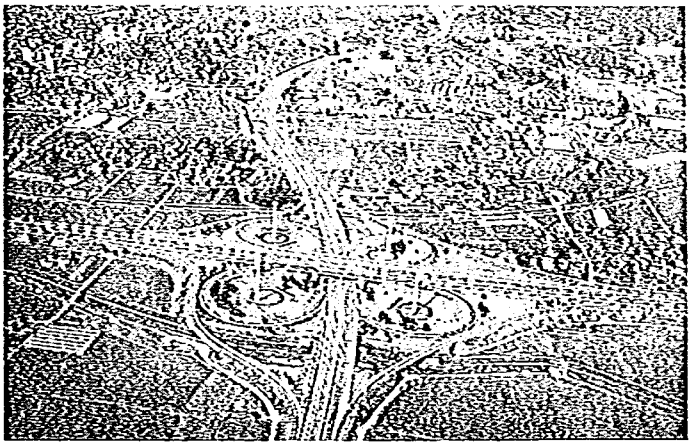


図－12　雲仙・普賢岳火山砂防計画

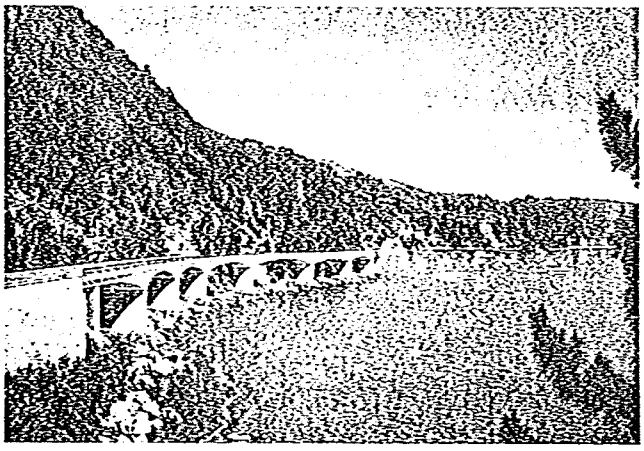
近代道路システムは、九州において高速輸送ネットワークづくりに貢献している。今や、九州の総高速自動車道計画1500kmのネットワークのうち、680kmの供用と340kmが建設中である。また、九州地方建設局は、交通渋滞の緩和や安全な交通の確保のために2000kmの幹線国道の整備、維持を担当している。



図－13　九州地方道路整備五箇年計画

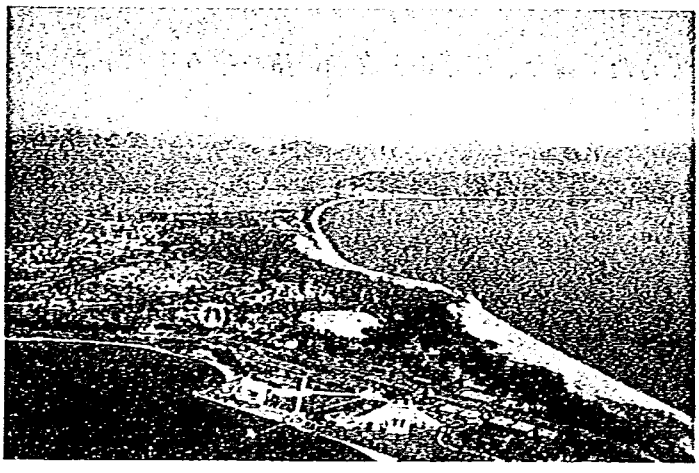


図－14　九州縦貫自動車道鳥栖ジャンクション

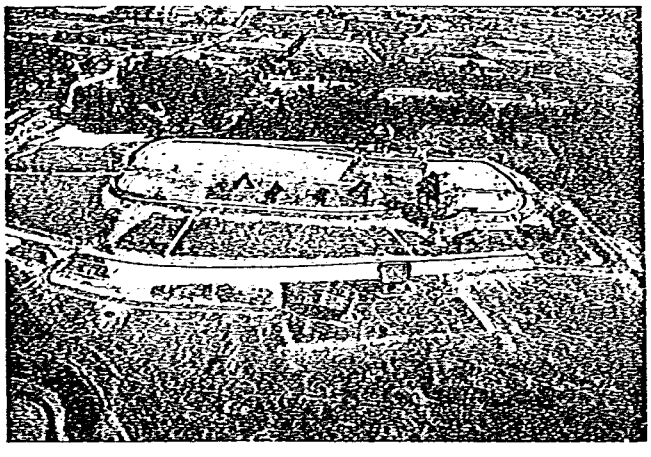


図－15　国道20号　早崎防災事業箇所（鹿児島市垂水市）

先ほど述べた自然美を形成している国立公園に加えて、建設省は海の中道海浜公園のような大規模な都市公園の開発を担当している。また、私どもは佐賀県の協力を得て、別タイプの公園となる歴史公園の開発に着手したばかりである。この公園整備の概念は、この地域が1世紀～3世紀におよび日本の古代国家の源であったという見識に基づいている。



図－16　海の中道海浜公園



図－17　吉野ヶ里歴史公園

「総合的土石流制御対策」



中国科学院成都山地災害及び環境研究所長
呉　積善　Wu Jishan

Ⅰ．プロジェクトの概要

1.目　的

土石流発生をコントロールし、土石流から南平市及び高速道路を守るための包括的対策を策定することがすでに採択されている。

2.概　要

南平市の後背地山岳部には流域面積2.62㎢にわたって土石流を引き起こす5ヵ所の小峡谷がある。植生がすべて枯渇してしまっているため、これらの峡谷ではしばしば土石流が発生し、1950年から1980年にかけてたびたび市街に被害を及ぼしている。

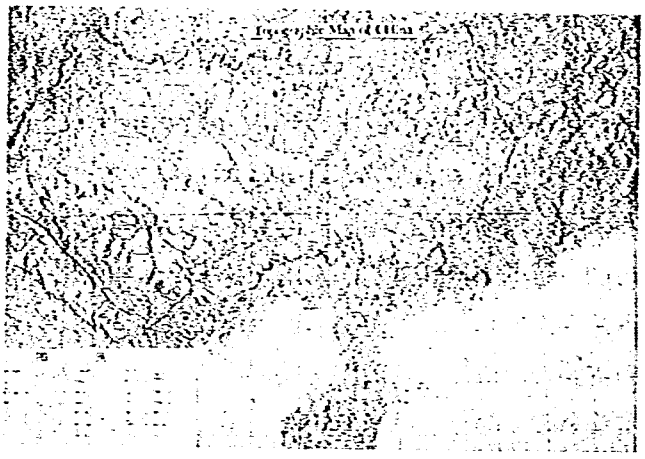
土石流調節事業は1980年からスタートし、1983年に終了した。このプロジェクトには次のような事業が含まれている。すなわち、1)135haにわたって播種および植樹を行う、2)山麓部に1ヵ所擁壁を設け、斜面を安定させるために53ヵ所のチェックダムを設ける、3)斜面末端部に4ヵ所の土石流溜まりを設けて土石流を受けるようにする、4)峡谷下流部に延長750mの河道（チャンネルワーク）を設けて洪水を吐く、5)特に市街を深刻に脅かしているシュイクゥン峡谷の出口においては土石流警報システムを確立する。

3.技術的課題

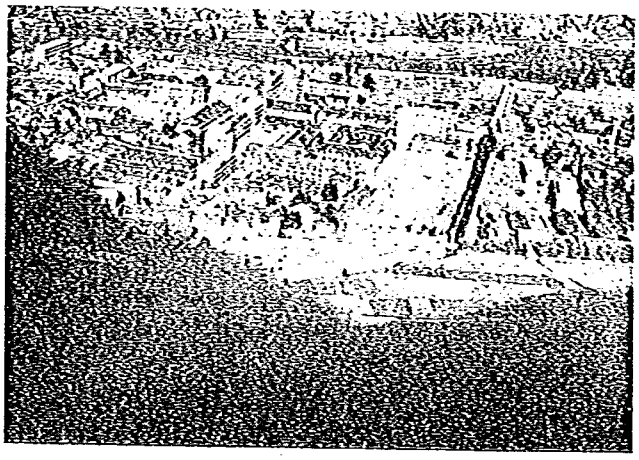
調節工事は総じて成功裏に終了したということができる。しかしながら、工事の技術的な部分に若干の手法的問題があった。すなわち、1)チェックダムの基部および河床工に土石流及び洪水による洗掘が起こったこと、2)斜面が不安定でかつダムサイトの地滑りが活発であったのに対してチェックダムの基礎が弱すぎたこと。

4.生活環境改善へ期待される効果

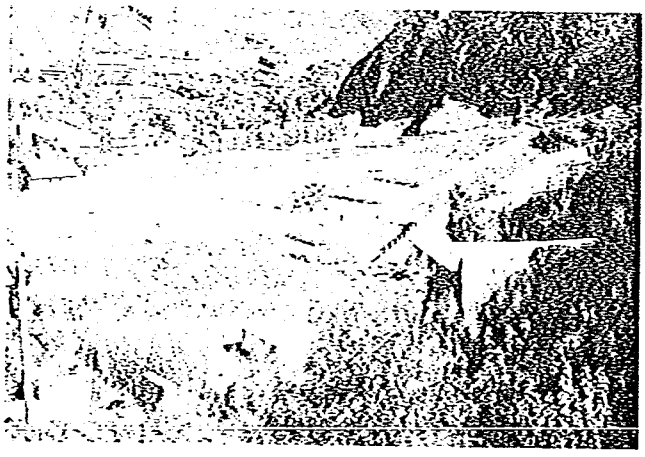
1983年以来、土石流はほとんどコントロールしてきた。また、南平市と高速道路をそうした土石流災害から守ることができた。



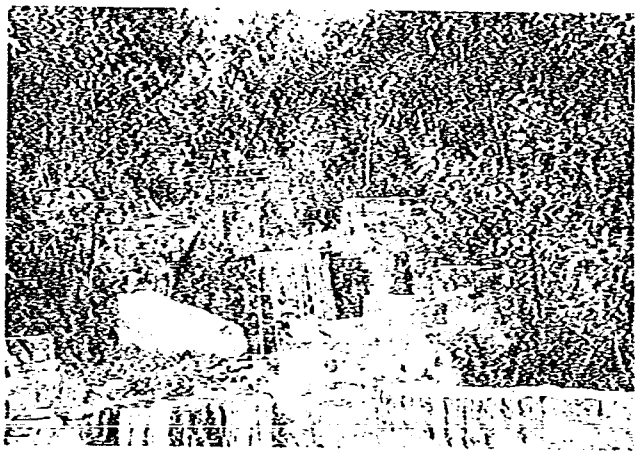
図－1



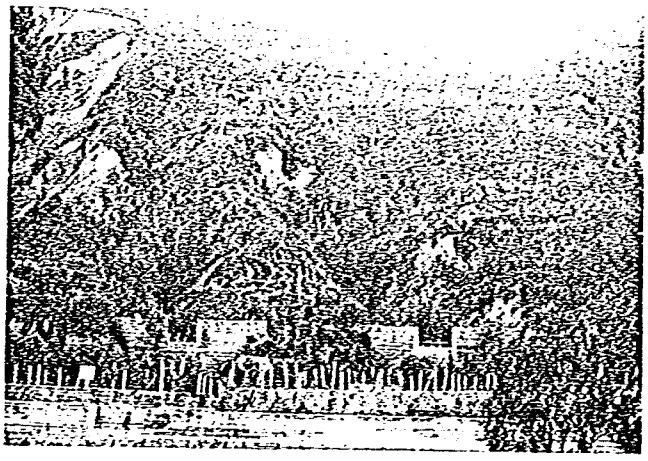
図－2



図－3



図－4

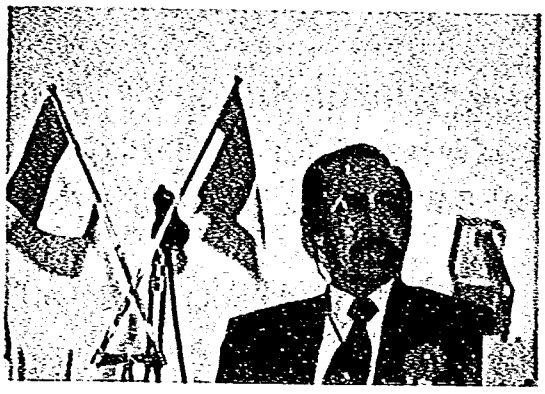


図－5

Ⅱ．現在、国策として特に力を注いでいる生活環境改善のための社会基盤整備（考え方、方針等）、それらを支える土木技術開発

広い流域における天然資源活用と環境保護との問題を組み合わせたもっとも格好なプロジェクトはズージアン（珠江）川流域の包括開発計画であろう。珠江川は中国南部ではもっとも大きい河川であり、中国領域内だけで442,000km²の流域面積を有する。珠江川河口部は中国でももっとも開発の進んだ地域のひとつである。この包括開発計画には洪水防御、舟運開発計画、かんがい、水供給、発電、水源・土壌保護、水質保全、河口部修復等各種の内容を含んでおり、主計画の継続が提議されている。グアンズー（広州）市、ナンニン（南寧）市その他の重要都市及び流域内の主要河道における洪水防御について、この計画は洪水防御基準を設けようとするものであり、洪水対策を提案し、また一連の水源保護プロジェクトを選定するものである。本計画は1993年５月23日、中国議会でも評価されており、将来この流域の天然資源の活用、環境保護、洪水防御の基礎をなすものである。

「水質保全対策」



インドネシア公共事業省研究開発庁次長
Soedarmanto Darmonegoro

Ⅰ．生活環境改善プロジェクトの概要

はじめに

インドネシアの産業は、過去20年間において着実な成長を見せてきた。国内の主要都市の中でも、Java島のJakarta、Surabaya、Bandung、Semarangなどで、工業地域が急速に発展しつつある。その結果、これらの都市の主要な川の汚染が深刻化してきた。

産業排水問題の調査の結果、現在Javaの主要な川に見られる汚染状況を軽減するためには、産業排水の放出に対する規制を強化する必要性が急迫していることが判明した。

調査によると、1991年から2000年までの10年間に、Javaの汚染の要因となっているおよそ 9,473件の工場に排水処理施設を建設するためには、合計222億8200万ドルの投資が必要とされる。

この投資総額のうち、13億8400万ドルは、7579件の工場を対象とするおよそ22の集中排水回収処理計画（CWCTS）の建設に、また1億9800万ドルは、CWCTSに含まれない工場を対象としたおよそ1894の工業排水回収処置計画（IWCTS）の設置のために必要な前処理施設の建設に用いられることになる。

1.目 的

（i）CWCTSの能力の試験および評価。

（ii）産業排水制御への投資のための優先プロジェクトの準備。

（iii）産業排水制御に関わる各機関の能力の強化。

2.概 要

Bandung近郊のCitarum川は、家庭排水と産業排水の両方に汚染されている。川の集水域の人口はおよそ500万人である。また、集水域のおよそ300件の工場のほとんどは排水処理設備を持たないため、川を汚染している可能性が高い。

Citarum川の汚染の影響は、大量の魚の死、あるいは生水や公共の地下水井戸の汚染などにも現われている。

このCitarum川が、飲料水、灌漑、漁業、水力発電、産業、レクリエーション、洗濯などの面で住民の要求を満たしていることを考慮すると、この汚染を制御するための何らかの処置が緊急に必要とされる。

South Bandungのおよそ80件の工場も、川の汚染に荷担している。その対策として、まず1982年に地方自治体は、水資源調査研究所に工場と協同した任務を命じた。ここでは、全ての工場からの排水は試験場に回収され、川への放出の前に処理が行なわれることになった。その後、工場側からの経済的援助のもとに、暗渠の建設が開始した。それと同時に、1985/1986年には公共事業省と国の住民環境対策局の援助のもとに、試験場の建設が開始された。

3.技術的課題

1982年以降に建設された暗渠の多くは随所が損傷しているため、質的な改良が必要である。ここでは、工場との協力体制が非常に重要とされた。

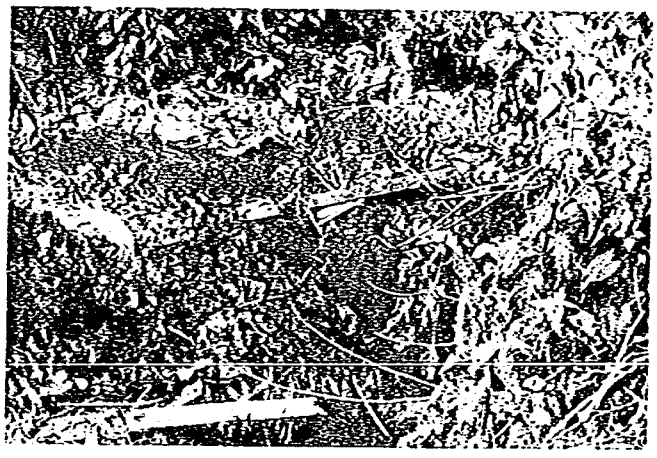
また、各工場からの排水状況の初期調査（1986）の結果、試験場には毎秒100リットルの処理能力が要求された。しかし、2度目の調査(1990) 結果に基づくデータによると、試験場には毎秒160リットルの処理能力が必要とされ、2000年には毎秒230リットルまで増加することが予測されたため、設計の変更が必要となった。

その他にも、工場側がどの程度の資金援助を行い、どの程度参加すべきかという問題があげられる。

4.生活環境改善へ期待される効果

このプロジェクトが1995年に実現した際には、これを模範とした試験場がインドネシアの他地域にも適用されることが予測される。

この地域システムは、費用も手頃であることから、現在全ての生物に大いに必要とされている、政府のクリーン・リバー・プログラムの実現に大いに貢献するものと思われる。



図－1



図－2



図－3

Ⅱ．現在、国策として特に力を注いでいる生活環境改善のための社会基盤整備（考え方、方針等）、それらを支える土木技術開発

1989年7月に、住民環境対策大臣はクリーン・リバー・プログラム（PROKASIH）という、すでにひどく汚染された川を浄化する目的の国家キャンペーンに着手した。まずこのプログラムでは、B3（Bahan Berbahaya Beracun－有害有毒物質）として知られている産業排水から川を守ることに的が絞られた。しかし、家庭排水、農業排水、風食の結果としての泥排水などは、このプログラムには含まれていない。

プログラムは、まずJavaで4地区、Sumateraで3地区、Kalimantanで1地区の計8地区で実行された。1991年9月にプロジェクトの評価が行なわれた後、1991/1992年には新たに11の地区がプロジェクトに含まれることが決定した。

政府は、環境影響解析（PP No. 29/1986）と水質汚濁制御（PP No.20/1990）に関して、2種類の規則を布告した。双方とも、インドネシアの産業の発展に伴って増加しつつある環境と汚染に関する問題を扱ったものであることは明らかだ。また、これらの規則を履行するために、政府は環境影響制御機関（BAPPEDAL）を設立し、Jakartaを含むインドネシアの各地域で環境影響解析（AMDAL）を実行した。

「韓国の主要河川の洪水確率分析」



韓国建設技術研究院企画調整室長
金　亘煥　Kim Keung Hwan

Ⅰ．生活環境改善プロジェクトの概要

1.目　的

韓国主要河川の地域的な洪水の頻度を分析し、その手法を確立すること。

2.概　要

(a) データを選別して地域的類似性を同定し、地域の代表的な頻度分布を示す一連の年最大洪水データから洪水の頻度分析の手法を確立する。

(b) 伝統的なモメント法によって変数を推定するこれまで用いられてきた分布から無作意に抽出されたサンプルは非対称分布からの乖離状況を示す。しかしながら、近年紹介されているL-モメント法を用いた「シック・テイルド（尾部の厚い）」分布からのランダムサンプルはそうした乖離状況を示さない。韓国の河川に対しては、このL-モメント法によって推定された一般的な最大値分布と変数による代表洪水法が、地域的な洪水頻度分析には適当であるよう思われる。

(c) およそ６千箇所／年の河川段階の日記録を解析に供することができる。流量測定が不十分なため、解析可能な流量記録に変換し得るのはその３分の１のみである。予備的な分析結果の示すところによれば、韓国の河川は地域的な洪水頻度分布の特性から３つのグループに分類することができるようである。 またその変位値は生起確率100年の場合でおよそ3.0、同50年の場合で2.5となった。

3.技術的課題

ある程度信頼し得る結果が得られたとはいえ、その結果を出す過程はきわめて困難をきわめた。旧来の方法と新しい方法とで推定したそれぞれの計画洪水における有意性のある相違を何とか特定しなければならないからである。

4.生活環境改善へ期待される効果

本プロジェクトの結果としてある程度信頼し得る計画洪水を推定することができたので、しっかりした水資源管理が可能となろう。地球的な規模での気候変動の激しい状況下においては、信頼し得る設計手法、特に基礎データとは一見関係なさそうにみえる周辺データによる設計手法の確立は予測しがたい気候環境を克服するための必要な手段のひとつになるだろう。

Ⅱ．現在、国策として特に力を注いでいる生活環境改善のための社会基盤整備（考え方、方針等）、それらを支える土木技術開発

■韓国における被害査定及び復興計画

全国災害防御・対策本部は各地域の行政当局を支援するために国家レヴェルの被害査定のガイドラインを毎年策定し、報告のあった被害推定が適正なものであるかどうかの評価を行うようにして

いる。災害が発生した場合、その地方の行政当局の担当者はこのガイドラインに従って総被害額を推定する。地方行政当局はその災害について犠牲者の軽重に応じた責任を負う。当該災害がきわめて深刻な被害を及ぼした場合、緊急救援活動の後、復興計画策定のために中央政府が現地調査を行う。

この現地調査団は関係省庁からの専門技術者からなり、被害額の最終査定を行い、それぞれの被災地の復興計画を策定する。調査終了後、定められた規定に従って復興計画実施に必要な資金が配分される。

OUTLINE OF THIS RESEARCH PROJECT

- Distribution Function with 3 or More Parameters
  - Conventional: EV1, 2, 3, LN2, 3, P3, LP3
  - This Project: GEV, Wakkeby, Pareto, GL
- Parameter Estimation
  - Conventional: Ordinary Moment Method, Max. Likelyhood Method
  - This Project: Probability Weighted Moment Method (Linear Moment)
- Frequency Analysis
  - Conventional: Point
  - This Project: Region

PRELIMINARY RESULTS

- Increase Reliability of Flood Estimation for a Site with Insufficient Length of Measured Records.

DISASTER DAMAGE ASSESSMENT AND REHABILITATION PLAN IN KOREA.

PRINCIPLE

- Restrict National Financial Aids at a Certain level.
  - Reduce National Financial Burden
  - Not to Weaken the Disaster Mitigation Efforts of the Local Governments and the Individuals

「クラング川清浄１０ヶ年計画」



マレーシア農業省灌漑排水局河川部長
Teh Siew Keat

Ⅰ．生活環境改善プロジェクトの概要

1.目　的

首都クアラ・ルンプールを貫流するクラン川の浄化に関する10年計画の目的は以下の通りである。

- クラン川及び主要支川の廃棄物及び泥土を除去する。
- クラン川及び主要支川の水質を最低、第Ⅲ級基準のレヴェルにまで改善する（水供給及び人体非接触型リクリエーションに利用の場合はより広範な処理を要する）。
- 特に都市／市街地内におけるリクリエーション施設を改善して水辺環境、特に景観の美化を図る。

2.概　要

確認されている汚染源の主なものは以下の通りである。

- 水辺の不法居住者 - およそ2,600家族が河川沿いに不法に居住しており、廃棄物投棄の場所として、また無蓋下水道として河川／流水を利用している。
- 土地の開発 - 人口の伸びに対応するための家屋の開発及び農業がクラン川に甚大な泥土を押し出す結果となっている。
- 非下水家屋 - 全流域のおよそ40%の家屋はいまだ下水手段を持っていない。そのためアンモニア化窒素分を河川にたれ流す結果となっている。
- 工場 - 工場群、特に不法工場群は油、化学的化合物残滓、有毒廃棄物等を河川にたれ流している元凶となっている。
- 畜産 - 11ヵ所の養豚農家がアンモニア化窒素分を河川にたれ流している。

環境を保全し、市街域住環境を改善しようとの要請と誓約に従って、政府は1992年クラン川浄化に関する10年計画に着手した。本計画の原案は当該河川の浄化、河道容量の向上を目的とした特定のサブ・プロジェクトのアクション・プランを基礎にしたものである。それはまたクラン川渓谷を当該河川流域の住民の新しいリクリエーション地域にすることを目指すものでもあった。計画は計８件のサブ・プロジェクトからなっており、それぞれは作業委員会の調整によって、互いに異なった機関によって実施されることなっている。以下に８件のサブ・プロジェクトを示す。

a)クラン川の浄化
b)泥土の除去
c)排泄汚物の除去
d)不法居住者の移転・再定住化
e)養豚廃棄物の処理

f)魚類生態系の復活

g)住民指導

h)水質管理

マレーシアでは河川はそれぞれの責任分野ごとに各種の国の省庁／機関によって責任の範囲に応じた注意が払われている。本計画の実施にあたっては、こうした各分野の省、部局、地方機関、及びセランゴール州政府の参加と同意を得たアクションプランを通じて、互いに協力し、統合的に、かつ整合性をもって行われることになる。

3.技術的課題

都市河川泥土除去に関わる維持管理作業にとって、保留河川の制約、機械工事には不十分な水面・橋床のクリアランス等は常に問題となっている。

4.生活環境改善へ期待される効果

2001年の計画終了時までにクラン川の河川環境は大きく改善され、以下のような効果が期待できる。

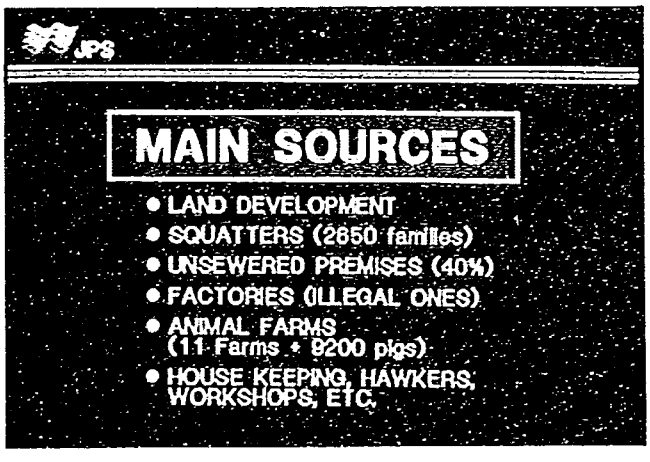
a)現在確認されている汚染源の主な部分は取り除かれることになろう。

b)河川の水質は第Ⅲ級基準のレヴェルにまで改善されるだろう。

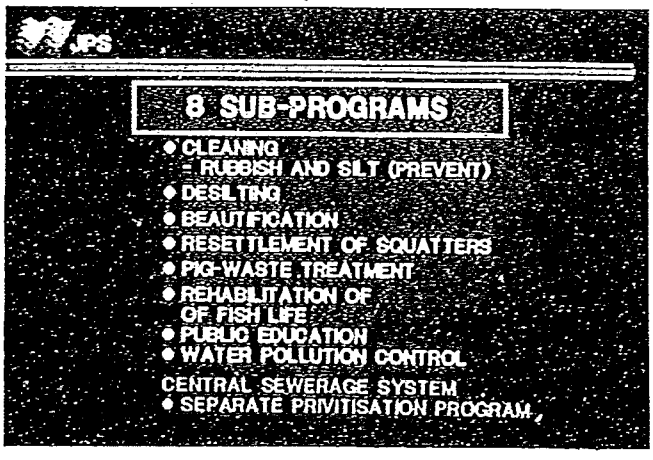
c)当該河川中にはより多くの水棲生物の生息を見ることができるだろう。

d)以前に不法居住者の住居、闇取引などの不法な商行為等でひしめいていた河岸は美しい歩道に生まれ変わり、造園技術を駆使した公園となっているだろう。

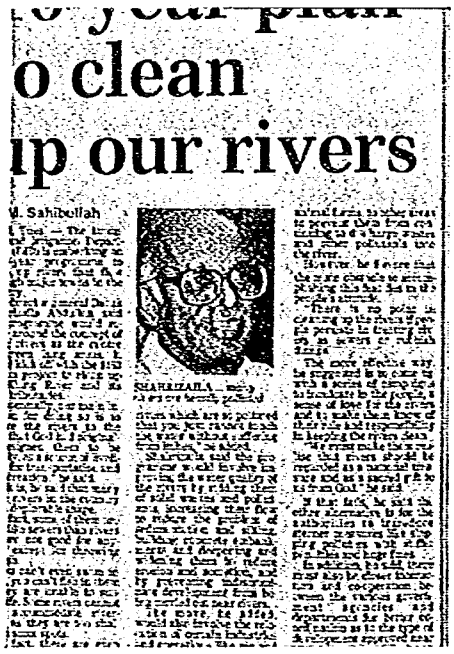
e)河川はボート、カヌー、釣り等のリクリエーションを楽しむことができるようになっているだろう。



図－1



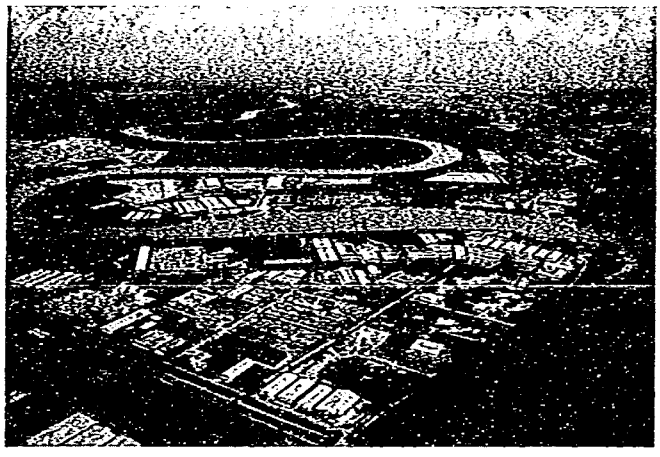
図－2



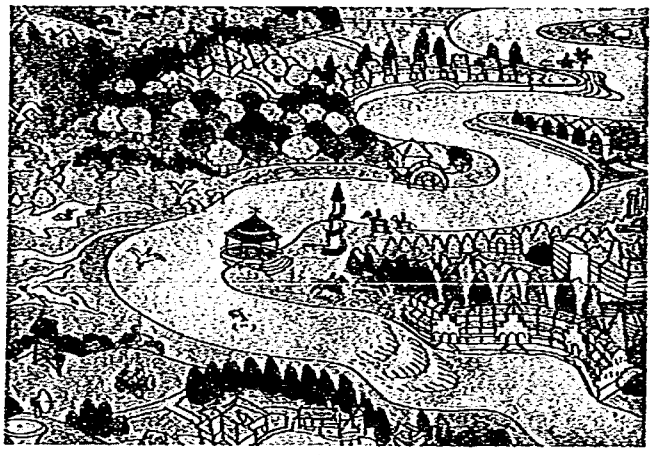
o clean
ip our rivers

M. Sahibollah

図－3



図－4



図－5

Ⅱ．現在、国策として特に力を注いでいる生活環境改善のための社会基盤整備（考え方、方針等）、それらを支える土木技術開発

同種の浄化計画を他の重要な河川、特に市街地を貫流しているペナン川、テミアン川、マラッカ川にまで拡大・適用することになろう。こうした努力は河川環境を大きく改善することになろうし、また国民の居住条件を大いに向上させることになろう。

「南ルソン高速道路計画」



フィリピン公共事業道路省研究基準局長
Jose H. Espiritu

Ⅰ．生活環境改善プロジェクトの概要

実施当局：　公共事業道路省
事業費：　1兆7,070億ペソ
資金源：　日本国、海外経済協力基金(OECF)による第16次円借款
道路延長：　47,746km

1．目　的

- 国内及び地域的経済を支え、成長を促し、また発展させるべく交通セクターにおける社会基盤を改善すること、及び
- 環境に与える影響を予測・評価し、対策、環境管理、監視（モニタリング）計画を提案すること。

2．概　要

自然環境に与えるマイナスの影響を最低限に抑え、公共用地ばかりではなくこれに隣接した地域で工事の影響を受ける地域の可及的速やかな復旧に資するための対策は以下の通りである。

土地の侵食防止及び法止め

a. 植生　- 一時的に植生をはぎ取られた地域については根覆いを行ったり、播種もしくは芝付けを行ったりなどして地表の地衣の維持管理を行う。

b. 法止め　- 掘削等による土壌の移動は最低限に抑え、植生地衣を施したり、コンタリング（等高線沿いに小段を設けたり擁壁を設けたりする工事）あるいは排水構造物等により法面の安定化を図る。

c. 浸透防止- 捨石もしくは蛇籠等を用いて洗掘が起こりそうな場所の堤防の安定化を図る。

d. 排水　- 側溝、カルバート、パイプ排水等を含む排水設備を設けて表流水を分水あるいは分散させて侵食を防止し、法面の保護を行う。それらは定期的に維持管理を行って機能の解除もしくは確実に機能するように計らう。

e. 大気特性- 露出している地表は溶け出したり砂塵となって大気中に浮遊するようになる。貯蔵土あるいは土取場の材料は砂塵が最小限になるよう安定化を図る。

水文学的影響

SLEEプロジェクトに含まれるさまざまな構成要素は地表水、地下水に直接に影響を与えることはない。高速道路沿いにおける各種産業もしくは商業活動の進展にともなって間接的な影響が出てくることはあるだろう。

大気特性

工事期間中においては、砂塵の飛散によって一時的に大気に影響を与える。土取場の土壌材料やトラック輸送の土壌材料については覆いを施す。

騒音

工事によって発生する好ましからざる影響の低減化は包括的に行うものとする。それには車両の使用、騒音の低減化、高速道路設計の改善、土地利用の管理等を含む。

土壌材料

土壌材料は丘陵地もしくは山岳地の既存の土取場を使用することですでに調査済みである。

洪水

排水構造物は侵食を避けるため放流点に並べて設け、拡散力を用いる。排水施設は定期的に維持管理が行われる。ボックスカルバートの敷設は過去50年間の洪水流量データに基づいて行われる。

廃棄物処理

コントラクターは工事にあたって固形廃棄物の処理計画を創案しこれを実施する。廃棄場所の選定にあたっては浸透を防止し植生に影響を与えないよう細心の注意を必要とする。環境に悪影響を与えるような廃棄物については、それら廃棄物を貯蔵できるように改良された特定の場所に貯蔵しなければならない。

3. 技術的課題

SLEE工事はいくつかの環境問題を発生せしめる。きたるべき経済活動の高度成長を考えるなら、しっかりした環境管理の方法を講じない限りこの問題に対処することはできない。加速の度合いを増しつつある都市化現象は地下水源に対してさらなる圧迫を加えることになろう。地下水の過剰揚水は他の水源を開発しなければ塩水の浸入という結果を招く。都市化の進展に伴う排水も、たとえば生活排水や工場汚水の受け皿として河川を利用することになる。これら考え得る間接的な影響は当該地域の都市計画における格別の管理法を必要とするだろう。

4. 生活環境改善へ期待される効果

プロジェクトはそれ自体、都市化に対して高い影響力を有しており、地域の潜在力、特に産業セクターのそれに対していっそうの拍車をかけることになろう。そして、マニラ首都圏とルソン南部との交易を通じて経済の発展を促す引き金になることは必至である。同様に、上述の環境に密接に関連する諸条件も下記の通り改善されることが期待される。

物理的環境

1. 法面、植生、浸透が十分に保護・防御される。
2. 大気特性が改善される。
3. 騒音公害が最小限に抑えられる。
4. SLEE影響圏を横切らない、もしくは圏内に位置しないので生態系が保護される。
5. 洪水は排水設備の敷設とその機能維持によって最小限に抑えられる。
6. 工事期間中の廃棄物は特定の場所に投棄・貯蔵される。

社会経済的影響

1. 土地の高度利用及び入植が促進される。
2. 雇用機会が創出され、所得の増大が図られる。
3. 公共サービスが改善される。
4. 大規模な交通需要に便宜を与える。

5. 考古学的・歴史的史跡の保護によって観光が促進される。
6. カラバルソン(CALABARZON)計画の輸送施設の要請に最終的に応えることになるバタンガス港と連結することができる

Ⅱ. 現在、国策として特に力を注いでいる生活環境改善のための社会基盤整備（考え方、方針等）、それらを支える土木技術開発

天然資源・環境省(DENR)は1987年にフィリピンにおける国家支援開発の戦略(PSSD)の策定に着手した。各社会階層からのそれぞれに異なったセクターとの一連の協議の末、PSSDの草案、形態及び要旨が1989年６月22日中央政府に提出された。このPSSD原案は1989年11月29日に最終的に承認された。

この天然資源・環境省(DENR)の作業に関連して、フィリピン大統領は1992年９月１日議会に対し国家支援開発のための行政命令第15号を出した。本行政命令は1989年に承認されたPSSDに盛り込まれていた国家自然保護戦略に方向付けを与えるものである。それは同時にフィリピン政府に対して、その国家支援計画の原則に忠実に、参加したリオデジャネイロで開催の地球サミットすなわち国連環境と開発に関する世界会議（UNCED)の場に持ち込むことを義務づけるものであった。これはリオ宣言とそのための行動計画であるアジェンダ21として公表され、気候変動及び生物の多様性に関する会議で議論された。

議会でのそうした動きに先立って、さまざまな環境関係の法案、布告、行政命令等が法規化されている。その主なものは以下の通りである。

1. フィリピン国保健衛生法規確立に関する大統領通達第856号（1975年12月23日）
2. 国家環境保全会議の創設に関する大統領通達第1121号（1977年４月18日）
3. フィリピン国環境政策策定に関する大統領通達第1151号（1977年６月６日）
4. フィリピン国環境法規策定に関する大統領通達第1152号（1977年６月６日）
5. 環境影響の公式表記体系の確立に関する大統領通達第1586号（1981年12月14日）
   これにはその他の環境管理関連の方策及び他の目的も含まれている。
6. 布告第2146号（1981年12月14日）
   これは大統領通達第1586号で制定された環境影響の公式表記体系の範囲内で環境に悪影響を及ぼす特定地域・特定タイプのプロジェクトを布告したものである。
7. 大統領通達第1586号で制定された環境影響の公式表記体系を実施するための改訂規定・規則を修正する天然資源・環境省(DENR)令第21号(1992年の一連)
   これらに応じて公共事業道路省は同省令第72号（1982年９月24日）を大統領通達第1151号に関して大統領通達第1586号で制定された環境影響の公式表記体系及び布告第2146号を実施するための規定・規則に関する公共事業道路省令として改訂した。

「シンガポール地下道路システム」



シンガポール国家開発省公共事業局土木技術担当課長
Khor Poh Hwa

Ⅰ．生活環境改善プロジェクトの概要

1.目　的

提案されている地下道ネットワークは以下のことを目的としたものである：

- 最低40%まで調査対象地域内における道路容量を引き上げ、交通渋滞を軽減し、交通ネットワークモデル地域内のサービスレヴェルD以下の道路を20%以下に抑える。
- 視界遮蔽物、騒音、排気量を最低限に抑え、もって道路容量の向上を図る。
- 歴史的建造物または建築学的に意義のある建造物、さらに既存の地上ルート、公園、村落・街区(コミュニティ)にかかる地下道ネットワークの影響を最低限に抑える。

2.概　要

地下道システムの最終目的はシンガポール政府の開発戦略を満たすことであり、全般的には「すばらしき熱帯都市」建設に資するための都市計画を支援することである。地下道建設に伴う環境や自然系へのマイナスの影響は極力許容できるレヴェルに抑える。検討された問題には以下のような各種の影響が含まれている。

国家的記念碑・記念建造物への影響
保護地区への影響
土地利用への影響
景観への影響
大気特性への影響
騒音・振動の影響

3.技術的課題

3.1 国家的記念碑・記念建造物は取り壊すべきではないが、この要求は設計においてはきわめて困難を伴うことも考慮される必要がある。対象地域内のいくつかの記念建造物は地下道ネットワークにきわめて近くに位置していたり、あるものは直上の地上に位置しており、それら工事期間中、補強工作が必要とされる。それら記念建造物に対する補強工作は主要な影響のひとつであるとの認識を要する。ある記念建造物は工事期間中、グラウティング（石積みなどの隙を埋める工事）突き固め、ブレイシング（筋かい、支柱）、あるいは土質改善等のような他のレヴェルの保護工事が必要となる。

3.2 保護地区内の建造物はすべて保護されなければならない。それらすべての保護地区のために以下のことが提案されている。

- それぞれの保護地区の建造物と周辺環境・雰囲気は極力これを保持する。

- 物理的環境は歩行者用舗道、広場、標識等を設置し、景観等を改良してこれを改善する。
- 新しい活動等を導入して各地域の特性を強調するとともに観光価値のある古くからの伝統的な活動とも整合性を保つ。
- 民間セクターをも積極的に巻き込んで保護活動を行えるように手引き書（ガイドライン）を準備する。

3.3 2000年及び2030年時点の土地利用計画における地下道システムの適合性はもっとも重要な要素のひとつである。地下道システムは調査対象地域へのアクセス（出入り）を改善することになり、現在進行中の開発計画を支えるものでもある。それはまた共同開発の機会を創設することにもなり、土地上空使用権開発の機会をも創設することになる。

地下道システムは基本的には既存の地上道路の地下に建設されるので、現在及び将来にわたり、対象地域内の地上の土地利用計画への影響を最小限に抑えて車両の出入りを改善することになる。地下道システムが既存の道路に追随しない場所については、将来の開発による負荷を考慮したトンネルを設計することもでき、従って土地の少ないシンガポールの貴重な土地をきわめて有効に利用することができる。

土地利用へのやむを得ない影響としてはトンネル建設に伴う以下のような地上施設が考えられる。

地下への出入り施設

換気設備

送配電ステーション

換気設備は新規開発とあわせることによって視界遮蔽と占有土地を最小限にすることが可能である。

4.生活環境改善へ期待される効果

4.1 視界・景観特性

地下道建設に伴うプロジェクトの下記のような各地上施設は視界環境の特性を変化させることになろう。また運転者や歩行者、住民にとっては見慣れた美観を改めさせることにもなる。

地下への出入り施設及び進入斜路（ランプ）

換気設備

送配電ステーション

これらの施設の設計に当たっては、その形状、構造物の材料、色彩、構造、景観等について格別の注意をもってこれを行わなければならず、またこれらの施設の総合的な景観効果を強調するよう互いに相補完しあうよう留意しなければならない。

4.2 大気特性

地下道ネットワークの大気特性への影響は車両交通によってもたらされるものである。地下道ネットワークの建設によって通常ベースの場合に比べて対象地域内の一酸化炭素の排気量を著しく減少（4％まで）させることができる。この一酸化炭素の減少は交通パターンそのものを変化させるほどのものとなろう。すなわち、ほぼ4万kg／日（もしくは14,000トン／年）の一酸化炭素(CO)を減少させることになるのである。この地域的な分析には土地利用に影響を及ぼしやすいそれぞれの地下への出入り施設及び換気施設におけるレセプター（排気ガス被曝者）による大気特性の推定も含んでいる。土地利用に影響を及ぼしやすい地下への出入り地区別分析には病院、

一般住居、教会、公園、さらにはもっとも人通りが激しくかつ車両の排気ガスが直ちに大気に影響を及ぼす地域として知られている場所も含まれている。換気設備の分析によれば、もっとも危険なレセプターは当該換気設備の構造物の排気ガス放出孔と同じ高さを有する建造物（内に住む人々）である。

潜在的な大気特性への影響を減少させるための方策としては以下のようなものが考えられる。

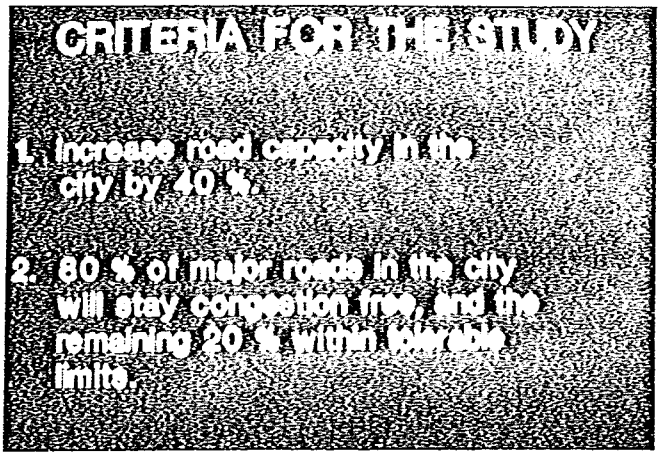
- 換気設備の排気ガス放出孔の高さを引き上げることによって周辺レセプターへの大気特性の彼らへの影響を減少させることができる
- 換気設備の排気ガスの単排気構造（シングル・ベント）をそれぞれを異なる高さにすることによって個々のレセプターへの大気特性の影響を最小限に抑えることができよう。
- 地下への出入り施設を公道用地に移設することによって、人通りで混雑する地域への影響を最小限にする。
- 地下への出入り施設周辺の将来計画を可及的速やかに立案することによって大気への影響を最小限にすることができる。

4.3 騒音及び振動

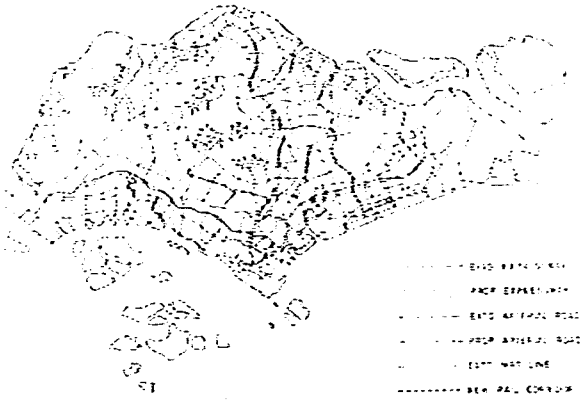
騒音問題は工事期間中の一時的影響と地下へ車両の出入りや、換気設備の稼働伴うもの及び地上を走行する車両から発せられるものといった長期的な影響とがある。土地の振動は通常工事関連のものがほとんどである。

騒音の緩和は地下への出入り施設に要求される場合が多い。その方策としては以下のようなことが考えられる。

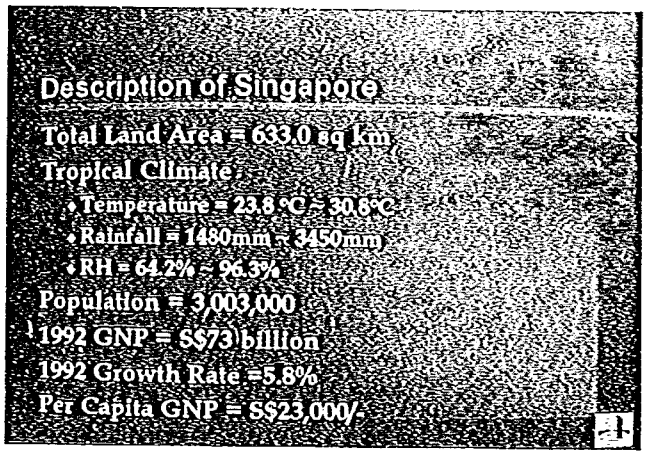
- 広範囲にわたって騒音遮蔽壁（ノイズ・バリヤー）もしくは植栽・植樹スクリーンを設ける。
- 地下への出入り斜路に吸音舗装を施す。
- 出入り斜路を延長するか騒音の影響を受けやすい場所から他へ移す。
- 斜路全体を覆ってしまう。



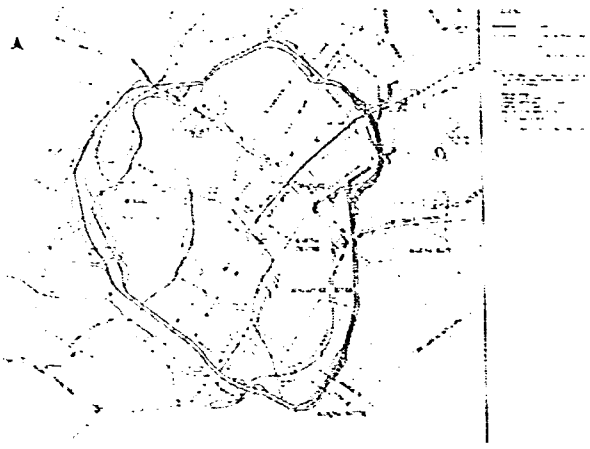
図－1



図－2



図－3



図－4

Ⅱ．現在、国策として特に力を注いでいる生活環境改善のための社会基盤整備（考え方、方針等）、それらを支える土木技術開発

緑化計画

環境省が推進してきたシンガポールの緑化計画は開発と環境のバランスのとれた戦略的な方向で立案されたものである。それはシンガポールが将来にわたって長期的に緑化モデル都市を目指すものであるとしており、緑化計画は関係あるすべての環境に目を向け、政府が環境について何をしてきたか、またそれらを保護し守り、環境の重要性を強調するためにどんな提案をしてきたかについて述べている。

緑化計画は2000年までにシンガポールを緑化モデル都市にしようとするものである。それは公衆衛生面と環境の質の面できわめて高い水準を有する都市ということになろう。緑化計画はまた地球的な規模の環境保護に対する国際的な努力をも支援するものであり、シンガポールは環境関連の国際会議やセミナーで積極的な役割を演じることにもなるだろう。

シンガポールは2000年までに環境の管理及び技術の面で地域的な拠点となろうとしている。環境技術に関する研究・開発のための施設が開発され、国内各組織や多国籍企業に対しては財政面で十分な支援体制を敷くよう勧奨している。1993年には環境技術研究所が新たに設立された。

「都市大気汚染対策」



タイ内務省公共事業局材料研究部長
Anusornant Mahavinichaimontri

Ⅰ．生活環境改善プロジェクトの概要

1.目　的

- 環境改善及び天然資源の継続的使用のための枠組を確立すること
- タイ国民の生活環境を改善すること
- 次代への遺産としての国の天然資源保護に資すること

2.概　要

発電、交通、各種工業等エネルギー集約的産業活動が集中した結果、タイの都市域における大気特性は悪化の一途をたどっている。バンコク広域首都圏（BMR)に限っても全国のほぼ75%の工業を擁しており、そのエネルギー消費量はタイ全土のほぼ58%にも達している。従って、首都圏は他の開発途上諸国と同じく、典型的な大気汚染問題に直面しているということができる。

その汚染源は二酸化硫黄（SO_2)、酸化窒素（NO_x)、一酸化炭素(CO)、ばい煙その他浮遊粒子（SPM)、及び車両エンジンによる鉛害等、燃料消費からくるものである。これら汚染源の長期的廃棄による高濃度化は呼吸器官への甚大な刺激等、人体にきわめて深刻な問題を引き起こす。1981年に全国循環大気特性基準(NAAQ)を設定、逐次これを改訂して国家環境委員会による監視を行ってきた。バンコクの主要道路付近を対象に1989年に実施した大気特性調査の結果をこのNAAQ基準と比較したところ、そのほとんどの場合、一酸化炭素(CO)、ばい煙その他浮遊粒子（SPM)、及び車両エンジンによる鉛害等の汚染源の濃度は基準を越えるものではなかった。

しかしながら、きわめて広範囲にわたって高濃度化が進んでおり、しばしば、特にばい煙その他浮遊粒子(SPM)については基準を越えるところもあった。

3.技術的課題

<u>交通に起因する大気汚染</u>

最大のエネルギー消費源としての交通がタイ国における最大の大気汚染問題の元凶であることが明らかとなっている。1990年度、交通による全エネルギー消費量のほぼ51%がバンコク首都圏（BMA)(バンコク広域首都圏：BMRの内部地域）のみにおけるものであった。1990年度交通エネルギー消費量のおおよそ75%は陸上交通によるものであり、その他は水上交通及び航空によるものである。陸上交通のエネルギー消費はそのほとんどが道路交通によるものである。鉄道交通によるエネルギー消費は全交通エネルギー消費量の１%に満たない。一方、バンコクの車両数は1980年度の60万台から1990年度の230万台へと急速に増加してきているのである。

図.1 は交通セクターにおけるエネルギー消費の状況を燃料別に示したものである。ディーゼルオイル及びガソリンがもっとも重要な燃料であることがわかろう。

交通セクターにおける主な大気汚染源は鉛害、一酸化炭素(CO)、酸化窒素（NO_x)、炭化水素及びディーゼルオイルや二気筒オートバイ・エンジンの不完全燃焼によるばい煙である。交通は唯一最大の酸化窒素（NO_x)と炭化水素の排出源である（酸化窒素については全排出量の87%を占めるし、炭化水素については同じく41%を占める）。バンコクにおける大気中の鉛のほとんどは車両エンジンの燃料に含まれる鉛なのである。二酸化硫黄(SO_2)、浮遊粒子（SPM)の高濃度化に対する交通セクターからの影響の度合いは工業や発電のそれよりも低い。

交通セクターに起因する大気汚染を軽減する方策としては排気ガス規制のみならず燃料やエンジンそのものの改良及び交通量を維持する道路網の整備も行わなければならない。

工業に起因する大気汚染

すべての工業はその生産プロセスにおいてエネルギーを消費する。多くの工業プラントはそれぞれ独自のボイラーや発電器をプラント内に備えており、それらは採掘燃料を消費している。図.2は工業セクターのエネルギー消費の状況を示したものである。生物残滓燃料及び石油製品が主要　燃料源であることがわかる。また、工業プラントエネルギー需要のほぼ18%は国の電力網からの電力購入でまかなっていることもわかる。

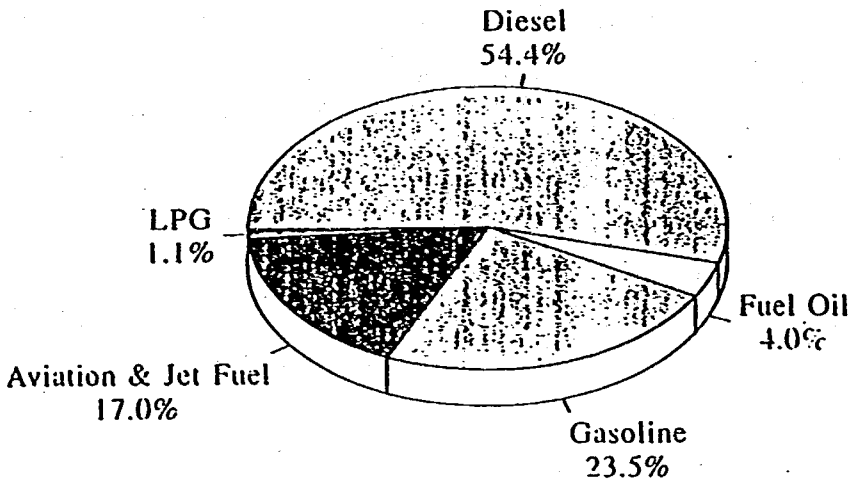
工業単独で二酸化硫黄(SO_2)全排出量の21%、酸化窒素(NO_x)については12%、ばい煙その他浮遊粒子(SPM)については何と全排出量の56%をも占めていることが明らかになっているのである（これについては工業は三つのセクターのうち最大の排出源となっている）。これらの数字には買電による間接的な大気汚染は含まれていない。工業のうちもっとも大気汚染に与える影響の高いものは非鉄鉱業(セメント工業、ガラス、陶磁器工業等)及び食品工業である。

発電に起因する大気汚染

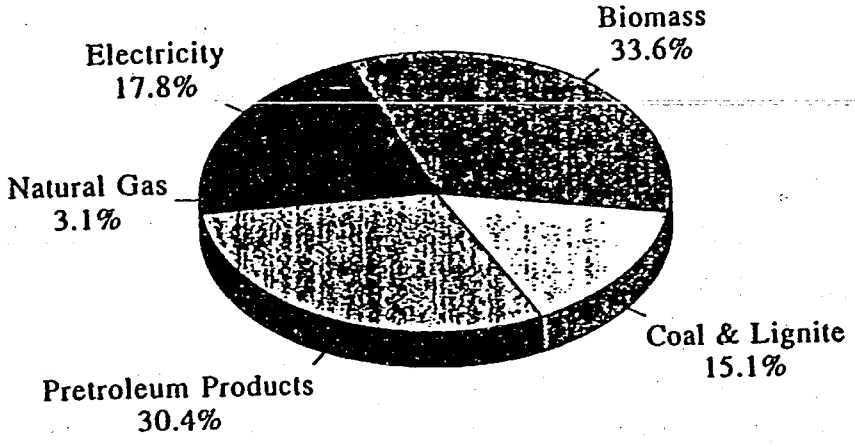
発電セクターは二酸化硫黄（SO_2)全排出量の56%、酸化窒素（NO_x)の16%をそれぞれ排出しているが、その他の汚染源については比較的少ない。現在、発電に供されている主な燃料は天然ガス(40%)、石油(29%)、及び亜炭(22%)である。石炭及び亜炭は、国内調達のできる資源をできるだけ用いようとする国の方針に沿ったものとして、発電におけるより重要な燃料源としての期待が高い。発電所における石炭及び亜炭の使用割合は1990年度における22%から2006年度には66%にまで伸びるものと推定されている。言うまでもなく、この燃料への切り替えは大気に排出する汚染源量の問題で論議を呼ぶことになろう。

4.生活環境改善へ期待される効果

バンコク及びタイ国内のいくつかの他の諸都市におけるエネルギー集約的産業活動の高度集中化はそうした地域における典型的な大気汚染問題を引き起こしてきた。タイ国政府は車両の動向が環境に与える影響を減少させるような方策に関する交通セクターにおける包括的な計画の策定を迫られている。工業及び発電のセクターについては、燃料油の硫黄含有量は減少しつつある。排出基準はすべての産業でいずれ徐々に受け入れられるだろう。各種制限もバンコク首都圏（BMA)及びその他の人口稠密地域における汚染発生源と目される工業にも受け入れられ始めている。エネルギー政策も電力需要低減のための各種方策が見直されつつあり、電力をより有効に利用するようにとの勧奨政策も受け入れられつつある。



図－1　1990年度の交通セクターにおけるエネルギー消費状況



図－2　1990年度の工業セクターにおけるエネルギー消費状況

Ⅱ．現在、国策として特に力を注いでいる生活環境改善のための社会基盤整備（考え方、方針等）、それらを支える土木技術開発

環境改善のための社会基盤増強に資する国家計画及び政府が推進する第六次全国経済・社会開発計画に関する特記すべきプロジェクトのひとつは以下の通りである。

(1) 環境開発の計画の内容を明確にし、これが実施面においてもより有効に機能するようにとの意図から、第六次計画期間中における環境開発のための指針（ガイドライン）は以下の４原則をその内容としている。

(1.1) 環境開発は可能な限り経済開発を支えるものでなければならない。

(1.2) 経済・社会開発計画と環境開発計画とをリンクするような、特に政府と民間セクター、地域組織、住民との関係を調整するようなシステムを確立しなければならない。

(1.3) より有効な実施を保証するため、運用計画の形で環境開発のための指針（ガイドライン）を策定しなければならない。

(1.4) 問題の発生を待つというよりも、実施に移す前に環境問題を考慮にいれた予防策に重点を置かなければならない。

(2) 第六次計画期間中における環境開発の方針は以下の諸項目からなる。

(2.1) 全体として環境開発計画は経済開発との調和を図る。

(2.2) たとえば、河川流域特性のカテゴリーを特定できるような計画を策定するとか、東部海岸地域やソンクラ湖流域を管理する等、特定の地理学的特性を有する地域ごとに環境計画を立案し、管理する。

(2.3) 環境に関する法、規則、規定を逐次改訂し、それらがさまざまなセクターにおける経済開発にとってより適正でかつこれを支えることのできるものにする。

(2.4) 環境事業に適合するように基礎的な行政機構を改善する。それには組織、環境専門家や支援体制、監視体制、研究調査、環境情報システム等の育成・創設も含む。

(2.5) 環境を破壊せず汚染問題をもたらさないで天然資源を有効に利用し得るような先進技術の使用を勧奨していく。

(2.6) 民間セクター及び一般大衆に対して正しい認識を勧奨し、環境問題に関する自覚を求める。彼らもまた可能な限り環境保護・推進事業に参加するべきだからである。

